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Rick Crosslin, teacher and writer
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The Children's Museum of Indianapolis

The Children’s Museum of Indianapolis is a nonprofit institution dedicated to providing extraordinary learning experiences for children and families. It is one of the largest children's museums in the world and serves people across Indiana as well as visitors from other states and countries. In addition to special exhibits and programs, the museum provides the infoZone, a partnership between The Children's Museum of Indianapolis and The Indianapolis-Marion County Public Library. The infoZone combines the resources of a museum with the services of a library where students can read, search for information and find the answers to their questions. Other museum services include the Dinosphere Web site that contains games, Webquests and other digital resources. Field trips to the museum can be arranged by calling (317) 334-4000 or (800) 820-6214. Visit the Teacher's section at The Children's Museum Web site: www.ChildrensMuseum.org

Acknowledgments

Dinosphere

Dinosaurs

Acknowledgments

Dinosphere

Dinosaurs
Dinosaurs 6 – 8
Unit of Study

Enduring Idea:
Fossils are clues that help us learn about dinosaurs.

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A fossil is a window into the past that offers students unparalleled learning opportunities.

Enduring Idea

Fossils are clues that help us learn about dinosaurs.

Why study fossils? Fossils are clues to the past. They are nature's records written in rock. A fossil is the remains, imprint or trace of an organism preserved in the earth's crust. To some people fossils are just curious natural oddities of little value. To scientists, fossils are a window into past geologic ages — the physical evidence and data used to test hypotheses and build theories that lead to better understanding of ancient life. When children hold fossils their imagination instantly transports them to a world where dinosaurs walked the earth. Fossils are powerful learning tools that motivate children to “read” the clues they offer about prehistoric plants and animals.

A Unit of Study for Grades 6 – 8

This unit of study is designed for teachers of Grades 6 – 8. A companion unit of study with different lessons and activities is available for Kindergarten and Grades 1 – 2 and another unit of study specifically for Grades 3 – 5. Lessons are designed to build upon each other. The lessons and activities can be completed with classroom resources and library books and by visiting The Children's Museum Dinosaursphere Web site. The best way to promote science learning in your class is to take a field trip to Dinosaursphere and complete the unit of study.

What's Ahead

Lesson One

Dinosaurs 101 — Fascinating Animals From the Past

Students learn what fossils are and the special conditions needed to form them. They also make a fossil cast. Students learn how the many different types of dinosaurs are named and classified.

Lesson Two

Dinosaurs — Rulers of the Cretaceous

Students analyze how animals live in groups and the ways dinosaurs may have interacted. Students explore dinosaur theories and learn how paleontologists and other scientists make dinosaur discoveries. Students use The Children's Museum Webquests to investigate dinosaur topics.

Lesson Three

Culminating Experience — Scientific methodosaurus

Students use scientific methods to learn about dinosaurs. Students select dinosaur questions to use in a presentation following a scientific method. Students use digital resources to create reports and audiovisual presentations.

Indiana’s Academic Standards

This unit of study helps students achieve academic standards in:

- science
- language arts
- math
- social studies

Specific Academic Standards are listed with each experience. A complete list of the Indiana Science standards and indicators are included along with the National Science Standards in the resources section at the end of this unit.
Getting started

Children love dinosaurs because they are evidence that strange, fantastic worlds can exist. Imagination and reality come face to face when a child looks into the eyes and jaws of *Tyrannosaurus rex*. What did it eat? How did it move? Was it real? What does its name mean? How long ago did it live? These questions make children and scientists alike want to find out more. The best reason for studying dinosaur fossils is to provide students, teachers and parents a unique opportunity to use science to answer questions and solve problems. Science can be used to make observations, collect data, test ideas and draw conclusions about the dinosaurs’ world.

Indianapolis dinosaurs?

Why aren’t dinosaurs found in Indiana? Students often ask this question. Dinosaurs probably lived in Indiana long ago, but several major changes in climate have occurred in this state since the end of the Cretaceous. Large glaciers scoured, scraped and eroded the surface and bedrock of Indiana, where dinosaur bones may have been deposited. When the climate changed the melted glaciers produced tremendous quantities of water that moved sediments, soil, rocks and fossils out of the state. Fragile fossils cannot survive the strong natural forces that have shaped the Hoosier state. The youngest bedrock in Indiana, from the Carboniferous Period, 360 – 286 million years ago (mya), is much older than the Mesozoic Era fossil beds of the dinosaurs, 248 – 65 mya. Thus fossilized dinosaur bones have not been found in Indiana.

Science class environment

In *Dinosaur* students explore dinosaurs and fossils from a scientific perspective. Instead of just learning words, ideas and facts, they use science to build understanding. In this unit students are encouraged not just to learn about what someone else has discovered but also to try their discovery on their own — to explore the world using tools with their own hands. Reading, writing and math are essential elements of this scientific method. Students ask questions, make hypotheses, construct plans, make observations, collect data, analyze results and draw conclusions. A good science program provides experiences that offer an opportunity to learn in a unique manner. This unit of study combines the scientific method with hands-on experience.
Dinosaur classroom
You can enhance the study of dinosaurs by creating a “Cretaceous Classroom.” The Children’s Museum Store is a great place to find dinosaur books, puzzles, posters and models to outfit your learning space. Bookmark the listed Web sites on classroom computers. Create different areas in the room for exploration. Ask students to create artwork to show where dinosaurs lived. Create a space where students can add to a dinosaur mural as they learn more about these fascinating creatures. Post in your room a Vocabularyaurus section for new words to learn. Other great sources for turning your classroom into a prehistoric adventure area can be found at The Dinosaur Farm (http://www.dinosaurfarm.com/) and The Dinosaur Nest (http://www.the Dinosaurnest.com/).

Literature connection
Many outstanding dinosaur books, magazines, paperback books, videos and models are listed in the resources at the end of this unit. Two separate book lists are included: those specifically about plants and animals of the Cretaceous Period, and titles appropriate for a classroom library. In addition, annotated books are listed with each lesson.

Dino Diary
Students use a Dino Diary to write words and sentences, take notes, make drawings and record the data they collect during the lessons. At the end of each activity students are asked to respond to the following Dino Diary writing prompt, “Today I discovered …” Each experience ends with a writing component in the science journal. Two styles of templates are provided in the resource section of this unit.

Dinosphere link
Plan a field trip or get more information via the Web site. www.childrensmuseum.org. A museum visit provides extraordinary learning opportunities for students to explore the world of dinosaurs. Museums serve as field trip sites where fossils and immersive environments help motivate visitors to learn more about the world. The Children’s Museum Dinosphere provides a doorway into the Cretaceous Period, where visitors come face to face with dinosaurs. Visitors will see real dinosaur fossils in lifelike exhibits, discover how fossils tell stories about the past and learn the latest findings from the world’s top paleontologists. More information, including Webquests, can be found at The Children’s Museum Web site. In addition, many of the print selections listed in the unit are available through InfoZone, a branch of the Indianapolis-Marion County Public Library located at The Children’s Museum. For teaching kits and other hands-on classroom resources, see the Web site for the Teacher Resource Center at I.U.P.U.I. For more information to to www.clin.iupui.edu. Then go to “Community and Business Outreach.” On the side menu, click on “Teacher Resource Center.”
Lesson 1: Dinosaurs 101 — Fascinating Animals From the Past

Get ready to dig

In this lesson students learn what fossils are and how they form. They explore how fossilized bones are assembled to form skeletons. They also learn that by studying fossils they can learn clues about the lives of dinosaurs. Students will learn the unique conditions that must occur in order for a fossil to form. It is amazing to realize that the fossilized neck bone of the Maiasaura was once part of a living, breathing dinosaur millions of years ago. By understanding how fossils form, students learn about the Cretaceous Period and how a living dinosaur became a fossil. Students learn that a dinosaur is named by three criteria and that each part of a name has a meaning. Students create new dinosaur names and decode real names using Greek and Latin words. The lesson focuses on the way we name dinosaurs after unique body parts or behaviors.

How do fossils form?

Only a small number of living plants and animals become fossils. Other animals eat most dead plants and animals. Some, however, are shrouded in mud or sand. Those covered over many millions of years hardened and turned to stone. More recently, wind, water and sun have slowly eroded the rock, exposing the hidden fossilized remains. Specific conditions are required for fossils to form. Plants and animals in areas of mud, sand, ash or other sediments are most likely to become fossilized. Once the plant or animal is buried and the sediment has hardened, other factors play important roles in fossil formation — oxygen, sunlight, microorganisms, permineralization and other geologic forces. Even with millions of years to form, a fossil is still the result of a rare and unique process.

Extinction

What happened to the dinosaurs? Students learn reasons why dinosaurs are not alive today. They learn that paleontologists use fossil clues and observations to understand dinosaurs. Students will also learn why some scientists believe that dinosaurs may be related to today’s birds. Students role-play to learn about the life discoveries of famous paleontologists.

Paleontologists

Sir Richard Owen, Robert Bakker and Barnum Brown are dinosaur hunters whose discoveries rocked the world of paleontology. In this unit of study students learn about the people who have discovered and named dinosaurs. Students learn that paleontology draws upon a diverse group of scientists. Through research and reports students learn about the skills and educational background needed to be an official fossil hunter, a paleontologist.

Where do people find fossils?

Fossils can be found all over the world, but some of the best dinosaur fossils are found in dry climates where the land has eroded to expose sedimentary rock. Western North America is a great place to look. Many dinosaur fossils (including Tyrannosaurus rex) have been found there.

Who digs fossils?

Paleontologists are scientists who study fossils and ancient life. They need help from volunteers and students to excavate or dig up fossils. In fact, one of the best-known fossil sites is the Ruth Mason Dinosaur Quarry in South Dakota. Ruth Mason picked up fossils on her ranch when she was a girl, yet it took years to convince others of her amazing discovery — a bone bed filled with thousands of fossilized dinosaur bones! Many of the bones prepared in the Dinosaur Paleo Prep Lab came from the Ruth Mason Quarry.

Fossils must be found and preserved quickly before natural forces of erosion — wind, water and sun — destroy them.

Visit The Children’s Museum Web site to learn how specific dinosaur fossils became part of Dinosaur. Look at the Dino Institute Teacher Dig to see Indiana teachers explore, dig and discover real dinosaur fossils.
Dinosaurs 101 — Fascinating Animals From the Past

EXPERIENCE 1

How a Dinosaur Fossil Forms

Indiana Academic Standards

Science — 6.2.5, 6.2.7, 7.3.8, 7.7.2, 8.2.6
Language Arts — 6.4.1, 6.4.5, 6.4.9, 6.5.2, 7.4.1, 7.4.4, 7.4.5, 7.4.9, 7.5.5, 8.4.1, 8.4.4, 8.4.5, 8.4.9
Social Studies — 7.3.7, 8.3.4

Focus Questions

- How does a fossil form?
- Can fossils be made today?
- What are bones and skeletons?
- Are the most deeply buried fossils the oldest or the youngest?
- What can be learned by comparing fossils?
- What can be learned about a dinosaur fossil?

Objectives

Students will:

- List some conditions that are needed for fossils to form.
- List, observe and examine different types of fossils.
- Compare and contrast, make drawings and write about fossils.
- Write about and draw the necessary steps for a fossil to form.

Vocabulosaurus

- fossil — Latin for “dug up,” evidence of past life, the remains or traces of plants and animals that have turned to stone or rock.
- adaptation — a body part or behavior that produces an advantage for the animal. This could be feathers, fur, scales, teeth or beaks, or migration and hibernation.
- model — a representation that is both like and different from the real thing.
- erosion
- expose
- sediments
- life
- death
- extinct
- mold
- imprint
- cast
- plaster
- resin
- magnifying lens
- centimeter ruler
- positive
- negative
- tooth
- prey
- carnivore
- dinosaur
- Tyrannosaurus rex
- Triceratops horridus
- Hypacrosaurus
- Gorgosaurus
- Maiasaura

Dig tools

Paper, pencils, art supplies, construction paper; a cast of a dinosaur tooth; seashells, leaves, pennies; pictures of fossils; fossil and dinosaur reference books.

How a dinosaur fossil forms

- Set up all materials on a supply table.
- Show and describe a fossil and pass it around the room.
- Ask the following questions: What is this? Have you seen anything like it before? What? Describe the fossil. How long is it? How heavy is it? Where did the animal live? How did it live? How did it die? Are fossils found in Indiana?
- Use the Internet or books to learn more about how a fossil is formed. Describe each step and write key words or draw a picture on chart paper. Emphasize that several conditions must occur for a fossil to form. Fossils are rare. Most plants and animals in the world end up inside other animals as food. Make the connections among fossils and sediments and sedimentary rocks — fossils form when sediments cover the original organism.
- Give construction paper to each student. Have them fold the paper into six parts — one fold down the middle and two across — and number each section of the paper.
- Using the flow chart How a Fossil Forms as a guide, create captions for each square. Write declarative sentences on the board for students to copy in their charts. Ask students to select one of the dinosaurs found in Dinosphere as the subject of the project.
- Have students draw a picture for each of the six boxes, and then write a description. Students then share their completed projects with each other.
**Dino Diary**

Students draw pictures and write words and sentences to describe how a dinosaur becomes a fossil. Other questions they may answer in their diaries include: Where would fossils form today? Are there fossils in Indiana? What part of an animal or plant rarely becomes a fossil? What parts turn into fossils? Can anyone find a fossil? End the class period with writings and drawings under “Today I discovered…” in their diaries.

**Dino books**


---

**How a Dinosaur Fossil Forms**

<table>
<thead>
<tr>
<th>Step 1: Life</th>
<th>The dinosaur is alive and growing.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 2: Death</td>
<td>The dinosaur dies.</td>
</tr>
<tr>
<td>Step 3: Sediment</td>
<td>Sediments quickly cover the dinosaur.</td>
</tr>
<tr>
<td>Step 4: Time</td>
<td>Over a long time more sediments settle on the dinosaur.</td>
</tr>
<tr>
<td>Step 5: Fossilization</td>
<td>Water, sand and minerals fossilize the dinosaur.</td>
</tr>
<tr>
<td>Step 6: Exposure</td>
<td>The fossil remains are revealed and found after wind and water remove layers of sediment.</td>
</tr>
</tbody>
</table>

---

**Make it fossilize**

Students describe one or more conditions for a fossil to form, and complete the chart on how a dinosaur fossil forms. They can write words and sentences or create drawings for each step in the formation of a fossil and can put the steps in order. They understand that other fossils form in the same way. They know that not all animals become fossils and that a fossil does not have all of the parts of the living animal or plant. They can list examples of when an animal does not become a fossil. They understand that fossils are rare and can give an example of one that can be used to learn about the past. They can make drawings to show how objects become buried in sediments, and can explain why the object on the bottom is the oldest. Challenge students to answer the following question: Why have no dinosaur fossils been found in Indiana?

---

**Dino Web sites**

- The Children’s Museum — Dino Institute Teacher Dig 2003
  - [http://www.childrensmuseum.org/dinodig/overview.htm](http://www.childrensmuseum.org/dinodig/overview.htm)

- Museum of Paleontology, University of California, Berkeley
  - [http://www.ucmp.berkeley.edu/index.html](http://www.ucmp.berkeley.edu/index.html)

- Enchanted Learning — Comprehensive e-book about dinosaurs
  - [http://www.zoomdinosaurs.com](http://www.zoomdinosaurs.com)

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*When a dinosaur dies the remains change several times before the fossils are formed.*
How a dinosaur fossil forms — step by step

**Life:** Dinosaur is alive.
- Dinosaur is eaten or rots. No fossil is made.
- Dinosaur is located where correct conditions exist. A fossil may form.
- Dinosaur is quickly buried. A fossil may form.

**Death:** Dinosaur dies.
- Dinosaur is covered by sand, mud, ice, ash or other sediments.
- Dinosaur is covered slowly or incompletely. No fossil is made.
- Dinosaur is disturbed and uncovered. No fossil is made.

**Sediment:** Dinosaur is covered by sand, mud, ice, ash or other sediments.
- Dinosaur is covered slowly or incompletely. No fossil is made.
- Dinosaur is disturbed and uncovered. No fossil is made.

**Time:** After much time more sediment covers the organism.
- Dinosaur is disturbed and uncovered. No fossil is made.

**Fossilization:** Conditions exist for fossilization, recrystallization and/or permineralization to occur: temperature, pressure, acidity, chemicals, moisture and sediments. Water seeps into the organism and over time it decays and is replaced by other minerals.
- Dinosaur is not located where conditions can cause fossilization. No fossil is made.
- Natural forces of erosion — water, wind and ice — carry the dinosaur fossil away. A fossil formed but was destroyed.
- Human forces such as construction and water dams break apart and/or move the dinosaur fossil. A fossil formed but was destroyed.

**Exposure:** Erosion exposes the fossil.
- Erosion or human activity exposes the fossil and it is discovered.

A fossil is formed, discovered and collected.

**Paleo-points for the teacher**

Use the following steps to aid in understanding how a fossil forms. Use a fleshed-out (one that shows skin and muscles) dinosaur model and a model of a dinosaur skeleton. Go through each step to demonstrate how the dinosaur could become fossilized if all of the required conditions are met. The conditions necessary to form fossils can change at any time, which is why fossils are rare.

What happens when The Children's Museum finds a fossil?

It's fun but not easy to get a fossil out of the ground and into the lab for preparation. The first thing scientists do when they find dinosaur fossils is to make a map of the site in order to keep track of where every fossilized bone was found. Then they start digging. Fossilized bones are wrapped in plastic field jackets to keep them snug for shipment to the lab. Scientists also like to study the matrix of rock around the fossilized bones for clues. When all of the fossilized bones have been cleaned and reassembled, scientists must determine a way to display the skeleton. Often they make a special frame that holds all the fossilized bones in place. If there are missing bones, scientists make plastic and rubber casts of fossilized bones from other dinosaur skeletons. Then they decide how the skeleton will be posed — running or standing still, eating or fighting? The result is an amazing display!

**Bonus: Digging deeper!**

**Dinosaur skeletons**

Visit the Dinosphere Web site to see amazing skeletons of fossilized dinosaur bones. The Children's Museum dinosaur skeletons are unique because real fossilized bones are on display. Fossilized bone is much heavier than the cast replicas used in some exhibits. The real fossils are displayed so that visiting scientists can remove individual specimens for study. The museum replaces a borrowed fossil with a cast replica, allowing visitors to enjoy and learn from the exhibit while scientists examine the real fossil. Fourteen dinosaur skeletons are on display in Dinosphere. All but Stan the T. rex, one baby Hypacrosaurus, one Prenocephalops and the two Bambiraptor specimens contain real fossilized bones. Bucky, made from real fossilized bones, is a unique skeleton of a teenage T. rex. In this experience students explore how casts of fossilized bones are created and used to learn about dinosaurs. Students make observations, draw diagrams and share their findings. They make a clay mold to create a plaster copy of a real fossil.

For 65 million years this bone was preserved underground. Now foil and plaster protect it until it can be prepared.
What did dinosaurs eat?

Were they meat-eating carnivores or plant-eating herbivores? It is not easy to determine what dinosaurs ate. In some cases scientists have actually found the fossilized bones of the last animal a dinosaur consumed before its death. Some meat-eating dinosaurs were found with the fossilized bones of other dinosaurs located where their stomachs would have been. Other dinosaurs have been found with fossilized bones of their own species where their stomachs would have been. This means some dinosaurs may have eaten their own kind. On the other hand, a duck-bill dinosaur called Edmontosaurus was found with bark, pine needles and conifer cones inside its ribcage.

Dinosaur dung

This is a perfect opportunity to use science vocabulary to set the mood for class discussion on unpleasant topics. Using the word “dung” or “feces” lets students know that it is acceptable to talk about bodily functions in a mature and scientific way. Coprolites are the fossilized feces or digestive wastes of dinosaurs. Only on rare occasions have the coprolites been found “inside” a dinosaur skeleton. Coprolites have been found around the world and come in different sizes and shapes. Fossilized dinosaur bones, lizard bones and plant materials have been found in the coprolites. Much of the information about the diet of dinosaurs comes by indirect methods. Scientists can study the shape of fossilized dinosaur teeth and rib cages to compare them with those of modern animals. For example, the beak of a Triceratops like Kelsey suggests that it was a plant eater. The beak would be perfect for snipping off vegetation. The flat teeth of the duck-bill dinosaurs were made to grind plants. A plant eater would also need a large rib cage to support a stomach large enough to digest the plant materials. Living reptile carnivores, meat eaters, have flat, knife-shaped teeth with serrations. This helps them hold on to and cut and saw into the flesh of other animals. A large lizard has teeth that make it easy to cut through animals with thick or tough skins. Some modern reptiles, such as the crocodile, have spear-like teeth without serrations. These are used to grasp slippery fish or larger land animals. These two types of teeth are similar to those of Tyrannosaurus and other meat-eating dinosaurs. Modern birds of prey have sharp claws or talons much like Tyrannosaurus but on a much smaller scale.
EXPERIENCE 2
What’s in a Dinosaur Name?

Focus Questions
• How is a dinosaur named?
• What does the name mean?
• Can new dinosaur names be created?
• Can words be broken into parts that have meaning?

Objectives
Students will:
• Name three different ways dinosaurs are named.
• List dinosaurs and the body parts they are named after.
• List one or more new dinosaur names by a body part.
• Use an apparatus to decode real and created dinosaur names.

Get ready to dig

Dinosaurs are a special group of animals with interesting names that often are long and hard to pronounce. Students are empowered when they can pronounce these multisyllabic names and know what they mean. Dinosaurs are named for unique body parts or behaviors, for the location where they were found or after a person. This makes for some fun and confusion! The Edmontosaurus was originally found in and named after a layer of rocks near Edmonton, Canada. So an Edmontosaurus is the dinosaur from Edmonton. Ask students if they can guess where you might travel to dig up an Argentinosaurus. They should be able to tell you Argentina. Other dinosaurs are named after famous people or for the lucky person who found them. Who do you think the dinosaur Jenghizkhanosaurus was named after? The answer is Genghis Khan.

Paper, pencils, scissors; drawings of dinosaurs; Dino Diaries; dino word strips; What’s in a Dinosaur Name? chart, pages 14 – 15. Additional Greek and Latin words are located in the reference section, pages 87 – 88.

Vocabulosaurus
• Greek and Latin words — Scientists use many of these words and word parts to describe plants, animals and the world. Many word parts are included in this lesson. The focus is on the following:
  • uni
  • bi
  • tri
  • rex
  •odon
  • mega
  • micro
  • saurus
  • ped
  • ops
  • cephal
  • cerat
  • rhino
  • tyrant
  • vore

Discovery of an imprint of Edmontosaurus skin is a significant and rare find from The Children’s Museum’s Dino Institute Teacher Dig 2003 in South Dakota.
DIG IN ...

What’s in a Dinosaur Name

Part 1 — Science names

- Ask students to name any dinosaurs they can think of. Make a list of their responses. Use the reference section of this unit of study to list the Dinosaur dinosaurs. Ask students to use their Dino Diaries to draw a picture and write the name of their favorite Dinosaur dinosaur. If they cannot name a dinosaur use Kelsey the Triceratops for the lesson. Ask them if they know what the dinosaur name means. Several students will know that Triceratops means “three-horned” dinosaur. Write the name and the word parts on the board and ask students to copy it in their diaries. (Greek kerat or cerat = horned)
- Tell students that scientists and other students name dinosaurs in three different ways. Write the following on the board:
  - Dinosaur Name
  - (1) body part or behavior
  - (2) where found
  - (3) person — finder or famous.

In Dinosaur there are examples of all three types of dinosaur names. Kelsey the Triceratops horridus is named after body parts. The Lambeosaurus, a duckbilled cretaceous dinosaur, is named after a person. It is named in honor of Lawrence Lambe, an early Canadian fossil hunter. The Edmontosaurus annectens is named for Edmonton, Canada, where it was found.
- List on the board the following words and their meanings: uni – one, bi – two, tri – three, quad – four, cerat – horn, rhino – nose.
- Ask students how many horns a “Quadceratops” will have. Since quad means four, the answer is four horns. Ask students to make as many different types of combinations of the words on the board as they can. Have them draw a picture of the head of their new dinosaur that shows the correct number of body parts for the name. Ask them to write sentences to describe their dinosaur. For example, “My Quadceratops has four horns.”

Part 2 — Create a Dinosaur Name

Students will create a genus name using the What’s in a Dinosaur Name? worksheet.
- Make copies of the What’s in a Dinosaur Name? worksheet. Students can cut the three word strips apart. Each strip contains a list of Latin and Greek words they will use to create a genus name for a dinosaur. Then cut along the dotted lines of the skull drawing. Slip each of the three strips into the slots in the skull.
- Have students move each strip up and down to make new names, then write the names they create in their Dino Diaries. They can start by using two strips and add the third strip as their skills improve. Make sure they leave a blank space for the species name of their dinosaur.
- Ask them to follow the same rules that scientists use when they name a dinosaur species. The species is named after a place or a famous person. For example, the four-horned dinosaur that might be found in Indianapolis becomes Quadceratops indianapoliensis.
- Students create new names and list them in their Dino Diaries. Use the What’s in a Dinosaur Name? chart to help decode real dinosaur names.
- A larger list of Greek and Latin word parts used in science can be found in the reference section of this unit of study on pages 87 – 88. Use these words to make more dinosaur names. Have students share their new names with the class. Make three blank strips where students add the new words. Ask students to include at least one real dinosaur name in their list. As each student shares his or her list, the class should try to determine which dinosaur names are real and which are made up.
- Read aloud to the class Dr. Robert Bakker’s When to Capitalize and Italicize Dino Names - T. REX — No! T. rex — Yes! on page 19. Ask students to research and identify by the scientific name several common plant and animal fossils found in Indiana.
What's in a Dinosaur Name?

Name: ___________________________________________

Cut apart the dinosaur name strips on this page. Slide the name strips into the *Tyrannosaurus rex* What's in a Dinosaur Name? skull worksheet. Move the strips up and down to create dinosaur names. You can make names of dinosaurs that are in *The Children's Museum Dinosphere*. For example, try *Triceratops*, which means three-horned face. Find the three name strips for tri, cerat and ops.

### Word Parts

- **uni**
  - one
- **tria**
  - three
- **tyrant**
  - terrible
- **bi**
  - two
- **mega**
  - big
- **cerat**
  - horn
- **rhino**
  - nose
- **cephale**
  - head
- **ped**
  - foot
- **micro**
  - small
- **vore**
  - eat
- **odon**
  - tooth
- **ops**
  - face
- **saurus**
  - lizard
- **rex**
  - king
What's in a Dinosaur Name?

Name: ____________________________________________

Cut along each dotted line.
Lesson 1
Grades 6 – 8

Make it fossilize

Students can list the three ways dinosaur names are created and can use 10 or more Latin and Greek words to describe a dinosaur. With practice students will be able to use the What's in a Dinosaur Name? chart to decode actual dinosaur names found in Dinosphere. They should be able to recreate Triceratops horridus and T. rex using word parts from the worksheet.

Dino Web sites

Dinosphere link on The Children’s Museum Web site
http://www.childrensmuseum.org

Museum of Paleontology
http://www.ucmp.berkeley.edu/index.html

Enchanted Learning — Comprehensive e-book about dinosaurs
http://www.zoomsdinosaurs.com

Dino books


Paleo-points for the teacher

Classifying Plants and Animals

Scientists classify all plants and animals including dinosaurs using the binomial system created by Swedish naturalist and physician Carolus Linnaeus (Carl von Linné) in the 1750s. The binomial, or two-word, system uses one Latin or Greek word to represent the genus and another word for the species. The system uses the following major divisions to classify plants and animals:

**Kingdom – Phylum – Class – Order – Family – Genus – Species**

An easy way to remember the divisions is with this phrase: **Kids Please Come Over For Great Science!** Dinosphere dinosaurs are classified with this system. The complete listing can be found in the reference section of this unit of study.

Science names

The Englishman Richard Owen first used the word *dinosauria* in 1842. It is made from *dino*, which means terrible, and *sauros*, which means lizard. Put together, the words mean “terrible lizard.” A dinosaur that appears to be fast (*veloci*) and able to steal (*raptor*) eggs or other food is named *Velociraptor*. These dinosaurs are named after body parts or behaviors. By learning a few Latin or Greek words students are able to understand how dinosaurs are named. Students will learn that there are also nicknames for plants, animals and dinosaurs. For example, in Dinosphere the *Triceratops horridus* is nicknamed Kelsey, while Bucky is the nickname of one *T. rex*. A plant or animal may have a nickname and a common name as well as a scientific name.

Bucky and Stan – *Tyrannosaurus rex*

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Animalia (animals)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phylum</td>
<td>Chordata (animals with spinal nerve cords) Subphylum Vertebrata (chordates with backbones)</td>
</tr>
<tr>
<td>Class</td>
<td>Archosaurus (“ruling reptiles”) Subclass Dinosauria (extinct reptiles, “terrible lizards”)</td>
</tr>
<tr>
<td>Order</td>
<td>Saurischia (lizard-humped) Suborder Theropoda (beast-footed)</td>
</tr>
<tr>
<td>Family</td>
<td>Tyrannosauridae (tyrant lizard)</td>
</tr>
<tr>
<td>Genus</td>
<td><em>Tyrannosaurus</em> (tyrant)</td>
</tr>
<tr>
<td>Species</td>
<td><em>rex</em> (king)</td>
</tr>
</tbody>
</table>

Kelsey – *Triceratops horridus*

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Animalia (animals)</th>
</tr>
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</tr>
<tr>
<td>Order</td>
<td>Oviraptoris (beaked, bird-hipped plant-eaters) Suborder Marginocephalia (fringed heads)</td>
</tr>
<tr>
<td>Family</td>
<td>Ceratopsidae (frilled dinosaurs, including horned dinosaurs)</td>
</tr>
<tr>
<td>Genus</td>
<td><em>Triceratops</em> (three-horned face)</td>
</tr>
<tr>
<td>Species</td>
<td>horridus (horrible refers to the horn)</td>
</tr>
</tbody>
</table>

Dino Diary

At the end of each class period students write or draw pictures under the heading “**Today I discovered ...**” in their diaries. The diaries will include notes and lists of dinosaur names from the lessons as well as pictures and drawings of real and created dinosaurs. Students should have written several new words and sentences that use the dinosaur names. Ask students to create a classification chart similar to the ones used to classify Kelsey (*Triceratops horridus*) to classify a dinosaur of their choice.
## Classifying Kelsey — A Dinosphere Dinosaur

<table>
<thead>
<tr>
<th>All Organisms</th>
<th>Plant Kingdom</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fungi Kingdom</td>
</tr>
<tr>
<td>Animal Kingdom</td>
<td>Protists Kingdom</td>
</tr>
<tr>
<td></td>
<td>Bacteria Kingdom</td>
</tr>
</tbody>
</table>

### Animal Kingdom

- Invertebrates (95% of all animals do not have backbones), Porifera, Nematoda, Arthropoda, Arachnida, Mollusca, Cnidaria, **Chordata** (5% of all animals have backbones), and other phyla.

### Chordata Phylum

- **Vertebrata**
  - **Subphylum**
    - **Archosauromorpha**
      - **Class**
        - **Archosauria** (living reptiles — Testudines/Chelonia (turtle/tortoise), Squamata (lizards/snakes), Crocodylia (crocodiles, alligators/caymans).
        - **Nonliving extinct reptiles** — Pterosauria (winged reptiles), Plesiosauria and Ichthyosauria (marine reptiles) and other orders.
        - **Dinosauria subclass** ("terrible" lizards from the Mesozoic Era)

### Dinosauria Subclass

- **Ornithischia**
  - **Suborder**
    - **Marginocephalia** Suborder (thick-headed reptiles), **Ceratopsidae Family** (horn-faced) and others

### Genus Triceratops

- **Species horridus**
  - **Triceratops horridus**

This makes Kelsey an organism in the **Animal kingdom**, in the phylum **Chordata**, subphylum **Vertebrata**, in the class **Archosauria**, subclass **Dinosauria**, in the order **Ornithischia**, suborder **Marginocephalia**, in the family **Ceratopsidae**, of the genus **Triceratops** and the species **horridus**.

This classification system can be used with each dinosaur in **Dinosphere**. An easy way to remember the different groups, Kingdom — Phylum — Class — Order — Family — Genus — Species, is with the phrase, **Kids Please Come Over For Great Science!** The chart on the next page shows how each classification fits within a larger group.
How Plants and Animals Are Classified

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Kelsey – Animalia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phylum</td>
<td>Kelsey – Chordata</td>
</tr>
<tr>
<td>Subclass</td>
<td>Kelsey – Dinosauria</td>
</tr>
<tr>
<td>Order</td>
<td>Kelsey – Ornithischia</td>
</tr>
<tr>
<td>Family</td>
<td>Kelsey – Ceratopsidae</td>
</tr>
<tr>
<td>Genus</td>
<td>Kelsey – Triceratops</td>
</tr>
<tr>
<td>Species</td>
<td>Kelsey – horridus</td>
</tr>
</tbody>
</table>

More information on how dinosaurs are classified can be found at the following taxonomy Web site. It is not intended for elementary students, but may be helpful for teacher research. The Dinosauricon, by Mike Keesey: [http://dinosauricon.com/main/index.html](http://dinosauricon.com/main/index.html)

### Bonus: Digging deeper!

In this lesson students explored ways that scientists name dinosaurs according to body parts or behaviors. Scientists name all plants and animals by following certain systematic rules. Dinosaurs are named three ways: by body part or behavior, according to where the dinosaur was found, and/or after a person who found the dinosaur or who was important to the discovery. In Dinosphere there are examples of all three types of dinosaur names:

- Kelsey, a Triceratops horridus, is named after body parts.
- A Lambeosaur is named to honor a person.
- The Edmontosaurus annectens is named for Edmonton, Canada, where it was found.

Use reference materials from the Internet and from books to find interesting names of dinosaurs. Help your class decode these names. Each morning a new name can be added to the chalkboard or word list. Students will enjoy seeing how the binomial system also works for plants and other animals. Research the names of some common plants and animals that are found at home and in the classroom. Make a list in your room or label the ones you find. The information in paleontologist Robert Bakker’s article provides a clear understanding of how dinosaurs are named.

### Dinosphere museum link: When you visit

When students visit Dinosphere they see life-size fossilized dinosaurs in a variety of sizes. They can use the Greek and Latin word parts they have learned in class to understand the names of dinosaurs in the exhibits. In Dinosphere many other mammals and plants are on display to immerse visitors in the sights, sounds and smells of the Cretaceous Period. With a little extra effort students and teachers can name the plants and animals as accurately as any scientist. A complete listing of the scientific names of the plants and animals on display in Dinosphere is found in the reference section of this unit of study.

**Triceratops**

Three horns on my face,
I lived in the Cretaceous with many strange beasts,
If you invite me to dinner,
Make it a plant-eaters feast!

— Caroline Crosslin
When to Capitalize and Italicize Dino Names

T. REX — No! T. rex — Yes

by Robert Bakker

What’s a species?

_Tyrannosaurus rex_ has two names, and so does every species of beetle, botfly, pronghorn antelope and bacteria. And so do you. Every single species of plant and animal has two names! As in many Asian human cultures, the family name comes first. _Tyrannosaurus_ is not the name of one single species but of a cluster of closely related species. In Mongolia we find _Tyrannosaurus baatar_, a little earlier than our American _T. rex_. You can tell _T. baatar_ from _T. rex_ because _T. baatar_ has more teeth and the tooth crowns are sharper. Here’s an example from dog species: _Canis lupus_ is the wolf. _Canis latrans_ is the coyote. Two species in the species cluster we call _Canis_ (the technical name for a cluster is a genus). The definition of “species” is simple: it’s a group of closely related individuals who keep their genes to themselves in the wild. Wolves and coyotes are two separate species because they coexist in Canada and Montana and they don’t interbreed, even though they are very similar genetically (in zoos, if you force them, wolves and coyotes might interbreed).

How do you tell species apart from fossil bones?

When we say _T. rex_ was a different species from _T. baatar_, we mean the differences in teeth and bones are so great that we think these two populations would not interbreed if they ever met. Can we tell all species apart from their fossil bones? No, not all of them can be identified. There are some species groups alive today who do not mix their genes but whose bones are so similar that if they were fossils we wouldn’t know the species are separate. A classic example: Some species of the High Plains Pocket Gophers are virtually identical in their skeletons but do have such strong differences in genes that they cannot interbreed. Fortunately, most of these “hidden species” are small critters such as rodents. Nearly all living species of really big animals today can be told apart from their bones — you can tell an African elephant from an Indian elephant, and you can tell apart all five rhino species from bones, and all the 27 species of gator and croc. If we have complete specimens, we probably could tell apart nearly all the dinosaur species. But when all we have is some bone fragments from dinos, it’s usually really hard to be sure that a box of bones comes from one species or two or three.

How do we write species names?

The species-group (genus) is always capitalized and always in italics. Always write: _Tyrannosaurus_. Never _tyrannosaurus_. Never: _Tyrannosaurus_. The rules apply to us humans too. We are _Homo sapiens_ and it’s wrong to write _Homo sapians_. We are the only species of _Homo_ alive now. But over the last million years there were others, such as the famous Neanderthal man _Homo neanderthalensis_. The species name is never capitalized, but always italicized. Also write: _Tyrannosaurus rex_. Never: _tyrannosaurus Rex_. Never: _T. rex_. Most of the time, when we’re talking about dinosaurs, we don’t use both names, just the species-group name. Most dino books talk about _Stegosaurus_ without being specific, without naming the separate species called _Stegosaurus angulatus_, _S. stenops_ or _S. laticeps_. That’s OK, because all the “steggies” look pretty much alike to the untutored eye. If you went to a zoo and saw coyotes and wolves in pens next to each other, and you wanted to talk about all the doggie-species together, it would be fine to say, “Look at the Canis!” Why do we say _T. rex_ all the time? It is because this one species is so big and famous, and because the two names sound so cool when said together.

Practice speaking species-talk

Do this to practice. Make yourself a nametag that says, “Hi — I’m a _Homo sapiens_! My favorite dino is _Tyrannosaurus rex_.” Make each of your friends wear a nametag, with their own favorite dinosaur species — they’ll have to look up the species name. For instance, the common Mongolian raptor is _Velociraptor mongoliensis_. The common T’s are _Triceratops horridus_. It’s OK to abbreviate the species-group name if there’s no risk of confusion. That’s why folks say _T. rex_.

What’s a dinosaur “family”? Species groups who are closely related are brought together into what are called families. The dog family, home to wolves, coyotes, foxes and jackals, is _Family Canidae_. Always capitalize Latin family names. _T. rex_ and its cousins _Albertosaurus_ and _Gorgosaurus_ are in the Family _Tyrannosauridae_. We can use an informal lowercase way to talk about families. We use the “id” (that doesn’t mean we’re psychoanalyzing dinos). If I say “the canid family,” that’s informal-speak for _Family Canidae_. If I say “the tyrannosaurids,” that means the same thing as “_Tyrannosaurus_ family” or _Family Tyrannosauridae_. You don’t have to capitalize tyrannosaurids. But you do have to capitalize words with the Latin ending -_idae_. That means you are speaking formally, so you must capitalize: _Tyrannosauridae_.

Don’t get overwrought on this one — you’ll confuse the second-graders and bore the adults. Stick to “id” and lower case unless you’re talking to grad students. everybody loves the tyrannosaurids at The Children’s Museum!”

Extra credit for dino-geeks: Here’s a paragraph that has all the Family usages:

“The Family _Tyrannosauridae_ includes all the big dino meat-eaters with two-finger hands, such as _Tyrannosaurus_ and _Gorgosaurus_. and the tyrannosaur family is the most famous family of all dinosaurs, since the world-favorite species, _T. rex_, is a tyrannosaur.”

_Dinosphere_ has the following dinosaurs.

*Family Tyrannosauridae*: _Gorgosaurus; T. rex_.

*Family Ceratopsidae*: _Triceratops horridus_.

*Family Protoceratopsidae*: _Prenoceratops plegianensis_.

*Family Hadrosauridae*: _Malasaura peeblesorum_. Some of us tyrannosaurid-aficionados think the differences in teeth are so great that the Mongolian species _baatar_ belongs to its own genus. That would mean we couldn’t call it _Tyrannosaurus baatar_. Instead, we’d say _Tobasaurus baatar_. This is a tough call. Heads and bodies are alike in the two species but the teeth are very different.
Dinosaurs 101 — Fascinating Animals From the Past

EXPERIENCE 3

What Happened to the Dinosaurs?

Focus Questions

● What happened to the dinosaurs that made them go away?
● Do dinosaurs have descendants living today?
● Who discovers information about dinosaurs?
● What do scientists use as evidence for a dinosaur idea or theory?

Objectives

Students will:

● List three or more reasons why dinosaurs are not alive today.
● Understand that anyone can study dinosaurs.
● Demonstrate how a fossil clue can support an idea or theory.
● Give examples of how anyone can study dinosaurs.
● Find out how can someone learn more about dinosaurs.

Indiana Academic Standards

Science — 6.11.1, 6.1.2, 6.2.7, 6.4.8, 6.4.9, 7.1.4, 7.2.8, 8.1.1, 8.2.7, 8.2.9
Language Arts — 6.2.7, 7.2.6
Social Studies — 7.3.7, 8.3.4

Vocabulosaurus

● paleontologist — a scientist who studies ancient life from fossils, including plants, invertebrates (animals without backbones) and vertebrates (animals with backbones).
● volcano
● extinct
● unique
● common
● idea
● climate
● meteorite

Dig tools

Dinosaur reference books; computer access; chalkboard; Dino Diaries.

What happened to the dinosaurs that made them go away?

Volcanic eruptions change the land and the atmosphere.

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Dig tools

Dinosaur reference books; computer access; chalkboard; Dino Diaries.

What happened to the dinosaurs that made them go away?

Volcanic eruptions change the land and the atmosphere.
What happened to the dinosaurs?

- Introduce this lesson by asking students, “What happened to dinosaurs?” Be prepared for many varied and unusual answers to this question. List one or two responses on the board without judgment. This would be an excellent time to emphasize the importance of asking questions in science. Often scientists start by speculating ideas and solutions. Their method becomes science when they formulate a plan to investigate the idea based upon observations and tests.
- Provide reference books about dinosaurs to the class. Each group should have one or more books to use. Bookmark dino Web sites for students to use.
- Divide the students into groups of four or five. Ask students to write the numbers 1 through 10 down the side of one page in their Dino Diaries. Then ask the class a simple question: Where have all of the dinosaurs gone?
- Set a time limit of five minutes. Ask each student to write reasons or words to answer the question next to the numbers in their Dino Diaries. Remind the class to write as fast as possible. Spelling does not count in this exercise. At the end of the set time students tally up their responses. You may want to add extra time. The focus is on encouraging students to brainstorm and record ideas. Each student receives one point or tally mark for each reason.
- Set an additional time limit of 10 minutes. Ask each group to share their ideas within the group. Tell them not to let the other groups hear their conversation. They can add any new ideas in their Dino Diaries. At the end of the 10-minute time, ask each group to tally all of their answers and points for the group, and select a representative to report this in the class discussion.
- Ask each group to select one reason dinosaurs are not alive today that most people agree on. This is the common or popular answer that other students in the class have on their lists. Ask one person in each group to put a check mark next to that common reason on their list.
- Have one member of each group stand and give another common reason. Each time another group has the same reason on its list, the group reporting gets 10 points. For example, if the first group names volcanoes as a common reason and three other groups also have that somewhere on their lists, the first group receives 30 points. Tally all the group points at the end of this round.
- Hand out dinosaur reference materials and allow computer access. Tell the class they have only 10 minutes to search for more information. They may continue to write reasons why dinosaurs are not alive today. Each new reason earns an additional point. Students will be motivated to read new materials in search of dinosaur information.
- Ask each group to select one reason dinosaurs are not alive today that is unique. This reason should be one they think no other group has selected. Ask one person in each group to draw a star next to their unique answer. Allow time for each group to select one idea.
- Have students repeat the reporting process as above. Remind students to name a unique reason they think no other student has listed. Award extra points for any new ideas.
- Ask each group to add up their points. All of the students are winners because they have searched, discussed, evaluated and learned reasons why dinosaurs are not alive today. Have students summarize what they have learned in their Dino Diaries. Ask them to include one or more questions that they still would like answered about dinosaurs.

Make it fossilize

Review the reasons that students listed. Explain to the class that ideas in science have evidence or data to support them. Scientists do not say, “Because I said so.” Instead, scientists show evidence and data to support their ideas. The class can start to examine the ideas about what happened to dinosaurs, focusing on the evidence. Scientists use facts to challenge speculations and build theories. Students will choose a response that they feel can be strongly supported with science evidence in Lesson 3.

Dino Diary

Students use their diaries to play the What Happened to the Dinosaurs? game and to complete the What Happened to the Dinosaurs? chart. Students should be able to generate two or more dinosaur questions that they would like to investigate. End each class period with time to write under the heading “Today I discovered …” in their diaries.

Eva Koppelhus and Philip Currie are paleontologists whose work helps others study and prepare fossils.
Dino Web sites

Dinosphere link on The Children’s Museum Web site
http://www.childrensmuseum.org

Jurassic Park Institute
http://www.jpinstitute.com

Museum of Paleontology
http://www.ucmp.berkeley.edu/index.html

Enchanted Learning — Comprehensive e-book about dinosaurs
http://www.zoomdinosaurus.com

Dino books


Paleo-points for the teacher

Younger students may not be able to understand extinction. Science explains that extinction is a normal process and every year some species become extinct. At the end of the Mesozoic Era a large extinction event occurred. However, it was not the first. Evidence suggests that much larger extinctions occurred prior to the Dinosaur Age. Students may agree with, disagree with or not understand evolution and its importance to adaptation. You can approach both extinction and evolution in a manner that allows students to ask questions. Science supports asking questions. Studying dinosaurs excites children and encourages them to learn. Put the following chart on the board. The three reasons listed are some of the strongest. Information about these three ideas is presented in Dinosphere. Students will be able to find many more. Encourage them to look at the evidence or data for each theory and to ask more questions.

Bonus: Digging deeper!

Students may enjoy researching and listing their Top Dinosaur Extinction Theories to share with the class. After reasons are selected the class can put them in order of least likely to most likely. They will enjoy making up their own reasons, however fanciful, to add to the list. Encourage students to use their imaginations.

Dinosphere museum link: When you visit

Dinosphere contains the latest information from today’s leading paleontologists about what may have happened to the dinosaurs. Visitors can learn more information at the many computer-learning stations. There are labels and activities that explore extinction theories and the most recent trends in learning about dinosaurs. Visit Dinosphere or The Children’s Museum Web site to learn more.

What Happened to the Dinosaurs?

<table>
<thead>
<tr>
<th>Theory or idea</th>
<th>Evidence that supports theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dinosaurs were killed when:</td>
<td></td>
</tr>
<tr>
<td>A meteorite hit Earth</td>
<td>Layer of chemicals in soil, large impact crater</td>
</tr>
<tr>
<td>Great volcanoes erupted</td>
<td>Large lava fields around world</td>
</tr>
<tr>
<td>Geological changes occurred</td>
<td>Climate changes, seasonal changes, new plants and animals</td>
</tr>
<tr>
<td>Dinosaurs are not extinct:</td>
<td></td>
</tr>
<tr>
<td>Some dinosaurs evolved into modern birds</td>
<td>More than 60 similarities between birds and dinosaurs</td>
</tr>
</tbody>
</table>
Lesson 2

Dinosaurs — Rulers of the Cretaceous

Introduction

Students study Dinosaurs’ dinosaurs to try to determine how they lived together. All animals have basic needs that include food, water, air, habitat and others of their own kind in order to reproduce. Students look for clues to see how dinosaurs met their basic needs by living in groups. They compare how modern animals live in order to find indirect clues about dinosaur behavior. Students will look for clues to how dinosaurs lived together and hunted in the main scenes at Dinosaurs. Each scene explores a different aspect of animal interaction.

Direct and Indirect Evidence

Modern iguanas have leaf-like teeth with rounded serrations for cutting plants. Cows, sheep and goats have flat teeth and spend much time chewing and grinding plants. Many dinosaurs had the same types of teeth, evidence that they were most likely plant eaters. Also, some had large rib cages, indicating large stomachs for digesting large amounts of plant material. Some dinosaurs have been found with a pile of well-rounded smooth stones where the rib cage was located. These stones are called gastroliths, or stomach stones, which modern herbivores use to help grind food in their stomachs. These are examples of direct evidence from studying a fossil clue to learn about dinosaurs. This is not the only way to learn about dinosaurs. We also use indirect evidence to learn about dinosaur behavior. For example, we cannot observe how a family of dinosaurs may have interacted 65 million years ago. We can observe modern animals to understand how they interact. From this knowledge we may be able to postulate ideas about how dinosaur families interacted. It is important to know the difference between direct and indirect evidence.

Paleo-artist Michael Skrepnick based this “Watering Hole” scene on the most current research about dinosaur habits and interactions.

Evidence of dinosaurs living together is rare for most species. Most fossils are incomplete and disarticulated (bones no longer joined together) when found. On rare occasions dinosaurs have been found with fossilized eggs and babies, with evidence of teeth and claw marks from other dinosaurs and with different-sized animals of the same species. These fossils help to explain how dinosaurs lived together. In the Mongolian desert a Protoceratops and a Velociraptor were found preserved in a death embrace, with the teeth and beak of the Protoceratops clenched around the leg of the Velociraptor. One claw of the Velociraptor was stuck into the ribs of the Protoceratops. This is direct evidence of how these two dinosaurs interacted. Another way to learn about dinosaurs is to study living animals. Their behavior can provide clues about how dinosaurs behaved and interacted. This provides indirect evidence.

Vocabulosaurus

- **predator** — an animal that lives by hunting and eating other animals, or prey. A lion is a predator. It hunts antelope, its prey.
- **prey** — an animal hunted by predators as food. Some prey are also predators. For example, a hawk is a predator that eats snakes. Snakes are also predators that eat frogs. Snakes are both predators and prey.
- **herd**
- **group**
- **family**

Focus Questions

- What was a dinosaur group?
- What types of activities do animals do together?
- How did dinosaurs interact with each other?
- How did they feed each other?

Objectives

Students will:

- Give examples of how families cooperate and work together.
- List basic needs of animals.
- List benefits and problems for animals living in groups.
- Identify, compare and contrast dinosaur interactions.
Why Do Animals Live in Groups?

- Ask the class to name animals that live in groups and animals that live alone. The group list could include herds, such as cows, sheep, antelope, and horses, and schools of fish, animal families, such as bears, dogs, wild cats, monkeys, and others. Animals that are often alone include some sharks, lions, crocodiles, alligators, and other large predators. Use books and Internet resources to find examples of animals in groups.
- Discuss with the class reasons why animals may need to be in a group. They should list the following: friendship, protection, families, reproduction, food, water, learning, homes and fun.
- Write the different reasons on the board or chart paper. Ask students to give one example for each grouping reason. Ask the class why some animals do not form groups and list the examples. This could include large adult males such as lions, moose and elephants.
- Ask the class to list what is good about living in a family group. Answers should include protection, food, home, learning, fun and love. All of these are good reasons to live in a family. Direct the discussion to the benefits animals have by living in family groups.
- Read Maia: A Dinosaur Grows Up by John R. Horner to your class. This book follows in detail the life cycle of a baby duckbill dinosaur from the Cretaceous Period. It is filled with facts and illustrations about the dinosaur as it grows from an egg to an adult.
- Discuss with the class ways that the dinosaurs in the book met their basic needs and have students list those ways in their Dino Diaries. Describe how living in a group helped the animals in the book find food, shelter and water.

Dino Diary

Students should select one of the scenes from the book Maia to study and draw. Encourage them to label parts of the dinosaur and make notes about how it might help the animal live in groups. They should also make several lists on how and why modern animals live together. End each class period with time to write under “Today I Discovered…” in their diaries.

Dino Web sites

Dinosphere link on The Children's Museum Web site
http://www.childrensmuseum.org

Dinosaur illustrations
http://www.search4dinosaurs.com/pictures.html#about

Jurassic Park Institute
http://www.ipinstitute.com

Bonus: Digging deeper!

Students can use what they have learned about animals and dinosaurs and construct simple food chains. Start by putting a food chain chart (see page 26) on the board. Have students complete the chart in their Dino Diaries. Add more food chains to the chart.

Make it fossilize

Students should be able to give reasons for their ideas about why dinosaurs lived in groups. The main focus is to be able to make a comparison with a modern animal to understand how a dinosaur may have behaved. Students should list reasons for their choices. Students can list the basic needs of the dinosaurs in a story about a family of maiasauras.

The assessment of this lesson is measured by the way students communicate what they believe orally and in writing.

Dinosphere museum link: When you visit

The Dinosphere story line, complete with drawings and maps of the scenes, is included in the resources section of this unit. Students can observe photographs of living animals to learn how and when they come together in groups. From this information students will better understand the reason why Dinosphere fossils are arranged the way they are. At each of the main scenes and through exhibit activities and labels, visitors explore the science of how dinosaurs lived together and interacted.
Preo-points for the teacher

Students may not understand that animal groups form and re-form for different reasons. Many antelope form large herds and migrate during certain parts of the season. Other times they are in smaller family groups that may not include a dominant male. African lions form prides in which the females and young live together without the older males. There are many other types of animal groups students can learn about. Students can find out more about how animals live by looking at how artists and scientists have depicted their behavior. Science and art have worked together to make the world of dinosaurs come alive. New information sometimes makes older artwork incorrect. When new science discoveries occur, new paintings, drawings and ideas emerge. For example, the *Iguanodon* was once thought to have a horn on its nose. It was depicted that way in art until complete skeletons were uncovered in Belgium with the horn on the hands. As we learn more our drawings of dinosaurs will continue to change and reflect new thinking. Ask students to view old movies, television shows and artwork to look at how dinosaurs have been depicted. Have them see if they can find ways science has changed what we think about how dinosaurs should be shown.

Dino books


Dino video


Cretaceous Food Chain ⇒ Energy Flow

| Sun Energy → Plants → Animals → Animals |
| Sun Energy → Sequoia Cones → Triceratops → Tyrannosaurus |
| Sun Energy → Cycads → Maiasaura → Gorgosaurus |
| Sun Energy → Modern Grass → Modern Mouse → Modern Hawk |

© Black Hills Institute of Geological Research

Gorgosaurs are theropods — dinosaurs with three toes on their feet.
Dinosaurs — Rulers of the Cretaceous

EXPERIENCE 2

Dinosaur Interaction

Indiana Academic Standards

Science — 6.1.1, 6.1.2, 6.2.7, 6.4.8, 6.4.9, 7.1.4, 7.2.8, 8.1.1, 8.1.2, 8.2.7, 8.2.9
Language Arts — 6.2.7, 7.2.6, 8.4.2

Focus Questions

- What types of activities did dinosaurs do together?
- How did they interact with each other?
- How did they feed each other?
- How did their body parts help them?

Objectives

Students will:

- List basic needs of a dinosaur.
- Identify and compare interactions in photographs of modern animals living in groups.
- List benefits and problems for animals living in groups.
- Identify three main areas in Dinosphere where dinosaurs may have interacted.
- Give example of dinosaurs living in groups.

Dig tools

Artist paintings and skeletal diagrams of the four main scenes of Dinosphere: T. rex Attack, Watering Hole, Predator or Scavenger, and Eggs and Nest; pictures of animals in groups, families and alone.

Get ready to dig

Dinosaurs, like all animals, interacted with their environment and other animals in diverse ways. Today we can study dinosaur interaction in three ways. The first way we can learn about dinosaurs is to study modern animals. All animals compete for basic needs, including food, water, habitat and relationships with others in their species. We can learn about dinosaurs by comparing and contrasting how modern animals interact to meet their basic needs. This indirect evidence can lead to speculation about dinosaur interaction. Often this speculation is the starting point for a scientific investigation.

Second, we can look for direct evidence in the fossil record. There are rare examples of dinosaur fossils that show how they lived and competed with each other. Dinosaurs have been found with fossilized eggs and babies. This suggests that some dinosaurs may have taken care of their young. Small dinosaur fossil remains have been found inside rib cages of large meat-eating dinosaurs. Recently an early mammal fossil was found inside rib cages of large meat-eating dinosaurs. Recently an early mammal fossil was found with the bones of a small dinosaur inside its rib area! This direct evidence helps to tell a story about the predator and prey interaction of dinosaurs.

Finally, we can learn about dinosaurs from other fossils that are preserved from the same time period. Paleontologists look for clues in the plants, animals, sediments and climate features to understand the habitat. This helps us know what the environment was like at that time. The Dinoshpere exhibit is filled with plant and animal fossil remains from the Cretaceous. A list of many of the fossils found in Dinoshpere is located on page 79 of this unit. Studying these fossils helps tell the complete story of dinosaur interaction.

Vocabulosaurus

- predator — an animal that lives by hunting and eating other animals, or prey. A lion is a predator. It hunts antelope, its prey.
- prey — an animal hunted by predators as food. Some prey are also predators. For example, a hawk is a predator that eats snakes. Snakes are also predators that eat frogs. Snakes are both predators and prey.
- scavenger — an animal that eats another animal it did not help to kill. A crow is a scavenger when it eats the remains of a dead animal.

The Children’s Museum of Indianapolis © 2005
Dinosaur Interaction
- Pass out the four Dinosphere scenes. Some students can look at the scenes on the computer at the Dinosphere Web site.
- Read the story line for each Dinosphere scene, located in the reference section of this unit of study.
- Ask the class to match each drawing with the story line. They should be able to tell from the descriptions read aloud.
- Pass out the four skeletal diagrams of the four scenes that visitors see in Dinosphere. Read the story line again. Students should be able to match each story with both the drawings and the skeletal diagrams.
- Ask the class to sort the scenes by how the animals are living in groups. Are they together for food? Protection? To learn? What modern animals can be seen in similar groups? Give examples of modern animals for each of the scenes shown. Ask the students to provide evidence for their choices and observations.
- Look at each Dinosphere scene and try to answer the main question. Ask students to use what they have learned by studying living animals to decide if the Dinosphere scenes are correct. Have them give reasons for their answers. Have each student select one scene to draw a picture of and write a story to tell what they think it is about. Make sure they give examples of living animals. For example, a student might say that Stan and Bucky are working together to attack Kelsey just like African lions work together to hunt. Divide the class into groups. Meet with each group and share the following questions for their report.

**Tyrannosaurus rex Attack Scene: What will be the outcome?**

Stan is an adult *Tyrannosaurus rex* and Bucky is a teenager. They are about to attack Kelsey, a large, full-grown *Triceratops horridus*. Stan looks like it is dodging Kelsey while Bucky makes its move to attack. All three animals have body parts that will protect them and help them fight. Stan has a huge mouth filled with teeth. Kelsey has long, sharp, strong horns that can stab deep into any animal. What will happen? Which dinosaur will win? How will the animals interact? Use reference materials to learn about the body parts on these terrific creatures. What animals living today might interact the same way? The noise and movement have terrorized two opossum-sized mammals, *Didelphodon*, hiding inside a nearby burrow. They are nocturnal animals and this afternoon skirmish has interrupted their nap. They could be trampled, so they stay hidden, hoping the predators will be chased away.

**Predator or Scavenger Scene: Was it an attack or a scavenger opportunity?**

Did the Gorgosaurus kill the duckbill? Or did it just find it dead and ready to eat? Is this a picture of a predator that has killed its prey? *Gorgosaurus* has all the tools needed to hunt and kill *Maiasaura*, but this gorgosaur has several broken bones. Could a human with a broken leg or arm find food easily? Sometimes on the side of the road a crow or other bird is seen eating a dead raccoon or a deer. A crow cannot kill a deer or a raccoon, but it would eat the free meal it finds. Ask students if they think the gorgosaur would eat a dead and rotting dinosaur.

**The Watering Hole Scene: Hypacrosaurus, Leptoceratops — is this a family?**

Is this a safe place to be? A family of hypacrosaurs is visiting the watering hole to drink. They must drink, but is it safe? Research other modern watering holes that animals use. In Africa many different animals come to drink at the local watering hole. At different times of the day, different animals use the same watering hole. How does the antelope get water without being attacked by lions? What would be the best time for these hypacrosaurs to visit this dinosaur watering hole?

**Dinosaur Eggs, Nests and Babies Area — Oviraptor**

Many living snakes and other reptiles just lay eggs and leave the babies to take care of themselves. Did the dinosaurs take care of their eggs and babies? If they did, what benefit or good things did the babies receive from the care? Ask students how their lives would be different if their parents had not taken care of them when they were babies. What reasons can they give for why dinosaurs would take care of their eggs and young? Each group can make a drawing or a list and give examples of what they think is the real story in each Dinosphere scene. Have the groups report their findings to the entire class. There is not a correct answer but each group should be able to defend their findings.
**Dino Diary**

Students should select one of the scenes in Dinosphere to draw and study. Encourage them to label parts of the dinosaur and make notes about how each part might help the animal live in groups. They should also make several lists on how and why modern animals live together. End each class period with time to write under the heading “Today I Discovered …” in their diaries.

**Dino books**


**Dino video**


**Paleo-points for the teacher**

Scientists have indirect evidence that dinosaurs lived in groups. Eggs, nests and nursery areas have been found. In these areas fossilized dinosaur bones of different ages have been found, which provides evidence that individuals of various ages lived together. Also, fossilized dinosaur track ways have been found that show animals of various ages traveling together. This provides strong evidence that some dinosaurs lived in groups.

**Dinosphere museum link: When you visit**

The Dinosphere story line, complete with drawings and maps of the scenes, is included in the resources section of this unit. Students can observe photographs of living animals to learn how and when they come together in groups. From this information students will better understand the reason why Dinosphere fossils are arranged the way they are. At each of the main scenes and through exhibit activities and labels, visitors explore the science of how dinosaurs lived together and interacted.

**Bonus: Digging deeper!**

View a dinosaur video with your class. There are several excellent educational videos available. View the movie with a focus on dinosaur interactions and basic needs. Afterward, have students make a list of all the ways dinosaurs in the movie met their basic needs, interacted and lived in groups.
**EXPERIENCE 3**

**Dinosaur Webquests — Who Should Own the Bones?**

**Indiana Academic Standards**

**Science** — 6.1.1, 6.1.2, 6.1.4, 6.2.5, 6.2.7, 6.2.8, 7.1.3, 7.1.4, 7.1.5, 7.1.6, 7.2.8, 8.1.1, 8.1.2, 8.1.4, 8.1.8, 8.2.7, 8.2.8, 8.2.9, 8.2.10

**Language Arts** — 6.2.6, 6.2.7, 6.2.8, 6.4.5, 6.4.6, 6.4.7, 6.4.9, 6.5.7, 7.2.6, 7.4.1, 7.4.3, 7.4.4, 7.4.7, 7.4.9, 7.5.2, 8.4.1, 8.4.2, 8.4.4, 8.4.5, 8.5.4, 8.5.7

**Social Studies** — 7.3.7, 8.2.4, 8.3.4

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**Focus Questions**

- Who should own dinosaur bones?
- Do all fossils have the same value?
- If you own the land do you own the fossils?

**Objectives**

Students will:

- Research information and opinions about dinosaur fossil ownership.
- List positive and negative arguments and opinions about a topic.
- Write a persuasive letter supporting one position on a controversial topic.
- Present and discuss information, statements and personal opinions to support a position.
- Vote online in support of the question, “Who owns the bones?”

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**Vocabulosaurus**

- opinion
- academic
- paleontologist
- commercial
- editorial

**Dig tools**


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**Get ready to dig**

For many years, commercial and academic paleontologists have disagreed about who should own excavated bone fossils, regardless of where these discoveries are made. The Children's Museum Web quest is a fictitious story about the plight of two college students who made an interesting discovery while hiking one day. The two students try to sell fossils they found in a national park. The law says you can't excavate or sell fossils found on government land. So, who owns the bones? Students will predict the outcome of this situation and compare their choice to others' choices by participating in an online vote. In addition to this, students consider another challenging scenario involving a poor farmer and a fossil collector.
**Dig In ...**

- Students will visit the Dinosaur Web site to participate in the Webquest. They may work in small groups or individually on the project. The Webquest starts with the reading of two scenarios about the ownership of fossilized dinosaur bones.
- The students' job is to read the two differing opinions, academic paleontologist versus commercial paleontologist, and then study two other cases.
- Students will read two additional accounts of fossil ownership.
- Students will decide which opinion they agree with most and write a letter to the newspaper editor supporting the opinion.
- Students will share their opinions with the class. After the class presentations students will go online to vote for the scenario they most agree with.

**Make it fossilize**

Create with your class a writing rubric that will allow them to assess their letters to the editor. They will also discuss their findings and conclusions. Students should be able to list positive and negative arguments and opinions about a topic they support.

**Bonus: Digging deeper!**

Make a timeline from the Important Dates in Dinosaur Discovery. A reference timeline is included in the resources material in this unit of study. Students can illustrate each discovery on poster board. Many important dinosaur discoveries have been made since 1970. Use additional reference materials to complete the timeline.

---

**Dino Diary**

Students should revise and write a copy of their letter in the Dino Diary. Students should share their letters with the class. Students can make a list of comments that are in favor and against their position. End each class period with time to write under the heading "Today I discovered ..." in their diaries.

**Dino book**


**Dino Web sites**

The Children's Museum Web site — Dinosaur Webquests
http://www.childrensmuseum.org/dinosaur/kids/webquests.html

Great Fossil Hunters of All Time
http://www.enchantedlearning.com/subjects/dinosaurs/

Fossil Halls, American Museum of Natural History
http://www.amnh.org/exhibitions/FossilHalls/fossil-halls2.html

Stemberg Museum of Natural History (unofficial virtual tour)
http://www.oceansofkansas.com/Stembrg.html

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**Paleo-points for the teacher**

Students may think that the only job of a paleontologist is to dig up fossilized bones. However, the field is diverse. Paleobotanists study plants and sedimentologists study the soil found with fossils. Another paleontologist may spend years learning how leg and hip bones work together. There are many different areas for men and women to pursue in the field of paleontology. The National Geographic magazine article “Dinosaurs: Cracking the Mystery of How They Lived” (March 2003) features many different and specialized paleontologists and their work.

**Dinosphere museum link: When you visit**

Students will be able to see real fossil bones in Dinosphere. They can follow the journey a fossilized bone takes from the dig site to the museum. The various steps are outlined in Dinosphere and on The Children’s Museum Web site. In the museum’s Paleo Prep Lab students will be able to touch real fossilized dinosaur bones and meet people who work on fossils. Dinosphere has many areas where students can explore dinosaur fossils and help to uncover fossilized bones in a simulated dig site. Students can identify, sort and make drawings of the different teeth found in the 14 animals on display in Dinosphere.
Lesson 3: *Scientific methodosaurus*

**Enduring Idea**
Fossils are clues that help us learn about dinosaurs.

**Introduction**

Not everyone is lucky enough to be Bucky Derflinger, the youngest person ever to find a *Tyrannosaurus rex*. When Bucky was a fourth-grader he found his first fossilized *T. rex* bone and took it to school. His South Dakota teacher told him it was not a fossilized dinosaur bone. It’s a good thing that he did not give up looking for dinosaurs, because a few years later he found the only teenage *T. rex*. Today the dinosaur named for Bucky is on display in *Dinosphere*. In this experience students have an opportunity to make a discovery of their own. They use scientific methods to learn about dinosaurs. Students select dinosaur questions to use in a presentation following a scientific method. Students use digital resources to create reports and audiovisual presentation.

Each layer of dirt at the Bucky site may contain clues about life in the Cretaceous Period. These rocks are not found in Indiana.

Why aren’t dinosaurs found in Indiana?

Students often ask this question. Dinosaurs probably lived in Indiana long ago, but several major changes in climate have occurred in this area since the end of the Cretaceous. Large glaciers scoured, scraped and eroded the surface and bedrock of Indiana, where dinosaur bones may have been deposited. When the climate changed the melted glaciers produced tremendous quantities of water that moved sediments, soil, rocks and fossils out of the area. Fragile fossils cannot survive the strong natural forces that have shaped the Hoosier state. The youngest bedrock in Indiana, from the Carboniferous Period, 360 – 286 million years ago (mya), is much older than the Mesozoic Era fossil beds of the dinosaurs, 248 – 65 mya. Thus fossilized dinosaur bones have not been found in Indiana.
**Lesson 4**

**Scientific methodosaurus**

**CULMINATING EXPERIENCE**

Using scientific methods to learn about dinosaurs

**Indiana Academic Standards**

- **Science** — 6.11, 6.12, 6.13, 6.2.5, 6.2.7, 7.1.1, 7.1.4, 7.1.5, 7.2.7, 7.3.3, 8.1.1, 8.1.2, 8.1.8, 8.2.6, 8.2.7, 8.2.8, 8.2.10
- **Language Arts** — 6.2.7, 6.4.1, 6.4.5, 6.4.6, 6.4.7, 6.4.9, 6.5.3, 6.7.5, 6.7.6, 6.7.7, 6.7.9, 6.7.11, 6.7.13, 6.7.14, 7.4.1, 7.4.3, 7.4.4, 7.4.5, 7.4.7, 7.4.9, 7.5.3, 7.7.1, 7.7.3, 7.7.4, 7.7.5, 7.7.6, 7.7.10, 7.7.11, 8.2.5, 8.4.1, 8.4.4, 8.4.5, 8.4.6, 8.4.9, 8.5.3, 8.7.1, 8.7.2, 8.7.3, 8.7.4, 8.7.5, 8.7.12
- **Social Studies** — 7.3.7, 8.3.4

**Get ready to dig**

What did it eat? How did it move? Was it real? What does its name mean? How long ago did it live? It is questions like these that make children and scientists alike want to find out more. The best reason for studying dinosaur fossils is to provide students and teachers a unique opportunity to use science to answer questions and solve problems. Science can be used to make observations, collect data, test ideas and draw conclusions about the dinosaurs’ world. Science discoveries are directly tied to how the ideas are communicated. In this lesson students will select a question about dinosaurs to use in a science investigation. Students will share ideas supported by their findings in a symposium. Dinosphere will be used as a living laboratory for students to investigate and test their ideas.

**Focus Questions**

- How are fossils used to learn about dinosaurs?
- What evidence is used to prove a science idea?
- Do scientists disagree about dinosaur ideas?
- How are conflicting ideas resolved in science?

**Objectives**

Students will:

- Select a dinosaur question to research.
- Take notes and propose theories about dinosaurs.
- Write and display information about dinosaurs.
- Share what they have learned with others.
- Visit Dinosphere to conduct a science investigation.

**Vocabulosaurus**

- **scientific method** — the principles and procedures used to recognize and formulate an idea, collect data through observation and experiments, and test a theory.
- **hypothesis** — an unconfirmed theory or supposition used to explain certain facts, and to guide in the investigation of others. This can sometimes be considered a working hypothesis.
- **symposium** — a meeting or conference where a specific topic is discussed.

**Dig tools**


Dinosphere field trip: This lesson is greatly enhanced by bringing students to the museum to make their own observations and collect data. Students not visiting the museum can take the Dinosphere virtual tour found at the following Web site to complete the project: [http://www.childrensmuseum.org/dinosphere/virtual_tour/overview/index.html](http://www.childrensmuseum.org/dinosphere/virtual_tour/overview/index.html)

For every hour digging in the field another 10 hours are needed to prepare the fossils.
Divide the class into small groups of three to five students. Provide each group with computer access resources for the lesson at the following Web site: http://www.childrensmuseum.org/museumexport/csi.htm

Review with the class the resources that are available at the Web site.

Dinosaur Questions is a set of over more than 200 questions about Dinosphere. Educators developed these questions specifically for the Dinosphere gallery. They are organized around themes.

Dinosaur Image Gallery is a set of dinosaur images designed for students to copy, cut and paste into presentations. It contains images of dinosaurs found in Dinosphere.

Fossil Image Gallery is a set of fossil images designed for students to copy, cut and paste into presentations. It contains images of many of the fossils of the plants and animals that lived with the dinosaurs found in Dinosphere.

Scientific methodosaurus PowerPoint Template is a blank template for students to create a computer presentation about a dinosaur topic.

Students will record information for all of the following slides on paper, in the Dino Diary or in their science journal prior to creating the Microsoft PowerPoint presentation. The final group presentation includes the following slides:

Scientific methodosaurus
Slide 1: Student names, school, teacher and date.
Slide 2: Question or problem selected for the project.
Slide 3: Hypothesis created from the project question.
Slides 4 & 5: Research that states four to 10 statements of fact or findings.
Slides 6 & 7: Observations that list four to 10 items observed in Dinosphere.
Slide 8: Conclusion describing evidence that does or does not support the stated hypothesis.
Slide 9: Bibliography listing all the sources used in the project.

Step 1: PowerPoint Template
Slide 1: Introduction
Students open the Microsoft PowerPoint template. The slide contains the name of the project, all the students’ names, school, grade level, teacher name and date. Students can copy and paste this information onto slide 1 of the PowerPoint presentation.

Slide 2: Question or Problem
Students select one question from the Dinosaur Questions list to use in the project. Students may also create their own question or problem. Make sure that the subject or content of the project is about a topic from the Cretaceous Period. There are many fascinating dinosaurs and fossils that were from the Triassic and/or Jurassic periods.

However, Dinosphere contains plants, animals and dinosaur fossils from the Cretaceous. Students should put their question or problem onto slide 2.

Slide 3: Hypothesis
Students convert their question or problem into a testable statement. The hypothesis is an unconfirmed theory or supposition used to explain certain facts and to guide in the investigation of others. This can be considered a working hypothesis. Often is easier for students to begin a working hypothesis with, “We believe that...” and end it with a statement. For example, the following question can generate two different hypotheses.

Question: Did an asteroid kill the dinosaurs?

Hypothesis 1: “We believe that an asteroid killed the dinosaurs.”

Hypothesis 2: “We believe that an asteroid did not kill the dinosaurs.”

The group should confirm their hypothesis with the teacher before proceeding to the next step. It is important that the hypothesis is focused and can be tested or investigated. After the teacher has confirmed it, students can put their hypothesis on slide 3.

Slides 4 & 5: Research
Students use books and the Internet to research information about their questions. This is an important step to take because the information found will help direct the rest of the project. The outcome of this step is for the group to become experts on their subject. Direct students to use reading and note-taking strategies to collect information about their question. Students take notes in their Dino Diary. The notes are changed into talking points or statements for the presentation. This information is put onto slides 4 and 5.
Ask your students: Who would win this fight between two tyrannosaurs and a triceratops?

Slides 6 & 7: Dinosphere Observations
Students are encouraged to visit the Children’s Museum Dinosphere to make observations and collect data to support their hypotheses. Dinosphere is a unique laboratory filled with dinosaurs and fossils from the Cretaceous. The gallery staff, curators and paleontologists are available to talk with the students about their projects while they visit the museum. Dinosphere is designed for students to ask questions and seek answers. A class may decide to conduct their observations online through a virtual tour of Dinosphere.
http://www.childrensmuseum.org/dinosphere/virtual_tour/overview/index.html
Students put the observations they collect onto slides 6 and 7.

Slide 8: Conclusion
Student review their observations collected from Dinosphere. Their observations should determine if the hypothesis is correct — or supported. It may be that the observations do not support the hypothesis. It is important that the students understand that a good science investigation may lead to a conclusion that does not support the hypothesis. Several factors could cause this. The hypothesis may be wrong, other factors might be involved, more questions are needed, or additional testing or a different question may be needed. Students should recognize and explain that hypotheses are valuable, even if they turn out not to be true, if they lead to fruitful investigations. The information is put onto slide 8.

Slide 9: Bibliography
Students list all reference materials used in the project. They should follow standards on citing sources. Review with the class the format for citing books, periodicals and Internet sources. This informational bibliography is put onto slide 9.

Step 2: Dinosaur and Fossil Images
Two different galleries of images are provided for students to use in the project. The images contained in the galleries are of the correct size and resolution for use in the project. Students will also add other features to make the presentations dynamic and interesting. Make sure they focus on the content first, and then they can add images and effects that enhance their presentation.

Step 3: Presentation/Assessment
Once completed students should be given time to practice their presentation. Each student in a group should be responsible for presenting a portion of the project to the class. When each group is ready, organize a Scientific methodosaurus Symposium for students to share their projects. Students should be able to share their ideas supported by observations, evidence and facts. Students should welcome questions about their findings from other students. Monitor the discussions and emphasize that often the outcome of one science investigation will lead to another investigation.
A family of Alamosaurus welcomes your class to Dinosaur!
## Dinosaurs

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What are dinosaurs?

Dinosaurs are a special group of animals that were alive more than 65 million years ago. Dinosaurs are an extinct subclass of Archosauria, the “ruling reptiles.” Other extinct reptiles include the flying pterosaurs and the marine plesiosaurs and ichthyosaurs. Living reptiles include three orders: turtles/tortoises, crocodiles/alligators, and lizards/snakes. A reptile is a member of the animal kingdom and has a backbone. Reptiles have scales and claws, and develop from yolk-filled eggs that are laid or mature inside the mother’s body. Many scientists are working to understand the relationship between dinosaurs and living animals such as birds. Today it is generally accepted that dinosaurs and birds share a common ancestry. Some scientists believe that the dinosaurs are not extinct but have slowly evolved into birds. Children can use a simple five-step rubric to identify a dinosaur.

All dinosaurs:

1. are diapsids, which have two additional sets of openings in their skulls not counting the nostrils or the eye sockets. All reptiles except turtles are diapsids.
2. were alive during the Mesozoic Era that lasted from 245 to 65 million years ago. Geologists divide the Mesozoic Era into three distinct periods — Triassic, Jurassic and Cretaceous.
3. had one of two types of hip joints, called bird-hipped or lizard-hipped.
4. held all four legs under the body, not out to the sides like modern lizards and crocodiles.
5. moved and lived on land — did not live in the water or fly in the air.

If the animal meets all of these criteria, it is a dinosaur.

How long ago did dinosaurs live?

It may be impossible for students to understand how long ago dinosaurs lived. It is easier for adults to understand long periods of time. A first-grader begins to understand how long a school week is, but may not be able to grasp a decade. A high-school student understands the significance of being 18 years old, but may not fully comprehend the time span of a century. Many adults find it hard to imagine what the world was like 10,000 years ago. Such a large amount of time is difficult to put into perspective. Dinosaurs were alive during the Mesozoic Era that started more than 245 million years ago, and it lasted for 160 million years. This means that the extinction of dinosaurs was complete 61 million years before the earliest human fossils, from 4 million years ago. John McPhee coined the term “deep time” in 1981 to help people understand the immensity that is covered in geologic time. It is likely that young students will have difficulty understanding the Dinosaur Age. What can be understood is that dinosaur fossils are astonishing tools that excite children to learn about the past.

The multiple openings in this skull help identify it as a diapsid.
Why focus on the Cretaceous Period?

The Cretaceous world (144 – 65 million years ago) must have been a pretty amazing place. There were lots of different kinds of dinosaurs, including the ones best known today, such as *Tyrannosaurus rex* and *Triceratops*. Dinosaurs lived all over the world, even in the polar regions. There were small birdlike dinosaurs and huge, long-necked sauropods. It was during the Cretaceous Period that the first flowering plants appeared, along with trees such as maples, oaks and walnuts. What happened at the end of the Cretaceous — a meteorite striking the earth, erupting volcanoes or changing climates — continues to fascinate people today. This was the last period of the Dinosaur Age. Almost half of all the dinosaurs known about were alive during the Cretaceous Period. They included *Iguanodon*, *Deinonychus*, *Hypsilophodon*, *Torosaurus* and *Saltasaurus*. Many of the present-day continents were starting to form. The Western Interior Seaway covered the middle of present-day North America from Alaska to Mexico, filling the land from the Rocky Mountains to western Iowa.

Also alive during the Cretaceous Period were dragonflies and other insects, frogs, turtles, crocodiles, fish and small mammals. Other non-dinosaurs swam the saltwater oceans and flew through the warm, moist skies. Marine reptiles included giant ichthyosaurs, plesiosaurs, pliosaurs, and mosasaurs that lived on a diet of fish, squid and shellfish. In the air flew other fantastic creatures that were not dinosaurs. The pterosaurs, or flying reptiles, were as small as crows or owls and others were giants. The *Quetzalcoatlus* flew with a wingspan more than 12 meters long — bigger than some airplanes. Pterosaur wings consisted of a thick layer of skin covering their fingers and hands. Plant life included ferns, cycads (plants with huge fan-shaped leaves similar to pineapple plants) and evergreen trees. At the end of the Dinosaur Age broad-leaved trees such as oaks and flowering plants such as the magnolia began to appear. Common grasses of today were not present then. The Cretaceous Period holds the fossil clues to solving the mysteries of the dinosaurs.
What is a fossil?
The word fossil comes from the Latin “dug up.” Scientists define fossil as preserved evidence of ancient life. Preserved means that ancient life has survived in a form recognizable today. Many times but not always, fossils are living things that have mineralized or turned to stone. A fossil can also be an imprint of skin, a footprint hardened into rock, the hard parts of an insect trapped in amber, the thin carbon layer of a leaf or the actual bones and tissues of a mammoth. Evidence includes bones, teeth, claws, shells and any hard parts that have become mineralized. Most scientists agree that a fossil must be 10,000 years or older to qualify as ancient life. Many living things can become fossils — plants, animals, single cell organisms and bacteria — if the conditions are right.

Often the term dinosaur bone and fossil are used interchangeably. However, no dinosaur bones have survived intact from the Mesozoic Era — only fossilized dinosaur bones. Each bone has gone through a rare process where actual living tissue has been replaced or altered by minerals. Most plants and animals do not become fossils because they are consumed as food. Animals eat plants and other animals to live. The process of eating and digesting the food destroys most chances for those food items to become fossils. However, some scientists have become experts at learning what clues can be found in dinosaur coprolite, or dung. The dinosaur fossils found so far represent only a very small sampling of life in the Mesozoic Era. Mud and water play an important role in how living organisms become fossilized. Mud and water are associated with lakes, deltas, floodplains and shores — all areas that optimize the formation of fossils. Many plants and animals may have lived in geographic areas and climates that rarely support fossil formation.

Some organisms that were alive in the Dinosaur Age are still living today. They are called living fossils. Examples include crocodiles, turtles, cockroaches, ferns, coelacanths, horsetail rushes, ginkgos, spiders, dragonflies and horseshoe crabs. The fossil record is rich in opportunities to learn about the past but much more lies buried, waiting to be uncovered. This helps to make digging for fossils an ongoing and exciting endeavor for adults and children.

Dinosphere contains many examples of Cretaceous Period plants and animals other than dinosaurs. A complete list of exhibit fossils is located in the resource section of this unit.

Classifying plants and animals
Scientists classify all plants and animals, including dinosaurs, using the binomial system created by Swedish naturalist and physician Carl von Linné (often called Carolus Linnaeus) in the 1750s. The binomial, or two-word, system uses one Latin or Greek word to represent the genus and the second for the species. The system uses the following major divisions to classify plants and animals:

- **Kingdom**
- **Phylum**
- **Class**
- **Order**
- **Family**
- **Genus**
- **Species**

An easy way to remember the different groups is with this phrase: Kids Please Come Over For Great Science!

Dinosphere dinosaurs can be classified with this system. The complete classification chart is on page 70.

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<td>Family</td>
<td>Ceratopsidae (frilled dinosaurs, including horned dinosaurs)</td>
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<tr>
<td>Genus</td>
<td>Triceratops (three-horned face)</td>
</tr>
<tr>
<td>Species</td>
<td><em>horridus</em> (horrible — describes the horns)</td>
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</tbody>
</table>
Dinosphere Dinosaurs: 
Stars of the Cretaceous —
Dinosaur Background Information

Stan —
*Tyrannosaurus rex*
One full-size cast replica skeleton in Dinosphere

Background
*T. rex* lived about 67 million years ago, and only in the areas currently called the Great Plains, or the western portions of North America (the United States, Mexico and Canada). The “tyrant lizard king” species existed for a span of 3 million years of Earth’s history (30 times as long as modern humans have existed so far). Life was tough at the top of the food chain. Despite its reputation as a biting, slashing killer, *T. rex* lived on the edge. A tasty herd of migrating duckbills might not show up on time. Without a ready supply of food, starvation loomed. There were fights with potential mates or rivals and wounds became infected and rapidly fatal. Disease was also a threat, including osteoarthritis and bone deformities that could make movement painful and difficult. Families of tyrannosaurs may have helped each other, however. They may have cared for their young and brought food to them in the nest. As the youngsters grew, they learned how to hunt from adults. Perhaps sleek teenagers served as a diversion to drive prey to waiting adults. Even grown theropods may have banded together to find food. Large duckbills or a *Triceratops* may have been too big for one carnivore to take on, but two or more could work together to attack and kill prey. *T. rex* had other adaptations that helped it to hunt effectively. Forward-facing eyes could quickly spot and focus on prey. An acute sense of smell located food, while strong legs moved swiftly to the attack.

Why Stan is significant:
**Completeness**
The *T. rex* known as Stan probably has the best preserved and most complete dinosaur skull yet discovered anywhere in the world. Nearly every fossilized bone of Stan’s skull was recovered during excavation. In addition, the skull was almost entirely disarticulated, meaning that each fossilized bone was separated from the others. Disarticulation allowed the fossilized bones to be preserved with little or no distortion or crushing during millions of years of burial. The disarticulation of the fossilized skull bones also provided scientists a unique ability to examine each individual specimen as well as to study each one’s connection and movement in relation to the others. Thus, an entire new body of knowledge has been acquired about the functions and kinetics (motions) of *T. rex* skulls and also of other large theropod skulls. Forty-seven separate fossilized bones plus 35 loose fossilized teeth were reassembled in the reconstruction of Stan’s skull. Only two small skull bones from the inside of Stan’s lower jaw were missing. The study and reconstruction of these skull elements provided clear evidence that *T. rex* had the largest brain, the keenest eyesight and sense of smell, the strongest teeth and the most powerful jaws of any other dinosaur identified to date.

Skull and brain
The brain was long and narrow, with well-developed olfactory bulb(s), optic nerves and auditory nerves. Hence, scientists believe that the *T. rex* had extremely good senses of smell, sight and hearing. The skull was deep and massive and featured a rather short snout. Forward-facing eyes provided depth perception, which allowed the *T. rex* to judge distance while moving.

Teeth and jaws
A tyrannosaur’s mouth, teeth and jaws were specialized for biting and swallowing chunks of prey. More than 50 saw-edged teeth, some as long as 12 inches, could tear into flesh like knives. Bulging muscles on the skull enabled *T. rex* to twist its head and gulp down whole chunks of meat. And as teeth were shed, new teeth grew to fill the gaps. The jaws were narrow toward the front but widened out to be broad at the cheeks. The lower jaw was hinged at the midpoint between the jawbone and the chin to increase the size of the bite. The joint between the left and right mandibles (lower jaw) was moveable. Sharp teeth were up to 7 inches (18 cm) long, and the largest teeth were shaped like saw-edged steak knives. The worn crowns on Stan’s teeth indicate that *T. rex* ate tough, likely fresh, meat rather than rotting carcasses (and thus was not just a scavenger but a hunter). The aging, long roots of older teeth dissolved so that they could fall out and be replaced by stronger new teeth. The upper teeth were curved and very sharp, like huge scalpels. When eating, the *T. rex* probably moved the lower jaw backward so that the sharp lower teeth could tear through flesh while the upper teeth held dinner in place.

Arms
The first complete *Tyrannosaurus* forearms were found in 1988; before that discovery, the arms were thought to have been weaker than they are considered now. Although *T. rex* arms were no longer than human arms, one single arm was probably strong enough to lift 400 pounds. The muscular but short arms may have propped up the dinosaur’s body as it rose from lying or crouching to standing. The arms may also have been used as grappling hooks to fight and hold other dinosaurs.
Stan’s pathologies
Stan has some interesting pathologies — or healed injuries — that create a picture of what life was like for such predators. The T. rex has several broken and healed ribs, as well as a scar that may match the size and shape of a T. rex tooth. At some point, Stan also suffered a broken neck. As it healed, two vertebrae fused together and a third was immobilized by extra bone growth. Even more spectacular is a hole in the back of the skull. A piece of fossilized bone 2 by 5 inches broke off inside the braincase. Pete Larson, of the Black Hills Geological Institute, speculates that the size of the hole matches a T. rex tooth. Whatever the immediate effect of these injuries, Stan lived through them to fight another day. Perhaps disease or old age finally killed the T. rex. As Stan’s carcass rotted in the sun, scavengers pulled apart much of the skeleton and skull. Spring floods eventually covered the bones, which remained buried for 65 million years.

Discovery
In the spring of 1987, amateur paleontologist Stan Sacrison was exploring outcrops of the Hell Creek Formation near the town of Buffalo, S.D., when he came across a large dinosaur pelvis weathering out of a sandy cliff face 100 feet above the prairie.

Most Tyrannosaurus specimens, including Stan, are from Hell Creek Formation, Harding County, S.D.

Size
Stan is one of the last, largest and most powerful of all predatory dinosaurs. The T. rex is likely to have been the largest carnivorous land animal (theropod) of any age. An adult T. rex is about as heavy as an elephant, tall enough to look through a second-story window and long enough to stretch out across the width of a tennis court (10 to 14 meters from head to tail). Like other tyrannosaurs, Stan was lightweight (4.5 to 7 tons) because of hollow bones and large skull openings.

Name
T. rex was described in 1902 by American paleontologist Henry Fairfield Osborn, who named it the “dinosaur king.” From then until the 1960s, few T. rex skeletons were known to exist. T. rex anatomy wasn’t well known until new discoveries aided the completion of the whole skeleton form. The discovery of two more skeletons, one in Montana in 1988 and another (Sue) in 1990, allowed for better understanding of the Tyrannosaurus skeleton and anatomy. Since then, through books, movies and comic strips, T. rex has become the most popular, best-recognized dinosaur of all.

Lifestyle and behavior
T. rex may have hunted alone or in packs. It may have followed migrating herds of herbivorous dinosaurs and targeted the sick, young and weak dinosaurs, and may also have ambushed its prey, charging with wide-open jaws at perhaps 20 mph when an unsuspecting dinosaur came near. The T. rex diet included Triceratops and Edmontosaurus; fossils of these species have been found with T. rex bite marks. Although it may have laid eggs, no fossilized Tyrannosaurus eggs have yet been found. T. rex grew continuously throughout its long life. Because fossilized dinosaur bones have been found in regions that were cold when the dinosaurs were alive, and since birds are the closest relatives of dinosaurs (not crocodiles, lizards or snakes), Tyrannosaurus and other dinosaurs may have been warm-blooded.

Dinosphere link
Stan is a cast model of the original in the collection of the Black Hills Institute.

Dinosphere Dinosaur Classification
Kingdom — Phylum — Class — Order — Family — Genus — Species
Kids Please Come Over For Great Science!

### Stan — Tyrannosaurus rex

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<td>Subclass Dinosauria (extinct reptiles, “terrible lizards”)</td>
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<tr>
<td>Order</td>
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<td>Suborder Theropoda (beast-footed)</td>
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<tr>
<td>Family</td>
<td>Tyrannosauridae (tyrant lizard)</td>
</tr>
<tr>
<td></td>
<td>Carnosauria (meat-eating lizard)</td>
</tr>
<tr>
<td>Genus</td>
<td>Tyrannosaurus (tyrant lizard)</td>
</tr>
<tr>
<td>Species</td>
<td>rex (king)</td>
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</table>

Site
Tyrannosaurus rex — Stan

This is how Stan looked just before being moved to Dinosaur.
Resource Materials

Drawing

*Tyrannosaurus rex — Stan*

A fleshed-out T. rex.
**Bucky — *Tyrannosaurus rex***

**One full-size fossilized bone skeleton in Dinosphere**

**Background**
Bucky the *T. rex* is a rare find. This remarkable dinosaur is the first juvenile *T. rex* ever placed on permanent exhibit in a museum. Twenty-year-old Bucky Derflinger found it in 1998 near the small town of Faith, S.D. A rancher and rodeo cowboy, Derflinger is the youngest person ever to discover a *T. rex*.

**Why Bucky is significant:**

**Completeness**
Bucky is thought to be the sixth most complete *T. rex* (out of more than 40) ever discovered. Bucky is an important find. It is the first known *T. rex* discovered with a furcula (wishbone). The furcula may be an important link between dinosaurs and birds.

**Discovery**
This dinosaur is also from the Hell Creek Formation, but it is a true teenager, approximately two-thirds the size of an adult *T. rex* and other predators are relatively rare finds. On average, one predator is found for every 30 or 40 herbivores discovered. Juvenile finds are even more rare.

**Site**
The fossil remains of Bucky were scattered and difficult to find. So far the excavation site for this creature is nearly half the size of a football field, making the Bucky dig site the largest known *T. rex* excavation to date. Bucky is extremely well-preserved and was easily prepared because the surrounding rock matrix was rather soft and easy to remove. The fully prepared fossils have a dark, chocolate-brown patina.

**Size**
Bucky is almost the size of an adult *T. rex*. It is approximately 34 feet long and more than 10 feet tall.

**Name**
*T. rex* was described in 1902 by American paleontologist Henry Fairfield Osborn, who named it the “dinosaur king.” From then until the 1960s, only three *T. rex* skeletons were known to exist. *T. rex* anatomy wasn’t well known until new discoveries aided the completion of the whole skeleton form. The discovery of two more skeletons, one in Montana in 1988 and another (Sue) in 1990, allowed for better understanding of the *Tyrannosaurus* skeleton and anatomy. Since then, through books, movies and comic strips, *T. rex* has become the most popular, best-recognized dinosaur of all.

**Fossils**
To date, more than 33 percent of Bucky has been uncovered and verified. Bucky has a nearly complete set of gastralia (belly ribs) and a rare ulna (lower arm bone). Fossilized bones include the first furcula (wishbone) and the first bicolor toe ever found. Ancillary fossil material unearthed from the Bucky site will help scientists tell a more complete story. Materials excavated include Triceratops, Edmontosaurus, *Nanotyrannus*, *Champosaurus* crocodile, turtle, fish, shark and some plant material. It is interesting to speculate how all these remains came to be deposited in the same location. Perhaps Bucky died by a river and the remains, along with skeletons from other animals, washed downstream before sand and silt covered and preserved them.

**Dinosphere link**
Two *T. rex* specimens — one adult and one juvenile — are displayed in a hunting scenario in Dinosphere. The two have encountered a *Triceratops* and are rushing in for the kill. Perhaps the younger *T. rex*, Bucky, acts as a diversion to keep the *Triceratops* off balance. Stan, the adult, is coming in at the *Triceratops* from behind. The outcome of the battle is uncertain. Perhaps the two will be successful and enjoy a meal. Perhaps the powerful *Triceratops* will gore one or both predators.

**Dinosphere Dinosaur Classification**

**Kingdom** — **Phylum** — **Class** — **Order** — **Family** — **Genus** — **Species**

**Kids Please Come Over For Great Science!**

---

**Kingdom**
Animalia (animals)

**Phylum**
Chordata (animals with spinal nerve cords)
Subphylum Vertebrata (chordates with backbones)

**Class**
Archosauria (“ruling reptiles”)
Subclass Dinosauria (extinct reptiles, “terrible lizards”)

**Order**
Saurischia (lizard-hipped)
Suborder Theropoda (beast-footed)

**Family**
Tyrannosauridae (tyrant lizard)
Carnosauria (meat-eating lizard)

**Genus**
*Tyrannosaurus* (tyrant lizard)

**Species**
*rex* (king)
Skeleton Diagram
_Tyrannosaurus rex_ — Bucky

The shaded bones are real fossils.

Scale: 1 cm = .5 m
Tyrannosaurus rex — Bucky
Kelsey — Triceratops horridus
One full-size fossilized bone skeleton in Dinosphere

Background
Kelsey the Triceratops is a ceratopsian, or “horned dinosaur,” that lived during the Late Cretaceous Period more than 65 million years ago. Appearances can be deceiving. Triceratops, often depicted as a passive, plant-eating behemoth, was actually one of the most dangerous animals in the Cretaceous world to a predator such as T. rex. There is debate about whether Triceratops lived in herds. The skeletons of other ceratopsians have been found together in large bone-beds, but Triceratops is often found alone. Paleontologist Bob Bakker has speculated that they roamed the Cretaceous forests on their own and did not migrate. Only when T. rex couldn’t find a herd of duckbills would it try to attack a large and dangerous prey like Triceratops. It took a lot of food to feed Triceratops. Since it was herbivorous, it ate many pounds of cycads, ferns and other low-growing plants daily. It may also have used its horns to knock down small trees and then snipped the leaves with its parrot-like beak. Scientists know some of the plants that Triceratops devoured by studying phytoliths — tiny parts of plants that left scratch marks on the animals’ teeth or remained between teeth even after the animal fossilized. Kelsey has a short, pointed tail, a bulky body, columnar legs with hooflike claws, and a bony neck frill rimmed with bony bumps. Like other Triceratops, Kelsey has a parrot-like beak, many cheek teeth and powerful jaws. Why Kelsey is significant:

Completeness
More than 50 percent of Kelsey’s skeleton has been uncovered, making this specimen one of the top three Triceratops skeletons known to science and perhaps the most complete. Although Triceratops is one of the most popular dinosaurs with children, remarkably few have been found, and most that have been found are fragmentary.

Discovery
Kelsey was found by the Zerbst family in Niobrara County, Wyo., in 1997 and named after a young granddaughter. Kelsey was discovered eroding from a hillside on the ranch of Leonard and Arlene Zerbst. To date, the Zerbsts and paleontologists from the Black Hills Institute have excavated more than half of Kelsey’s skeleton. Alongside Kelsey were found more than 20 fossilized teeth shedded by a predatory dinosaur, Nanotyrannus, a smaller cousin of T. rex. Perhaps Kelsey died of natural causes and was scavenged, or perhaps she was attacked and killed by predators.

Site
Triceratops roamed what is now western North America at the very end of the Dinosaur Age. Kelsey was found on the famous Lance Creek fossil bed, where many Late Cretaceous dinosaur fossils have been excavated.

Size
The sheer bulk and size of Triceratops — up to 22 feet long and 9 feet tall and weighing as much as 6 tons — commanded attention. A thrust from one of its three sharp horns (the two above the eye sockets each measured up to 3 feet long) could be lethal to an attacker. Kelsey has a large skull over 6 feet (2 m) long, one of the largest skulls of any land animal ever discovered. The head is nearly one-third as long as the body.

Name
This specimen was named after the Zerbsts’ granddaughter Kelsey Ann. John Bell Hatcher described the first Triceratops fossils in 1889. Othniel C. Marsh named the specimen “three-horned face.” The name refers to the two large brow horns and the smaller nose horn of these animals. This easily recognized dinosaur has become widely popular, particularly among children who have seen movies featuring the behemoth as a peaceful, plant-eating creature.

Fossils
Triceratops skulls are huge — measuring up to 7 feet long — and heavy. Kelsey’s is solid fossilized bone, up to two inches thick, from the top of the frill to the tip of the beak-like mouth. The skull is also bumpy — or in scientific terms, displays rugosity. Some scientists speculate that this may be an indication of older age. The frill at the top of the skull was originally thought to be crucial for protecting the neck area. Scientists now think the frill may have been more important in mating rituals. A flush of blood over the frill might have attracted females or deterred rival males in shoving matches. Still another explanation for the frill is heat regulation. As the body warmed up, heat escaped from the frill and body temperature was stabilized. Kelsey’s fossilized bones of interest are the huge cranium, massive femur, mandible teeth and great horn.

Dinosphere link
In Dinosphere, Kelsey charges the adult T. rex. Stan. Bucky, the younger T. rex, circles around Kelsey, ready to strike. Though two against one may seem like a mismatch, the outcome in such a fight would be uncertain. The Triceratops could wound one or both of the tyrannosaurs.

Dinosphere Dinosaur Classification
Kingdom — Phylum — Class — Order — Family — Genus — Species
Kids Please Come Over For Great Science!

Kelsey — Triceratops horridus

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Skeleton Diagram

*Triceratops horridus* — Kelsey

The shaded bones are real fossils.

Scale: 1 cm = 28 cm
Drawing
*Triceratops horridus* — Kelsey
Baby Louie — Oviraptor
One full-size fossilized bone skeleton in Dinosphere

Background
About 65 million years ago in what is now Hunan Province, China, a dinosaur egg was just about to hatch. Sometime before, the mother had probably scooped out a wide, shallow nest, then laid eggs two at a time in a circular pattern in as many as three layers. Finally, she settled down on top of the nest, spreading out to keep it warm and safe from predators. But something went wrong. Perhaps something scared the mother and the nest was trampled. Maybe a predator tried to steal the eggs. Scientists who have studied the specimen say it looks as if Baby Louie was stepped on and crushed. However it happened, slowly rising water probably covered the eggs. But as silt and sand settled over the nest, Baby Louie’s fossilized bones remained surprisingly intact. Today, Baby Louie is a “star” dinosaur specimen that scientists continue to study. Paleontologist Charlie Magovern wants to look closely at the nest and focus on two other eggs, affectionately dubbed Huey and Duey. Perhaps improved scanning technology will help to determine if there are little fossilized bones inside those eggs as well. Baby Louie is the only known articulated dinosaur embryo ever discovered.

Why Baby Louie is significant: Completeness
It is not always obvious which species of dinosaur laid a particular egg, even when fossilized bones are found inside. This is because embryonic skeletons are small and fragile, and the skeleton is initially made of cartilage that does not preserve well before calcification occurs. This specimen, however, is remarkably well-preserved and remains in an articulated position. Baby Louie was delicately prepared by utilizing a powerful microscope and small needles to carefully free it from the rock matrix. Several years have been devoted to preparing this dinosaur specimen for exhibit.

A unique find
Baby Louie is an unusual dinosaur specimen representing an unknown giant species of Oviraptor with some very birdlike characteristics. This Late Cretaceous specimen consists of the fossilized remains of a small dinosaur in an egg. While most embryonic remains are jumbled piles of fossilized bones, Baby Louie is extremely rare in that the fossilized bones are intact and well-articulated. Did dinosaurs incubate their eggs? Did they raise their young? How were they related to modern birds? These are questions to which Baby Louie may be able to provide answers. Recently paleontologists identified a fossilized bone from the skull as part of a lower jaw. The shape of this fossilized bone — beaklike without teeth — is similar to the lower jaw of the group of dinosaurs that includes Oviraptor. Some scientists believe this is an extremely large new species.

Discovery
The amazing discovery of this dinosaur embryo within its nest is beginning to unlock the mystery of what kind of theropod laid such eggs. In 1994 Charlie Magovern discovered this embryo while working on a large egg block from China in his preparation laboratory. He named the embryo Baby Louie after photographer Louie Psihoyos, who photographed it for the May 1996 issue of National Geographic magazine. Magovern spent years using a stereoscopic microscope and small needles to free the tiny fossilized bones from the rock.

Site
Baby Louie was excavated from the ancient rocks of the Shiguo Formation in the Hunan Province of China.

Name
In 1923, the first of these dinosaurs ever found was dubbed Oviraptor or “egg robber” because the remains were in a nest of eggs mistakenly identified as those of another species. It was proven in 1994 that the eggs were actually laid by the dinosaur itself, leading to the assumption that Oviraptor cared for its young much as today’s birds do. What scientists know about Baby Louie has changed over time. At first, Baby Louie was thought to be a therizinosaur embryo. Artist Brian Cooley sculpted a fleshed-out version for the cover of the May 1996 National Geographic magazine. Later, scientists examining Baby Louie found telltale signs of an ornithomimid. Other scientists have reviewed the findings and now believe it is an Oviraptor or perhaps a new genus. The debate continues.

Fossils
Baby Louie’s fossilized bones include many that are crucial to identification, including cranium, mandible, femur, dorsal vertebrae, tibia, cervical vertebrae, metatarsal and manus claw.

Dinosphere link
Baby Louie is displayed in a special case in Dinosphere. The exhibit plays an important role in the discussion of eggs, nests and dinosaur babies.

Dinosphere Dinosaur Classification
Kingdom — Phylum — Class — Order — Family — Genus — Species
Kids Please Come Over For Great Science!
Fossil

*Oviraptor* embryo — Baby Louie

Baby Louie’s skull and other bones are clearly visible. The fossil bones are full size.

This model of Baby Louie was created by paleo-artist Brian Cooley.

The Children’s Museum of Indianapolis

Drawing

*Oviraptor* embryo — Baby Louie

Scale: 1 cm = .5 cm

© 2001
Sculpture

*Oviraptor* embryo — Baby Louie

Working from the fossilized bones, artist Gary Staab created this model of what Baby Louie might have looked like as a hatchling.
**Maiasaura peeblesorum**

*One full-size fossilized bone skeleton in Dinosphere*

**Background**

When paleontologist John Horner walked into a small rock shop in Bynum, Mont., in 1978, he had no idea what he was about to find. The owners, the Brandvolds, showed Horner a coffee can full of little fossilized bones. Horner saw at once that they were fossilized baby dinosaur bones and asked where they were found. The Brandvolds showed him the site, which was later dubbed “Egg Mountain” for the hundreds of eggs and nests excavated over many seasons. The Brandvolds, it turns out, had discovered a new species of dinosaur, which Horner named *Maiasaura*, meaning “good-mother lizard.” Horner speculated that these dinosaurs cared for their young. He studied baby *Maiasaura* skeletons and surmised from their soft fossilized bones that they couldn’t walk just after hatching. He guessed that they probably stayed for about a month in the nest and depended on the adults to bring them food. Bits of fossilized eggshell were also found, indicating hatchlings stayed long enough to trample their shells. Though more recent research has challenged Horner’s hypothesis, the “good-mother lizard” moniker has stuck. Like the hypacrosaurs, *Maiasaura* were duck-billed hadrosaurs. They probably had to eat many pounds of leaves, berries, seeds and woody plants each day to survive. *Maiasaura* had a toothless beak for snipping plants and hundreds of specialized teeth for chewing and grinding. Teeth were frequently worn down by all the chewing, but for each functioning tooth up to four or five were growing and ready to replace it. Maiasaurus had to eat almost constantly to get enough food to maintain their weight. And because they traveled in large herds for protection (perhaps up to 10,000 in number), they migrated in search of new food supplies.

**Discovery**

The *Dinosphere* *Maiasaura* is a composite skeleton, meaning it is made up of the fossilized bones of several individual dinosaurs. The fossils come from the Two Medicine Formation in Teton County, Mont. Cliff and Sandy Linster and their seven children — Brenda, Cliph, Bob, Wes, Matt, Luke and Megan — discovered a rich fossil site that holds the fossilized bones of many maiasours. For many years they have spent their summer vacations excavating dinosaurs at the site.

**Site**

The first *Maiasaura* fossils consisted of a 75-million-year-old nesting colony found in the badlands of Montana by John Horner and Robert Makela in 1978. The colony contained eggs, babies and adults. The number of specimens found gave rise to the belief in parental care and also to the theory that maiasours were social, with females nesting and living in large herds. Also found at the Linsters’ dig site were the remains of a large meat-eating gorgosaur and several small bambiraptors. These creatures likely fed upon the maiasours.

**Name**

Paleontologist John Horner named *Maiasaura* “good-mother lizard” because he believed that these dinosaurs took care of their offspring well after they hatched.

**Size**

Maiasours were large — up to 30 feet long, 12 to 15 feet tall and weighing roughly 3 to 4 tons. They walked on all fours, although they could also stand on two legs for feeding. Their hands had four fingers and their feet were shaped like hooves. They also had a long, stiff tail that helped with balance.

**Dinosphere link**

Meat-eating dinosaurs such as Gorgosaurus probably preyed on the maiasaur herds. In *Dinosphere* a maiasaur lies on the ground with a gorgosaur standing above it. Visitors are challenged to look for clues and solve this whodunit. Did the maiasaur die from natural causes or did the gorgosaur kill it?

**Dinosphere Dinosaur Classification**

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**Dinosaur — Maiasaura peeblesorum**

**Dinosaur — Edmontosaurus annectens**

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</table>
Skeleton Diagram
*Maiasaura peeblesorum*

The shaded bones are real fossils.

Scale: 1 cm = .5 m
**Gorgosaurus**

**One full-size fossilized bone skeleton in Dinosphere**

**Background**

When people see an illustration of *Gorgosaurus* they almost always think of its popular cousin, *Tyrannosaurus rex*. There are many similarities. Both were fierce carnivores with dozens of sharp teeth designed for biting and swallowing prey. They were bipeds with small muscular arms and a long tail that balanced the body. Eyes on the front of the skull and a highly developed sense of smell were important adaptations for hunting prey. There are a few differences between the two, however. First, they were not contemporaries. *Gorgosaurus* lived about 74 to 80 million years ago, several million years before the oldest known *T. rex*. Second, *Gorgosaurus* had a bony plate (rugose lacrimal) over its eyes. Then there's the difference in size. *Gorgosaurus* was about 25 feet long, slightly smaller than *T. rex*.

**Why the Gorgosaurus is significant**

Completeness

There have been only 20 *Gorgosaurus* specimens ever found, and this one is the most complete. One of the most valuable aspects of its discovery is a thin, V-shaped fossilized furcula, a bone commonly found in birds and often referred to as a wishbone. Long considered a characteristic only of birds, this evidence helps to bolster the claim that birds and dinosaurs are related. Further, almost all of the fossilized teeth are intact and still attached to the jawbone. The body is 75 percent complete.

**Discovery**

Cliff and Sandy Linster found this gorgosaur in 1997 in Teton County, Mont. It is an interesting and significant find. The furcula (wishbone) may help bolster the claim that birds and dinosaurs are related. There are interesting pathologies in the skeleton. Preparators have found major injuries in the left femur, a mostly healed compound fracture of the right fibula, and some fused vertebrae at the base of the tail. Scientists surmise that this gorgosaur walked with pain and probably had help from others in its pack to survive.

**Site**

*Gorgosaurus* finds are rare, more so than *T. rex*. *Gorgosaurus* specimens have been discovered only in North America, excavated at sites in Montana, New Mexico and Alberta, Canada.

**Size**

An adult *Gorgosaurus* measures approximately 25 feet in length and 10 feet high at the hip. *Gorgosaurus* is smaller than *T. rex* and a more slender, fierce fleet-footed hunter, capable of pursuing prey at speeds in excess of 20 mph. It has a strong, muscular neck and more than sixty 4- to 5-inch-long serrated teeth. The teeth are not well suited to chewing, so *Gorgosaurus* may have swallowed large chunks of flesh whole. It has powerful legs, three-toed feet with sharp claws, and longer arms than *T. rex*.

**Name**

Lawrence Lambe, who named it “fearsome lizard,” first described *Gorgosaurus* in 1914. It was dubbed *Gorgosaurus* in reference to its enormous mouth and teeth. Later, scientists suggested it was a smaller form of *Albertosaurus* and took away its distinction as a separate species. In 1992, Phil Currie argued that *Gorgosaurus* was distinct from *Albertosaurus* and the terminology was restored.

**New species**

The well-preserved fossilized breastbone, extraordinary curved hand claws and rugose lacrimal (eyebrow bone) suggest it is a species previously unknown to science. Paleontologists, including Robert Bakker and Phil Currie, are currently studying the find.

**Fossils**

The fossilized bones are rare and complete. Fossilized bones of interest include a fibula with a stress fracture, and healed caudal and scapula fractures. Preparators working on the skull also found interesting features that were identified as vestibular bulae, very delicate structures in the nasal passages that are unusually well preserved. The find may shed new light on dinosaur physiology.

**Dinosphere link**

Found with the gorgosaur were the remains of a maiasaur and two *Bambiraptor* specimens. Perhaps the gorgosaur was feasting on the maiasaur while the raptors waited for their turn. Visitors to Dinosphere are challenged to decide whether the maiasaur was killed or scavenged.

**Dinosphere Dinosaur Classification**

*Kingdom — Phylum — Class — Order — Family — Genus — Species*

**Kids Please Come Over For Great Science!**

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**Gorgosaurus**

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© The Children’s Museum of Indianapolis 2005
Skeleton Diagram
Gorgosaurus

The shaded bones are real fossils.

Scale: 1 cm = .5 m
Drawing
Gorgosaurus

Scale: 1 cm = 0.5 m
Frannie — Prenoceratops pieganensis

One full-size fossilized bone skeleton and one cast model skeleton in Dinosphere

Background
There’s something mysterious about Prenoceratops. It doesn’t seem to belong to the usual cast of Cretaceous creatures. Scientific analyses of the bones of our dinosaur reveal that it is in fact not a Leptoceratops but a completely new type of dinosaur — a Prenoceratops. Differences in the bones of the skull are significant enough to give this animal a new genus and species name. It does, however, remain in the same family as Leptoceratops and other “primitive” members of the dinosaur group that includes Triceratops and other horned dinosaurs (these “primitive” members of this group are called basal neoceratopsians). This is roughly the same relationship that dogs and foxes have. Phil Currie explains that at the end of the Mesozoic Era, most dinosaurs were specialists. That is, they had adapted and evolved in special ways to meet the challenges of a changing environment. Prenoceratops, however, was a generalist. It was around for a very long time in geological history and did not seem to develop unique adaptations. Perhaps it survived on the fringes of the forest or in the uplands where there was less competition for food from fewer predators. Prenoceratops is a small, primitive member of the ceratopsian family. Unlike its larger cousin Triceratops, the diminutive Prenoceratops is a rare occurrence in the fossil record.

Why Frannie is significant:
Completeness
This specimen is a fully adult Prenoceratops that contains about 60 percent original fossilized bone. Paleontologists at the Museum of the Rockies in Bozeman, Mont., assert that this dinosaur represents an entirely new genus. Prenoceratops is a primitive cousin of another Dinosphere specimen — Kelsey the Triceratops. Prenoceratops, however, had only a small frill and no horns. It measured approximately 6 feet long and weighed 120 to 150 pounds. About 3 feet tall, Prenoceratops probably walked on four feet but may have had the ability to stand on two for feeding. Its slender build indicates that it could move quickly. Like Triceratops, Prenoceratops had the characteristic parrot beak that helped snap and grind plants. Scientists point out, however, that Prenoceratops teeth were different from those of other ceratopsians, being broader rather than long. Prenoceratops had only two teeth in each position, compared to the batteries of teeth found in other herbivores. And each tooth had only a single root, compared to ceratopsians’ double root. Paleontologists are not sure if Prenoceratops was a solitary or herding animal. It is related to Leptoceratops, and only a few of these creatures have been found in the fossil record, so it is possible that it roamed by itself or in very small herds. In 1999, fossils of six Leptoceratops sub-adults were found in a bone bed in the Two Medicine Formation, perhaps lending credence to the idea that Prenoceratops lived in small groups. Discovery
Dorothy and Leo Flammand found this Prenoceratops in Powell County, Montana, in the summer of 1995. About 60 percent of the skeleton is actual fossilized bone. Using the matrix as a dating tool, it is estimated that the age of the fossil is between 65 and 74 million years old.

Site
The Flammands found this dinosaur among the rocks of the Two Medicine Formation, which dates back to the Maastrichtian Stage of the Late Cretaceous Period, 74 to 83 million years ago.

Size
This animal is a Protoceratopsian dinosaur, a primitive member of the ceratopsian family that weighed less than 150 pounds, stood at less than 3 feet tall on all fours and was less than 6 feet long.

Name
This new genus of ceratops has been named Prenoceratops and this dinosaur was given the species name pieganensis. The genus name means “sloping horn-face” and the species name is the name of the tribe of Blackfeet Indians that live on the reservation where the specimen was found.

Fossils
Fossilized bones of interest include the cranium, which is the hallmark of the species, unique teeth, phalanges for digging and an unusual scapula.

Dinosphere link
In Dinosphere, the Prenoceratops watches for predators and feeds on low-growing plants near a group of hypacrosaurs at a small watering hole. This scene shows something about dinosaur diversity: Not all dinosaurs were large or carnivorous. Some, like Prenoceratops, were small creatures that spent most of their time hiding or feeding.

Dinosphere Dinosaur Classification
Kingdom — Animalia (animals)
Phylum — Chordata (animals with spinal nerve cords)
Subphylum Vertebrata (chordates with backbones)
Class — Archosauria (“ruling reptiles”)
Subclass Dinosauria (extinct reptiles, “terrible lizards”)
Order — Ornithischia (bird-hipped)
Suborder Marginocephalia (fringed heads)
Family — Ceratopsidae (frilled dinosaurs)
Genus — Prenoceratops (slender-horned face)
Species — pieganensis (after the Blackfeet Indian tribe who lived in the area where it was found)
Skeleton Photos

*Prenoceratops pieganensis* — Frannie

Prenoceratops is a small, primitive member of the Ceratopsidae family.
Drawing

*Prenoceratops pieganensis* — Frannie

The shaded bones are real fossils.

Scale: 1 cm = 8 cm
Hypacrosaurus stebingeri
One full-size adult fossilized bone skeleton, one full-size juvenile fossilized bone skeleton, one full-size baby fossilized bone skeleton and one full-size baby cast model skeleton in Dinosphere.

Background
Hypacrosaurus is a large, plant-eating dinosaur that roamed the earth towards the end of the Cretaceous Period. This creature is commonly known as one of the hadrosaurs, or “duckbill dinosaurs.” While some dinosaurs are rare in the fossil record, Hypacrosaurus is abundant. Some scientists liken duckbills to large herds of bison that once roamed the plains of North America. Barnum Brown described the first specimen in 1913 and noted its prominent nasal crest. The ancient remains of these three specimens provide a unique opportunity to show dinosaur family dynamics.

Why the hypacrosaurs are significant: Completeness
The largest is a composite skeleton of an adult hypacrosaur containing 75 percent fossilized bones. The juvenile skeleton is a composite containing 70 percent fossilized bones. The infant specimen contains 35 percent original fossilized bones.

Discovery
Hypacrosaurus is well-represented in the fossil record and thus is one of the best known dinosaurs in the world, with specimens in several museums. Because they required so much food to survive, it is likely that herds migrated to find a constant food supply. There was also safety in numbers, as carnivores were less likely to attack a herd of large, healthy adults. But traveling in numbers had its dangers. If a herd tried to cross a flooded river, hundreds could drown. That is one explanation for what might have happened to the Dinosphere specimens, which were found in fossilized bone beds containing parts of individual hypacrosaurs.

Site
The fossilized bones of these hypacrosaurs were discovered in 1990 in the rocks of the Two Medicine Formation in northernmost Montana, and were excavated over a period of five years.

Size
Hypacrosaurus was a big animal, averaging 30 feet long and 15 feet tall. To maintain its size, it had to eat as much as 60 pounds of plant material per day. Rows and rows of teeth on either side of its jaws sliced tough fibers. Like other duckbill dinosaurs, Hypacrosaurus had a long snout and a beak that helped it shred plants. It likely stayed in the forests, snipping plants and leaves up to 6 feet off the ground. It had strong back legs that supported its weight. Some scientists speculate that it could also balance on its hind legs to reach leaves in tall trees. Its front legs were shorter, but three of its four fingers were wrapped in a “mitten,” making it easier to walk. A long, thick tail helped the animal keep its balance. Scientists estimate it could travel up to 12 miles per hour in a hurry but that it usually walked on all fours at a much more leisurely pace.

Name
Hypacrosaurus means “almost the highest lizard,” which refers to the height of the crest on its head.

Unique features
Like many duckbill dinosaurs the Hypacrosaurus has an expanded nasal crest on its head that may have been used as a resonating chamber for communicating. Oddly enough only the adults had crests, leading paleontologists to theorize that the juveniles would have made much different sounds. Some scientists believe the crest may have been used as a display or signal to other hypacrosaurs, possibly in mating rituals. These animals are thought to have formed large herds, established migratory patterns and created nesting sites. It is possible that adult female hypacrosaurs traveled to nesting colonies in a sandy site, where they could scoop shallow impressions to hold up to 20 eggs. The eggs might have been covered by sand and plant material to keep them warm during incubation because the mothers were far too large to sit on the nest. After hatching from the cantaloupe-size eggs, babies measured about 24 inches long. Scientists debate whether the adults cared for the babies or left them to fend for themselves. Since they grew so quickly, young hypacrosaurs would have needed a supply of protein. Perhaps they ate insects in addition to plants. It is unclear how soon they may have joined the herd. Tiny young dinosaurs were apt to be trampled, so they may have banded together until they were big enough to travel.

Fossils
Fossilized bones of interest include the cranium and expanded nasal crest that may have aided in production of sound, a unique dental battery, dorsal and caudal vertebrae, chevron, femur, humerus, pes claw and manus claw.

Dinosphere link
In the Dinosphere story line, the four hypacrosaurs have separated from the herd to come to a watering hole. The adult is nervous and can smell a predator. While the juveniles drink, the baby is chasing a dragonfly, perhaps looking for a quick snack. Danger lurks nearby, both in the water and on the land; the mother is alert and ready to protect her young. Displaying the four together affords the opportunity to talk about dinosaur families, herding and migration.

Dinosphere Dinosaur Classification
Kingdom — Phylum — Class — Order — Family — Genus — Species
Kids Please Come Over For Great Science!

Duckbill — Hypacrosaurus stebingeri

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<td>stebingeri (after Eugene Stebinger, who found the first specimens)</td>
</tr>
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</table>
Skeleton Diagram

_Hypacrosaurus stebingeri_

The shaded bones are real fossils.

Scale: 1 cm = 0.5 m
The hypacrosaur is a large plant-eating duckbill that roamed the earth toward the end of the Dinosaur Age.
**Bambiraptor feinbergi**

**Two full-size juvenile cast model skeletons in Dinosphere**

**Background**
Bambiraptor lived about 74 to 80 million years ago, several million years before the oldest known T. rex. A carnivore, it lived and died with Gorgosaurus and Maiasaura.

**Why Bambiraptor is significant:**
Bambiraptor is significant because it is the most birdlike of all the raptor dinosaurs found. It is not known if they actually flew, but the well-preserved fossilized bones show strong relationship to birds. This small raptor is important in establishing the link between dinosaurs and birds. Only one skeleton has been found.

**Completeness**
The specimen is in excellent condition. Dinosphere features two cast models of the original.

**Discovery**
Wes Linster, son of Cliff and Sandy Linster, found the first teeth-filled jawbone of Bambiraptor.

**Site**
The specimen was found in 1993 at the Linster family site in Teton County, Mont.

**Size**
Bambiraptor was about 3 feet long and weighed about 7 pounds. Its 5-inch skull is about the size of a light bulb.

**Name**
Bambiraptor was named for its size. Bambiraptor feinbergi was named in honor of Michael and Ann Feinberg, who helped to ensure these fossils would be in the public domain for all to enjoy.

**Fossils**
The original is an almost perfect specimen similar to Archaeopteryx, especially the furcula (wishbone) and semi-lunate (wrist) bone. Some scientists believe Bambiraptor has the largest relative brain size of any known dinosaur.

**Dinosphere link**
Found with the Bambiraptor specimens were the remains of a maiasaur and a gorgosaur. Perhaps the raptors were trying to scavenge some of the maiasaur that the gorgosaur was eating. They would need to be quick to get food away from a gorgosaur. Visitors to Dinosphere are challenged to decide whether the maiasaur was killed or scavenged.

**Dinosphere Dinosaur Classification**

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<td>Archosauria (“ruling reptiles”)</td>
</tr>
<tr>
<td></td>
<td>Subclass Dinosauria (extinct reptiles, “terrible lizards”)</td>
</tr>
<tr>
<td>Order</td>
<td>Saurischia (lizard-hipped)</td>
</tr>
<tr>
<td></td>
<td>Suborder Theropoda (beast-footed)</td>
</tr>
<tr>
<td>Family</td>
<td>Coelurosauridae (very advanced meat-eaters)</td>
</tr>
<tr>
<td>Genus</td>
<td>Bambiraptor (baby raptor)</td>
</tr>
<tr>
<td>Species</td>
<td>feinbergi (in honor of Michael and Ann Feinberg)</td>
</tr>
</tbody>
</table>
Photograph
*Bambiraptor feinbergi*

*Bambiraptor feinbergi* is a small birdlike dinosaur with a very large brain case.

Scale: 1 cm = 5 cm
**Didelphodon vorax**

*Two full-size sculpted models in Dinosphere*

If you have seen an opossum, you know what *Didelphodon* might have looked like. Though no one has found anything more than a few pieces of a *Didelphodon* — fossilized teeth, jaw and skull fragments — scientists have speculated that it resembled today's opossum in shape and size. In fact, the genus name, *Didelphodon*, means "opossum tooth."

Barry Brown was searching for fossils in 2001 in Harding County, S. D., when he spotted a small area of eroding rock that was filled with "micro material" — tiny fossilized bones, teeth and claws from mammals, fish, amphibians, reptiles and dinosaurs. Finding a canine tooth still imbedded in the jaw was significant because previously fossil hunters had seen only loose fossilized teeth. The *Didelphodon* jaw helps scientists determine the size, position and number of the animal's other teeth, and serves as a useful comparison tool when studying other early mammals.

Despite its small size, *Didelphodon* was among the largest mammals in the world 65 million years ago. Dinosaurs ruled the land and mammals were an easy target for the giant carnivores. *Didelphodon* likely burrowed into the ground and slept during the day for protection. At night, it relied on its keen sense of smell and good vision to find insects, small reptiles, amphibians, other mammals and dinosaur eggs. Its teeth were especially well-suited for crushing, so it could probably feast on clams, snails and baby turtles as well.

Like today's kangaroos and koalas, *Didelphodon* was a marsupial that probably carried its young in a pouch. Though marsupials are found today primarily in Australia and South America, *Didelphodon* fossils have been found only in North America. In Dinosphere, the *Didelphodon* jaw will be exhibited near the two tyrannosaurs and the *Triceratops*. Visitors can easily imagine what it would have been like to hide in a burrow while big dinosaurs battled nearby.

---

**Dinosphere Classification**

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Animalia (animals)</th>
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<tr>
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<td>Infraclass Metatheria (pouched animals)</td>
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<td>Order</td>
<td>Marsupialia</td>
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<td></td>
<td>Suborder Didelphimorphia (opossums)</td>
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<td>Family</td>
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<tr>
<td>Genus</td>
<td><em>Didelphodon</em> (opossum tooth)</td>
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<tr>
<td>Species</td>
<td><em>vorax</em></td>
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</tbody>
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---

These two Didelphodon models are based upon small fossilized teeth and jaw bone.
Dig Site (Excavation) Map — Kelsey, *Triceratops horridus*

**Kelsey**  
*Triceratops* Dig  
4.22.98  
Zerbst Ranch, Wyoming  
Lance Creek Formation

Map produced by  
Terry Wentz  
Peter L. Larson  
Larry Shaffer

Illustrated by  
Larry Shaffer

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Black Hills Institute of  
Geological Research, Inc.
### Dinosphere Dinosaur Classification Chart

**Saurischia — lizard-hipped**

<table>
<thead>
<tr>
<th>Saurapoda — lizard-footed</th>
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<tbody>
<tr>
<td><em>Barosaurus</em></td>
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<tr>
<td>Camarasaurus</td>
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<td><em>Diplodocus</em></td>
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<td>Aragosaurus</td>
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<td><em>Saltasaurus</em></td>
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<td>Patagosaurus</td>
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<table>
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<tr>
<th>Therapoda — beast-footed</th>
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</thead>
<tbody>
<tr>
<td>Allosaurus</td>
</tr>
<tr>
<td><em>Oviraptor (Baby Louie)</em></td>
</tr>
<tr>
<td>Ceratosaurus</td>
</tr>
<tr>
<td><em>Gorgosaurus</em></td>
</tr>
<tr>
<td>Troodon</td>
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<tr>
<td><em>Tyrannosaurus rex</em> (Stan, Bucky)</td>
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<tr>
<td><em>Bambiraptor feinbergi</em></td>
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**Ornithischia — bird-hipped**

<table>
<thead>
<tr>
<th>Ornithopoda — bird-footed</th>
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</thead>
<tbody>
<tr>
<td>Camptosaurus</td>
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<tr>
<td>Corythosaurus</td>
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<tr>
<td><em>Edmontosaurus annectens</em></td>
</tr>
<tr>
<td>Heterodontosaurus</td>
</tr>
<tr>
<td><em>Maiasaura peeblesorum</em></td>
</tr>
<tr>
<td>Prosaurolophus</td>
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<tr>
<td><em>Hypacrosaurus stebingeri</em></td>
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</table>

<table>
<thead>
<tr>
<th>Ornithopoda — bird-footed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camptosaurus</td>
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<td>Prosaurolophus</td>
</tr>
<tr>
<td><em>Hypacrosaurus stebingeri</em></td>
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**Thyreophora**

<table>
<thead>
<tr>
<th>Stegosauria — roofed or plated reptiles</th>
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<tbody>
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<td>Stegosaurus</td>
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<tr>
<td>Kentrosaurus</td>
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<table>
<thead>
<tr>
<th>Ankylosauria — armored reptiles</th>
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<tr>
<td>Ankylosaurus</td>
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<tr>
<td>Hylaesaurus</td>
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**Ceratopsia — horn-faced**

<table>
<thead>
<tr>
<th>Protoceratops</th>
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<tr>
<td><em>Prenoceratops pieganensis</em> (Frannie)</td>
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<tr>
<td>Brachyceratops</td>
</tr>
<tr>
<td><em>Triceratops horridus</em> (Kelsey)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pachycephalosauria — thick-headed reptiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pachycephalosaurus</td>
</tr>
</tbody>
</table>

* *Dinosaur fossil bones in Dinosphere*
Dinosphere Floor Plan
The horns, claws, teeth and armor on these dinosaurs make the outcome undecided. Studying the fossils can reveal clues about how the fight might end.

**Tyrannosaurus rex Attack Scene — What will be the outcome?**

**Enduring idea**
Fossils are clues that help us learn about dinosaurs.

**Secondary messages**
Fossils show that life could be dangerous and short at the top of the food chain. Fossils show that some dinosaurs lived in family groups.

**Tertiary messages**
Dinosaurs fought for food, mates and territory. Disease and wounds were constant threats. Some dinosaurs helped each other.

**Story line**
What was it like to be a top predator? Fossils show that life could be dangerous and short at the top of the food chain. Fossilized T. rex bones display numerous injuries. By comparing tyrannosaurs to modern-day predators, scientists surmise that they were not always successful in catching prey. And when they were not hunting, dinosaurs were fighting each other for food, mates and territory.

In this scene two hungry tyrannosaurs, an adult and a juvenile, are stalking a Triceratops. Two against one seems like unfavorable odds, but the Triceratops is no pushover. It boasts three sharp horns that can inflict fatal wounds on either predator. Suddenly, the Triceratops charges the adult T. rex, aiming for the torso. The younger T. rex quickly lunges for the Triceratops. Maybe it is a foolish move. It risks being crushed underfoot or impaled. Who will win? Who will lose? Or will this encounter end in a stalemate?

The noise and movement have terrorized two opossum-size didelphodons hiding inside a nearby burrow. They are nocturnal animals and this afternoon skirmish has interrupted their nap. Because they could be trampled, they stay hidden, hoping the predators will be chased away.

Prey are not always easy to catch, so the two tyrannosaurs may go days or weeks without eating anything. In the meantime, they often fight with other tyrannosaurs over mates or territory. Broken bones, bites and claw marks are common injuries for these animals, while starvation always looms. It is not an easy life for a top predator like T. rex.
Dinosphere *Tyrannosaurus rex* Attack Scene
Michael Skrepnick Mural Sketch
What will be the outcome?

Paleo-artist Michael Skrepnick's "T. rex Attack" scene is based upon the most current research and findings about how dinosaurs interacted.
Resource Materials

Dinosphere Watering Hole Scene

The Watering Hole Scene: *Hypacrosaurus, Prenoceratops* — Is this a family?

Enduring idea
Fossils are clues that help us learn about dinosaurs.

Secondary message
Fossils show that some dinosaurs lived in family groups.

Tertiary messages
Some dinosaurs lived in herds and migrated to find food. Some dinosaurs helped each other. Some dinosaurs took care of their hatchlings.

Story line
How did dinosaurs interact with one another? The fossils featured in *Dinosphere* indicate that some dinosaurs lived in family groups. Fossilized bones of big and little dinosaurs are found together in fossil beds. Trackways show that some dinosaurs traveled together in herds for protection or to find food.

In this scene it is early morning in the Cretaceous world and creatures are gathered at a watering hole — a dangerous place for most animals. Adult and juvenile duckbill dinosaurs are thirsty. They have separated from the herd to find water. Nearby, two baby dinosaurs playfully chase a dragonfly. Do you think these dinosaurs are strangers? Or could they be a family, traveling together to stay safe and find food?

There is a crunching noise in some low-lying bushes by the water. One *Prenoceratops* snips and swallows leaves and twigs, while another slowly backs into a shallow hole to watch for predators.

In the murky water, garfish and frogs dart, wriggle and squirm. On a nearby rock, a turtle stretches out in the hot sun, while insects buzz overhead.
Dinosphere Watering Hole Scene

Paleo-artist Michael Skrepnick's "Watering Hole" scene is based on the most current research about dinosaur habits and interactions.
Dinosphere Predator or Scavenger Scene

Predator or Scavenger? A close examination of these fossils may help determine if the gorgosaur killed or scavenged the maiasaur.

Predator or Scavenger Scene: Was it an attack or a scavenger opportunity?

Enduring idea
Fossils are clues that help us learn about dinosaurs.

Secondary messages
Fossils show that life could be dangerous and short at the top of the food chain. Paleontologists find and prepare fossils and study them for clues about ancient life.

Tertiary messages
Dinosaurs fought for food, mates and territory. Disease and wounds were constant threats. Some dinosaurs lived in herds and migrated to find food. Today’s birds may be descendants of the dinosaurs.

Story line
Paleontologists find and prepare fossils and study them for clues about ancient life. The Linsters, a family of amateur paleontologists, found and dug up a gorgosaur, a maiasaur and two Bambiraptor specimens at one site in Montana. Other paleontologists prepared and studied these fossils in the laboratory using special technology. They have noted some unique characteristics of the gorgosaur and recognized similarities between Bambiraptor and today’s birds.

In this scene, scavengers gather silently at a kill site as the sun sets and a full moon rises. They watch and wait as a gorgosaur eats its fill of a maiasaur carcass. Is the gorgosaur a killer or a scavenger? It is a fast and agile runner. Perhaps it chased and outran the duckbill, then attacked when it separated from the herd. Or the maiasaur may have died from sickness or old age and the gorgosaur took advantage of a ready meal.

Feathered, birdlike Bambiraptor sit nearby, watching and waiting for the gorgosaur to leave. One slinks in to snatch a piece of the carcass. This is risky business, since the gorgosaur is within striking distance. The gorgosaur snarls and snaps at the intruders. A meal this big doesn’t come along everyday. The gorgosaur will make the scavengers wait a while longer.
Dinosphere Predator or Scavenger Scene
Exhibit Perspective
Was it an attack or a scavenger opportunity?

Paleo-artist Michael Skrepnick’s “Predator or Scavenger” scene depicts the question posed in Dinosphere: Did the gorgosaur kill the duckbill, or is it just a scavenger with an opportune find?
**Dinosphere Area**

**Dinosaur Eggs, Nests and Babies Area — Oviraptor**

**Enduring Idea**

Fossils are clues that help us learn about dinosaurs.

**Dinosaur Eggs**

How did dinosaurs interact with one another? Fossils show that some dinosaurs lived in family groups. Dinosaurs mated and laid eggs of different shapes and sizes. Some laid their eggs and left them. Others took care of their hatchlings. Paleontologists have found many dinosaur nests and eggs, and some fossil bones of female dinosaurs have been found on top of nests. Telltale clues in the fossilized bones of hatchlings suggest that some baby dinosaurs were cared for over a period of time.

Despite careful study of an extraordinary fossil from China, scientists aren’t sure what happened to the little dinosaur dubbed Baby Louie. Some speculate that the dinosaur died while hatching, while others believe it died still in the egg.

![Fossilized eggs contain clues that help us learn more about dinosaurs.](image_url)
In addition to the reconstructed dinosaurs described in this unit, Dinosphere contains numerous individual fossils that indicate the diverse plant and animal life of the Cretaceous Period.

<table>
<thead>
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<th>Fossil</th>
<th>Exhibit</th>
<th>Fossil</th>
<th>Exhibit</th>
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<td>Gorgosaurus</td>
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<td>Therizinosaur</td>
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<td>Prenoceratops pieganensis</td>
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<td>Hadrosaur</td>
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<td>Raptor embryo and nest</td>
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<td>Tyrannosaurus rex</td>
<td>Gorgosaur skull &amp; mandible</td>
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<td>Hemiptera</td>
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<td>Triceratops</td>
<td>Copal with inclusions</td>
<td>Agathis australis and others</td>
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<td>Gorgosaurus</td>
<td>Ammonite</td>
<td>Rhondiceras sp.</td>
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<td>Monoclonius</td>
<td>Ammonite in nodule</td>
<td>Promicroceras planicosta</td>
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<td>Protoceratops andrewsi</td>
<td>Jurassic ammonite</td>
<td>Dactyliceras sp.</td>
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<td>Archaeopteryx</td>
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<td>Allosaurus fragilis</td>
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<td>Camarasaurus</td>
<td>Amber</td>
<td>Agathis australis and others</td>
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<td>Duckbill</td>
<td>Pinecone fossil</td>
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<td>Dinosaur track</td>
<td>Anchiaraupinus sp.</td>
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<td>Seed fern</td>
<td>Alethoptenis grandini</td>
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<td>Saltasaurus</td>
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<td>Cladus sp.</td>
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<td>Oviraptor</td>
<td>Foot</td>
<td>Apatosaurus louisae</td>
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<td>Egg</td>
<td>Hypselosaurus priscus</td>
<td>Fossil wood</td>
<td>Cycadales</td>
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<td>Jaw</td>
<td>Didelphodon</td>
<td>Ginkgo leaf</td>
<td>Ginkgoites sibirica</td>
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<td>Cordulagomphus tuberculatus</td>
<td>Gallator trackway</td>
<td>Ichnogenus grallator</td>
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<td>Aeschnidum cancellosa</td>
<td>Triassic petrified wood</td>
<td>Araucaria sp.</td>
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<td>Aeschnidium cancellosa</td>
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<td>Araucaria sp.</td>
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<tr>
<td>Dragonfly Larva</td>
<td>Dragonfly</td>
<td>Jurassic horseshoe crab</td>
<td>Mesolimulus walchi</td>
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<tr>
<td>Dragonfly Larva</td>
<td>Dragonfly</td>
<td>Keichousaurus</td>
<td>Keichousaurus yuunanensis</td>
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<td>Sequoia dakotensis</td>
<td>Anomoza leaf</td>
<td>Anomoazmites inconstans</td>
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<td>Desmoceras sp.</td>
<td>Rhamphorhynchus</td>
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<td>Scaphite</td>
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<td>Araucaria mirabilis</td>
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<td>Lemuroceras sitampikyense</td>
<td>Petrified wood</td>
<td>Araucaria mirabilis</td>
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<tr>
<td>Crab</td>
<td>Grapsoideus</td>
<td>Jurassic shrimp</td>
<td>Aeger tipularis</td>
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<td>Baculite</td>
<td>Sycamore leaf</td>
<td>Ficus sycomorus</td>
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<td>Guitarfish</td>
<td>Rhombopterygia rajoides</td>
<td>Trilobites</td>
<td>Dalmanites limulus</td>
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<td>Coprolite</td>
<td>Coprolites</td>
<td>Apatosaurus vertebra</td>
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The Children’s Museum of Indianapolis © 2005
### Important Dates in Dinosaur Discovery

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>600 B.C.</td>
<td>Central Asian traders bring stories of griffins, based on the fossil record of <em>Protoceratops</em>, to the ancient Greeks.</td>
</tr>
<tr>
<td>300 A.D.</td>
<td>Chinese scholars record the presence of “dragon bones.”</td>
</tr>
<tr>
<td>1677</td>
<td>Robert Plot illustrates a thighbone, possibly of <em>Megalosaurus</em>.</td>
</tr>
<tr>
<td>1824</td>
<td>William Buckland names <em>Megalosaurus</em>, the first dinosaur to be scientifically described.</td>
</tr>
<tr>
<td>1825</td>
<td>Gideon Mantell and his wife find a dinosaur tooth and name the genus <em>Iguanodon</em>.</td>
</tr>
<tr>
<td>1842</td>
<td>Richard Owen coins the term <em>dinosauria</em>.</td>
</tr>
<tr>
<td>1850 – 1851</td>
<td>Models of <em>Iguanodon</em>, <em>Megalosaurus</em> and <em>Hylaeosaurus</em>, made by Waterhouse Hawkins, are displayed in the Great Exhibit at the Crystal Palace in London.</td>
</tr>
<tr>
<td>1856</td>
<td>The first dinosaur remains from the United States are described.</td>
</tr>
<tr>
<td>1867</td>
<td>Thomas Henry Huxley is the first scientist to suggest that birds are the direct descendants of dinosaurs.</td>
</tr>
<tr>
<td>1877 – 1895</td>
<td>“The Bone Wars,” a fierce scientific rivalry between Othniel C. Marsh and Edward D. Cope, sparks the discovery of hundreds of new dinosaur specimens in the American West.</td>
</tr>
<tr>
<td>1878</td>
<td>Miners discover dozens of <em>Iguanodon</em> skeletons at Bernissart, Belgium.</td>
</tr>
<tr>
<td>1930s</td>
<td>The Chinese scientist C.C. Young begins a series of expeditions to excavate dinosaurs in China.</td>
</tr>
<tr>
<td>1969</td>
<td>John Ostrom, of Yale University, publishes a description of <em>Deinonychus</em>, beginning a revolution in the way scientists and the public perceive dinosaurs.</td>
</tr>
<tr>
<td>1970–present</td>
<td>Increasing evidence suggests that dinosaurs are indeed the ancestors of birds. Continued study of specimens shows that dinosaurs were active, complex animals.</td>
</tr>
</tbody>
</table>

**Sources:**
Culminating Experience
was named after him in 1998. (1840 – 1897) is
visitors will see the (1873–1963) was a
to date near Canon City, Colo.
and found evidence of early in Antarctica. This discovery
2005
the first dinosaur to be Resource Materials
Culminating Experience
Resource Materials

Dinosaur Paleontologists and Advisers

Robert Bakker
Robert Bakker is one of the most noteworthy
dinosaur paleontologists in the United States,
an author and curator of the University of
Colorado Museum in Boulder. The paleontologist
depicted in the movie Jurassic Park 2 was
modeled after Dr. Bakker.

Phil Currie and Eva Koppelhus
Phil Currie is curator of dinosaurs at the Royal Tuley
Museum of Palaeontology, Alberta, Canada,
which has one of the world’s largest
collections of paleontological materials. He
and his wife, Eva Koppelhus, who is a paleo-
botanist, travel the world in search of fossils
and have coauthored several books about
dinosaurs.

John Lanzendorf
John Lanzendorf, of Chicago, is the owner of
the world’s largest and most complete collection
of dinosaur art. The John J. Lanzendorf
PaleoArt Prize was created in 1999 to recog-
nize the outstanding achievements of scien-
tific illustrations and naturalistic art in paleon-
tology. In Dinosphere visitors will see the
Gallery of Dinosaur Imagery featuring The
John Lanzendorf Collection.

Pete and Neal Larson
The Larson brothers excavated Sue, the most
complete T. rex found to date, and founded the
Black Hills Institute of Geologic Research in Hill
City, S.D. The brothers continue to make
significant finds and create displays for
museums around the world, including The
Children’s Museum.

Michael Skrepnick
Michael Skrepnick is a world-famous
Canadian artist whose paintings and draw-
ings of dinosaurs have illustrated articles,
books and presentations by top paleontol-
gists. His work is on display in Dinosphere.

Paul Sereno
Paul Sereno is a professor in the Department of
Organismal Biology and Anatomy at the
University of Chicago and considered an expert
in the research of South American and African
dinosaur material. He also led the team to
excavate and bring back the Super Croc fossils
that serve as the basis for the replica in
Dinosphere.

Dong Zhiming
Dong Zhiming is a professor of research at the
Chinese Academy of Sciences Institute for
Paleontology and Paleoanthropology. He is
The Children Museum’s contact for dinosaurs
from China and the Gobi.

Dinosaur Hunters
Adapted from “Great Fossil Hunters of All Time”
http://www.enchantedlearning.com/
subjects/dinosaurs/

Roy Chapman Andrews (1884–1960) was a biologist, U.S. fossil hunter and
director of the American Museum of Natural History from 1935 to 1942. Andrews led five
expeditions into Mongolia’s Gobi desert from 1922 to 1930, where he discovered the first
dinosaur eggs known to science; identified
many new species of dinosaurs; made impor-
tant finds about now-extinct mammals,
including the largest known land mammal,
Baluchitherium; and found evidence of early
Stone Age humans in Central Asia.

Robert Bakker is a prominent paleontol-
ologist and dinosaur artist who revolutionized
people’s concept of dinosaurs in the late
1960s. He brought to light new evidence that
supported the belief that dinosaurs were
warm-blooded, and suggested that dinosaurs
were active, fast-moving animals that stood
upright and did not drag their tails.

Barnum Brown (1873–1963) was a
famous U.S. dinosaur hunter and curator of the
American Museum of Natural History. He
explored the Red Deer River Canyons of
Alberta, Canada. Brown is well-known for
excavating more dinosaurs than anyone else
in his 66-year career at the museum. The
museum did not have a single dinosaur prior
to Brown’s arrival but had the largest collection
in the world at the time of his death. Brown
discovered many dinosaurs, including the first
T. rex specimens.

William Buckland (1784 – 1856) was a
British geologist at Oxford University. He
named Megalosaurus, the first dinosaur to be
scientifically described in a paper in 1824.

Kenneth Carpenter is a paleontologist
at the Denver Museum of Natural History. In
1992 Carpenter, along with Bryan Small and
Tim Seeber, found the most complete
Stegosaurus to date near Canon City, Colo.
Carpenter named many other dinosaurs and
has written books on dinosaurs.

Edwin Colbert (1905 – 2001) was an
American paleontologist who discovered a
Lystrosaurus in Antarctica. This discovery
helped prove the continental drift theory. In
1947 he found large fossilized dinosaur bone
beds at the Ghost Ranch in New Mexico.
Colbert named many dinosaurs, published
papers and was the curator of the American
Museum of Natural History and the Museum
of Northern Arizona. The dinosaur
Nedcolbertia was named after him in 1998.

Edwin Drinker Cope (1840 – 1897) is
considered one of the founders of vertebrate
paleontology in North America. He collected
thousands of specimens and named more
than 1,000 species of fossil animals. He also
named dinosaur families, including
Iguanodontidae in 1869.
**Dinosaur Hunters continued**

**Philip Currie** is one of the world’s leading dinosaur paleontologists and curator at the Royal Tyrrell Museum of Paleontology in Alberta, Canada. He has worked extensively in Canada and Asia and recently excavated feathered dinosaurs in China. He is a leading proponent of the connection between dinosaurs and birds. He discovered a number of new dinosaur species, including *Albertosaurus*.

**Georges Cuvier** (1769 – 1832) was a French vertebrate zoologist who developed a natural system of classifying animals based on comparative anatomy. He named many taxonomic groups of mammals, birds, reptiles and fish. His description of an extinct marine reptile, *Mosasaurus*, helped to make the theory of extinction popular.

**Benjamin Waterhouse Hawkins** (1807 – 1889) was a British artist and educator who worked with Richard Owen to build life-size dinosaur sculptures. He created sculptures and artwork in England and the United States.

**Susan Henderson** is an amateur fossil hunter who on August 12, 1990, discovered three large fossilized bones sticking out of a cliff in South Dakota. These fossils belonged to Sue — the largest, most complete and best preserved *T. rex* ever found.

**John R. Horner** is an American paleontologist from Montana who named *Maasaura* in 1979 and *Orodromeus* in 1988. He discovered the first egg clutches in the United States and the first evidence of parental care from dinosaurs. He is also the author of many books and was the technical advisor for the movies “Jurassic Park” and “The Lost World.”

**Thomas Henry Huxley** (1825 – 1895) was the first scientist to suggest that birds are the direct descendants of dinosaurs, in 1867.

**Eva B. Koppelhus** is a paleobotanist and adjunct research scientist at the Royal Tyrrell Museum of Paleontology in Alberta, Canada. She studies the microfossils left behind by pollen grains and spores from ancient plants, and writes dinosaur books with her husband, the paleontologist Philip Currie.

**Neal Larson and Peter Larson** excavated Sue, the most complete *T. rex* found to date, and founded the Black Hills Institute of Geologic Research in Hill City, S.D. The brothers continue to make significant finds and create displays for museums around the world, including The Children’s Museum.

**Gideon Mantell** (1790 – 1852) was a British fossil collector and an early pioneer of dinosaur research. He showed the big fossilized teeth he found in 1822 to the French anatomist Georges Cuvier, who believed they belonged to a new kind of animal, a plant-eating reptile. Mantell named it *Iguanodon*.

**Othniel Charles Marsh** (1831 – 1899) was an American paleontologist at Yale University’s Peabody Museum, where he established the field of vertebrate paleontology in North America. He named many of the dinosaur suborders, including Sauropoda in 1878 and Theropoda in 1881. He also named many dinosaurs and more than 500 new species of fossil animals found by his team. His feud with E.D. Cope, known as the “Great Bone Wars,” brought dinosaurs to the attention of the public.

**Ruth Mason** (1906 – 1990) found a large dinosaur fossil bed on her family’s ranch in Harding County, S.D., when she was 7 years old. Tens of thousands of dinosaur fossils have been found at the Ruth Mason Quarry near the town of Faith since then. The dinosaurs include large numbers of *Edmontosaurus annectens* — duck-billed, plant-eating dinosaurs. The quarry is also the site of The Children’s Museum Dino Institute Teacher Dig during the summer.

**John H. Ostrom** is best known for his description of *Deinonychus*, published by Yale University in 1969, which began a revolution in the way that scientists and the public perceived dinosaurs.

**Sir Richard Owen** (1804 – 1892) was a British anatomist who introduced the term *dinosauria*, from the Greek *deinos*, meaning terrible, and *sauros*, meaning lizard. He created the term in 1842 to describe several types of large extinct reptiles, fossils of which had been discovered in Europe. Owen’s classification went unchallenged until 1877 when the groups were divided into two orders, Saurischia and Ornithischia. Owen also named and described many dinosaurs.

**Robert Plot** (1640 – 1696), a British naturalist, published a drawing in 1677 of a fossilized bone fragment found in Oxfordshire. His was the first known drawing of a fossilized dinosaur bone — a thighbone, possibly of *Megalosaurus*.

**C.C. Young** (1897 – 1979) was a Chinese paleontologist responsible for supervising the collection and research of dinosaurs in China from 1933 into the 1970s. He was responsible for some of the most important fossil finds in history. The Chinese Academy of Sciences Institute of Paleontology and Paleoanthropology in Beijing houses one of the most important collections in the world due to Young’s scientific work.
Dinosphere Unit of Study Books


Cretaceous Period Books — Specific books about the plants and animals in Dinosphere


Dinosaur Books for the Classroom

Dinosaur Videos


Models


Dinosaur Web Sites*

Artwork of Waterhouse Hawkins
http://rainbow.ldeo.columbia.edu/courses/v1001/dinodis3.html

Dinoshore link on The Children’s Museum Web site
http://www.childrensmuseum.org

The Dinosaur Farm — retail toys, books, etc.
http://www.dinosaurfarm.com/

Dinosaur Illustrations
http://www.search4dinosaurs.com/pictures.html#about

Links to dinosaur sites
http://www.kidsites.com/sites-edu/dinosaurs.htm

The Dinosaur Nest — retail toys, books, etc.
http://www.thedinosaurnest.com/

9 Dinosaur Songs by Bergman Broom
http://www.dinosongs.com/music.htm

The Dinosauricon, by Mike Keesey

The Father of Taxonomy — Carolus Linnaeus
http://www.ucmp.berkeley.edu/history/linnaeus.html

Fossil Halls, American Museum of Natural History
http://www.amnh.org/exhibitions/Fossil_Halls/fossil-halls2.html

Great Fossil Hunters of All Time
http://www.enchantedlearning.com/subjects/dinosaurs/

Indiana Fossil Clubs and Sites
http://www.colossal-fossil-site.com/400-states/2/indiana-2.htm

Jurassic Park Institute (JPI)
http://www.jpinstitute.com

Museum of Paleontology, University of California, Berkeley
http://www.ucmp.berkeley.edu/index.html

Dinosphere Paleo Prep Lab link on The Children’s Museum Web site shows how a fossil is prepared.
http://www.childrensmuseum.org

Songs For Teaching — Dinosaur Songs
http://www.songsforteaching.com/DinosaurSongs.html

Sternberg Museum of Natural History
(unofficial virtual tour)
http://www.oceansofkansas.com/Sternberg.html

Strange Science — Art of Benjamin Waterhouse Hawkins
http://www.strangescience.net/hawkins.htm

Virtual Tour of Dinosaurs. Smithsonian Museum of Natural History
http://www.hrw.com/science/si-science/biology/animals/burgess/dino/tourfram.html

Weighing a Dinosaur — Robert Lawrence, D.C. Everest Junior High School, Schofield, Wis.
http://www.geology.wisc.edu/museum/hughes/dinosaur-weight_students.html

Enchanted Learning — Comprehensive e-book about dinosaurs
http://www.zoom dinosaurs.com

Zoom Dinosaur — Skeletons
http://www.enchantedlearning.com/subjects/dinosaurs/anatomy/Skeleton.shtml

Dinosaur Webquests

Dinosaur Webquests link on The Children’s Museum Web site
http://www.childrensmuseum.org

Paramount Elementary School, Robin Davis
http://www.alt.wcboe.k12.md.us/mainfold/schoopag/elementary/paramount/class–webs/1/davist/DinosaurWebquest.html

Vince Vaccarella for CPE 542 — Technology in Education
http://www.lfelem.lfc.edu/tech/DuBose/Webquest/Vaccarella/WQPS_VV.html

*Note: Web sites are current and active at time of publication.
Glossary

**Academic** — related to learning, especially higher education.

**Adaptation** — a body part or behavior that produces an advantage for the animal. For example: feathers, fur, scales, teeth and beaks, or migration and hibernation.

**Articulated** — fossils and fossilized bones that are still positioned in lifelike poses. This indicates little geologic energy in the area.

**Backbone** — the vertebrae forming the axis of an animal's skeleton (also called the spine).

**Bar graph** — a representation of quantitative comparisons using rectangular shapes with lengths proportional to the measure of what is being compared.

**Biography** — an account of the series of events making up a person's life.

**Biped** — an animal that walks or stands on two feet.

**Bone** — rigid connective tissue that makes up the skeleton of vertebrates.

**Bone bed** — a layer of rock filled with fossilized bones.

**Carnivore** — a flesh-eating animal.

**Cast** — a model or replica of something made from an impression or mold.

**Centimeter ruler** — a device for measuring length in metric units.

**Claw** — the long, sharp or rounded nail on the end of a foot or hand, like fingernails.

**Climate** — the average weather conditions at place over a long period of time.

**Commercial** — related to profit-making business.

**Common** — widely known or occurring frequently.

**Conifers** — mostly evergreen trees and shrubs with needle-shaped or scale-like leaves. Some types bear cones and some bear fruit.

**Contribution** — something given or accomplished in common with others.

**Cooperate** — to work together for a common goal.

**Coprolite** — fossilized excrement.

**Cretaceous Period** — the third and last period when dinosaurs lived, during the Mesozoic Era, from 144 to 65 million years ago.

**Cycads** — palmlike primitive plants, four families of which still exist.

**Death** — the end of life.

**Dental battery** — a set of hundreds of small, fossilized teeth that are continually wearing out and being replaced. Many plant-eating dinosaurs had dental batteries.

**Dig** — the excavation activities at a dig site.

**Dig site** — a place where fossils are found and dug (excavated).

**Dinosaur** — extinct reptiles found in the fossil record of the Mesozoic Era.

**Dinosauria** — “terrible lizard,” coined by Sir Richard Owen.

**Disarticulated** — Fossilized bones that are not positioned in the way the animal's skeleton would appear naturally. They may be broken, missing or rearranged. The Bucky site had disarticulated fossilized bones, which indicates much geologic energy there.

**Discovery** — to unearth or bring to light something forgotten or hidden.

**Displacement** — a method to determine the volume of an object by measuring the amount of water it displaces when submerged in a graduated cylinder.

**Editorial** — an oral or written expression of opinion.

**Erosion** — wearing away of the land by the action of water, wind and/or ice.

**Excavate** — to dig out and remove.

**Exposure** — to uncover, as when removing sand or mud from fossils at a dig site.

**Extinct** — No longer existing.

**Family** — a group of animals including parents and offspring; a group of organisms related by common characteristics.

**Fleshed-out** — a picture or model of a living animal depicting the color of its skin and shape of its body.

**Fossil** — preserved evidence of ancient life. Latin for “dug up.” It is the remains or traces of plants or animals that have turned to stone or rock.

**Frill** — the large bony collar around the neck of dinosaurs such as *Triceratops*.

**Gastrolith** — a stone or pebble ingested by an animal to help with grinding food for digestion.

**Geology** — the scientific study of the earth's history and life, especially as recorded in rocks.

**Gorgosaurus** — an earlier dinosaur relative of *Tyrannosaurus rex*.

**Greek and Latin words** — used by scientists to describe plants and animals.

**Group** — two or more animals gathered together for a common goal; a taxonomic term for an assemblage of related organisms.

**Head** — the upper or anterior part of an animal's body, containing the brain, the primary sense organs and the mouth.

**Herbivore** — an animal that eats plants.

**Herd** — animals that live in large groups and travel from place to place together.

**Hypacrosaurus** — a herding duckbill dinosaur of the Cretaceous Period.

**Hypothesis** — an unconfirmed theory or supposition used to explain certain facts and to guide in the investigation of others. Sometimes called a working hypothesis.

**Idea** — the product of mental activity: a thought, plan, method or explanation.

**Ichthyosaurs** — a group of marine (ocean) reptiles that are not dinosaurs but lived at the same time, including plesiosaurs, pliosaurs and mosasaurs.

**Imprint** — to leave a mark by means of pressure.
Invertebrates — animals without backbones. This includes shellfish, clams, insects, spiders and others.

Life — the state in which an organism is capable of metabolism, growth and reaction to stimuli.

Living fossil — an ancient organism that lived long ago and continues to exist today. Examples include crocodiles, turtles, cockroaches, ferns, coelacanths, horsetail rushes, ginkgo trees, spiders, dragonflies and horse-shoe crabs.

Magnifying lens — a small optical instrument that causes objects to appear larger than they are.

Maiasaura — a herding duckbill dinosaur from the Cretaceous Period.

Meter — a scientific unit of measurement equal to 39.37 inches.

Meteorite — a mass of atmospheric particles that has fallen to the surface of the earth without being totally vaporized. Many small meteorites often strike and burn up as shooting stars. Very large ones have left craters in the earth's surface.

Model — a representation of an object that can show many but not all the features of the actual item. A model is both like and different from the real thing.

Mold — a hollow form or matrix used to form a substance into a specific shape.

Negative — the absence of something; unfavorable.

Opinion — a personal view or judgment.

Ornithischia — an order of bird-hipped dinosaurs that were mostly plant-eaters.

Paleontologist — a scientist who studies ancient life from fossils, including plants, invertebrates (animals without backbones) and vertebrates (animals with backbones).

Palentology — the study of life in past geologic periods as known from fossil remains.

Plaster — a paste made of lime, sand and water that hardens into a smooth solid.

Positive — the presence of something; favorable.

Predator — an animal that lives by hunting and eating other animals, or prey.

Prey — an animal hunted by predators as food. Some prey are also predators.

Pterosauria — a subclass of large flying reptiles, including pterosaurs and pterodons, that were alive during the Dinosaur Age.

Research — the collection of information or the studious investigation or examination of information to discover and interpret facts.

Resin — a solid or semisolid organic material, typically translucent and yellowish to brown, formed in plant secretions. Synthetic resins are often used to make cast fossils.

Saurischia — a suborder of lizard-hipped dinosaurs, including prosauropods, sauropods and theropods.

Scale drawing — a representation of something reduced according to a ratio; for example a 1:10 scale drawing means 1 unit of measure represents 10 units of the real object.

Scavenger — an animal that eats another animal it did not help to kill. A crow is a scavenger when it eats the remains of a dead animal.

Scientific method — the principles and procedures used to recognize and formulate an idea, collect data through observation and experiments, and test a theory.

Scientist — an investigator or other person who applies the principles and methods of science to learn about something.

Sculpture — a three-dimensional work of art; impressed or raised markings on part of a plant or animal.

Sediment — solid fragments of living or dead material deposited by wind, water or glaciers.

Simulation — an exercise that models a real practice. A simulation can teach about the real thing, but it will not be exactly like the real thing.

Sir Richard Owen — a British scientist who coined the term *dinosauria* and created the exhibit at the Crystal Palace in London featuring Iguanodon and Megalosaurus.

Skeleton — the bones that support an animal.

Skull — the skeleton of the head of a vertebrate; the bony or cartilaginous case that holds and protects the brain and the sense organs, and protects the jaws.

Symposium — a meeting or conference where a specific topic is discussed.

Tail — the rear end or a prolongation of the read end of an animal.

*T. rex* tooth — large banana-shaped incisor of a top meat-eating predator of the Cretaceous Period.

Theory — an idea or hypothetical set of scientifically accepted facts, principles or circumstances offered to explain phenomena.

Triceratops — a large plant-eating dinosaur easily recognized by its head, frill and horns.

Tyrannosaurus rex — a large meat-eating dinosaur alive in the Cretaceous Period.

Unique — one of a kind.

Vertebrates — animals that have backbones, including fish, reptiles, amphibians, mammals and birds.

Volcano — an opening in the earth's crust through which molten lava, ash and gases are vented.

Waterhouse Hawkins — a British artist and educator who worked with Sir Richard Owen to build life-size dinosaur sculptures. He also created dinosaur sculptures and artwork in the United States.

Wire — a flexible metal strand used to create model forms.

X-ray — a photograph, as of a skeleton, obtained by the use of electromagnetic radiation.

For a comprehensive glossary of dinosaur terms visit: Enchanted Learning

**http://www.zoomdinosaurs.com**
What’s in a Dinosaur Name?

Create many new and real dinosaur names with these Greek and Latin words.

\[ a — on, in, at; plural; without \]
\[ acantho — spiny \]
\[ acro — high \]
\[ acu — sharp \]
\[ ae — plural \]
\[ aero — air \]
\[ allo — different, other, strange \]
\[ alpha — first \]
\[ alti — high \]
\[ ambul — walk \]
\[ amphi — around \]
\[ ampli — large \]
\[ an — not \]
\[ anato — duck \]
\[ ane — denoting \]
\[ anim — breath \]
\[ ankylo — fused \]
\[ ante — before \]
\[ anti — against \]
\[ apato — deceptive \]
\[ aqua — water \]
\[ archae — ancient \]
\[ arium — used for \]
\[ arya — used for \]
\[ asi — unhealthy \]
\[ aster — star \]
\[ ate — like, possessing \]
\[ audi — hear \]
\[ aur — ear \]
\[ aurus — lizard \]
\[ avi — bird \]
\[ bar(o) — heavy \]
\[ bi — two \]
\[ bola — throw \]
\[ brachio — arm \]
\[ brevi — short \]
\[ bronto — thunder \]
\[ caco — bad \]
\[ camara — chambered \]
\[ cantho — spine \]
\[ cardio — heart \]
\[ cam — flesh \]
\[ cami — meat \]
\[ caud — tail \]
\[ cele — swell \]
\[ celer — swift \]
\[ centri — one hundred \]
\[ cephalo — head \]
\[ ceptor — receiver \]
\[ cerat — horned \]
\[ chasm — ravine, canyon \]
\[ chord — string \]
\[ cide — killer \]
\[ circum — around \]
\[ cle — small \]
\[ clude — close \]
\[ coel — hollow \]
\[ con — with, together \]
\[ contra — opposite \]
\[ corpus — body \]
\[ cory — helmet \]
\[ cosm — universe \]
\[ crypt — hidden \]
\[ cycl — circle \]
\[ cyto — hollow \]
\[ dactyl — finger, toe \]
\[ dec — ten \]
\[ deca — ten \]
\[ deina — terrible \]
\[ derma — skin \]
\[ di — two \]
\[ dia — across \]
\[ din(o) — terrible \]
\[ diplo — double \]
\[ dors — back \]
\[ duce — to lead \]
\[ dupl — two \]
\[ dyma — putting on, off \]
\[ dynam — power \]
\[ dys — bad \]
\[ dysis — putting on, off \]
\[ ella — small \]
\[ ence — state of \]
\[ ennial — yearly \]
\[ epi — upon, over \]
\[ escent — growing \]
\[ esia — act, state of \]
\[ eu — well, good \]
\[ euoplo — well-armed \]
\[ exo — outside \]
\[ extra — outside of \]
\[ faun — animal \]
\[ fic — make \]
\[ fid — split \]
\[ fiss — split \]
\[ flora — plant \]
\[ foli — leaf \]
\[ form — form of \]
\[ fy — to make \]
\[ galo — rooster \]
\[ gel — stiffen \]
\[ gen — original \]
\[ geny — origin \]
\[ geo — earth \]
\[ geous — bearing \]
\[ gnathus — jaw \]
\[ gracile — slender-bodied \]
\[ graph — drawing \]
\[ gravi — heavy \]
\[ gryp — curved \]
\[ gymno — naked \]
\[ gyr — rotate \]
\[ hell — sun \]
\[ hemi — half \]
\[ hemo — blood \]
\[ herb — plant \]
\[ heter — different, other \]
\[ hippo — horse \]
\[ holo — whole \]
\[ homo — same \]
\[ hyal — clear \]
\[ hydra — water \]
\[ hypa — very \]
\[ hyper — over, above \]
\[ hypo — under, below \]
\[ i — plural \]
\[ ia — pertaining to \]
\[ ic — having \]
\[ icthy — fish \]
\[ id — having \]
\[ idium — small \]
\[ in — in, into \]
\[ ina — subclass \]
\[ ine — pertaining to \]
\[ infra — below \]
\[ inter — between \]
\[ intra — within \]
\[ intra — go into \]
\[ ite — belonging to \]
\[ itis — inflammation \]
\[ ject — to throw \]
\[ kilo — thousand \]
\[ lapse — to slip \]
\[ lat — wide \]
\[ later — side \]
\[ lepto — small \]
\[ lipse — leave \]
\[ lite — minerals \]
\[ luc — light \]
\[ lun — moon \]
\[ lysis — loosening \]
\[ lyte — loosening \]
\[ ma — act of \]
\[ macro — large \]
\[ magni — great \]
\[ maia — good mother \]
\[ mani — hand \]
\[ mari — sea \]
\[ me — act of \]
\[ meag — huge \]
\[ med — middle \]
\[ meg — large \]
\[ mes — middle \]
\[ meta — with, after \]
\[ micro — small \]
\[ milli — thousand \]
\[ mim — copy \]
\[ mimus — mimic \]
\[ mimus — mimic \]
\[ mono — single \]
\[ morph — form \]
\[ multi — many \]
\[ mut — change \]
\[ mycin — fungi \]
\[ myo — mouselike \]
\[ myria — many \]
\[ mytho — legend \]
\[ nano — small \]
\[ nect — swim \]
\[ neo — new \]
\[ noct — night \]
\[ nod — knot \]
\[ nome — name \]
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The Dinosphere units of study (K – 2, 3 – 5 and 6 – 8) address the following state and national academic standards:

Indiana Language Arts Standards

Kindergarten Language Arts Standards

Concepts About Print
K.1.1 Identify the front cover, back cover, and title page of a book.
K.1.3 Understand that printed materials provide information.

Comprehension and Analysis of Grade-Level-Appropriate Text
K.2.2 Use picture clues and context to aid comprehension and to make predictions about story content.
K.2.3 Connect the information and events in texts to life experiences.
K.2.5 Identify and summarize the main ideas and plot of a story.

Organization and Focus
K.4.3 Write using pictures, letters, and words.

Different Types of Writing and Their Characteristics
K.5.1 Draw pictures and write words for a specific reason.

Listening and Speaking Comprehension
K.7.1 Understand and follow one- and two-step spoken directions.

Oral Communication
K.7.2 Share information and ideas, speaking in complete, coherent sentences.

Speaking Applications
K.7.3 Describe people, places, things (including their size, color, and shape), locations, and actions.

Grade 1 Language Arts Standards

Concepts About Print
1.1.2 Identify letters, words, and sentences.

Vocabulary and Concept Development
1.1.7 Read and understand root words (look) and their inflectional forms (looks, looked, looking).

Structural Features of Information and Technical Materials
1.2.2 Identify text that uses sequence or other logical order.

Comprehension and Analysis of Grade-Level-Appropriate Text
1.2.3 Respond to who, what, when, where, why, and how questions and discuss the main idea of what is read.
1.2.4 Follow one-step written instructions.
1.2.7 Relate prior knowledge to what is read.

Writing Organization and Focus
1.4.1 Discuss ideas and select a focus for group stories or other writing.

Writing Applications
1.5.4 Use descriptive words when writing.

Listening and Speaking Comprehension
1.7.1 Listen attentively.
1.7.2 Ask questions for clarification and understanding.
1.7.3 Give, restate, and follow simple two-step directions.

Organization and Delivery of Oral Communication
1.7.5 Use descriptive words when speaking about people, places, things, and events.

Speaking Applications
1.7.10 Use visual aids, such as pictures and objects, to present oral information.

Grade 2 Language Arts Standards

Decoding and Word Recognition
2.1.3 Decode (sound out) regular words with more than one syllable (dinosaur, vacation).

Vocabulary and Concept Development
2.1.8 Use knowledge of individual words to predict the meaning of unknown compound words (lunchtime, lunchroom, daydream, raindrop).

Comprehension and Analysis of Grade-Level-Appropriate Text
2.2.4 Ask and respond to questions to aid comprehension about important elements of informational texts.
2.2.5 Restate facts and details in the text to clarify and organize ideas.
2.2.6 Recognize cause-and-effect relationships in a text.
2.2.7 Interpret information from diagrams, charts, and graphs.
2.2.8 Follow two-step written instructions.

Different Types of Writing and Their Characteristics
2.5.2 Write a brief description of a familiar object, person, place, or event that develops a main idea and uses details to support the main idea.
2.5.5 Use descriptive words when writing.
2.5.6 Write for different purposes and to a specific audience or person.

Listening and Speaking Comprehension
2.7.1 Determine the purpose or purposes of listening (such as to obtain information, to solve problems, or to enjoy).
2.7.3 Paraphrase (restate in own words) information that has been shared orally by others.
2.7.4 Give and follow three- and four-step oral directions.

Organization and Delivery of Oral Communication
2.7.9 Report on a topic with supportive facts and details.

Speaking Applications
2.7.11 Report on a topic with facts and details, drawing from several sources of information.

Grade 3 Language Arts Standards

Vocabulary and Concept Development
3.1.8 Use knowledge of prefixes (word parts added at the beginning of words such as un-, pre-) and suffixes (word parts added at the end of words such as -er, -ful, -less) to determine the meaning of words.

Research and Technology
3.4.4 Use various reference materials (such as a dictionary, thesaurus, atlas, encyclopedia, and online resources).

Different types of writing and their characteristics
3.5.2 Write descriptive pieces about people, places, things, or experiences that develop a unified main idea and use details to support the main idea.

Grade 4 Language Arts Standards

Vocabulary and Concept Development
4.1.4 Use common roots (meter = measure) and word parts (therm = heat) derived from Greek and Latin to analyze the meaning of complex words (thermometer).

Organization and Focus
4.4.1 Discuss ideas for writing. Find ideas for writing in conversations with others and in books, magazines, newspapers, school textbooks, or on the Internet. Keep a list or notebook of ideas.

Research and Technology
4.4.7 Use multiple reference materials and online information (the Internet) as aids to writing.
Different Types of Writing and Their Characteristics
4.5.4 Write summaries that contain the main ideas of the reading selection and the most significant details.

Speaking Applications
4.7.12 Make information presentations that focus on one main topic; include facts and details that help listeners focus; incorporate more than one source of information (including speakers, books, newspapers, television broadcasts, radio reports, or Web sites).

Grade 5 Language Arts Standards
Decoding and Word Recognition
5.1.4 Know less common roots (graph = writing, logos = the study of) and word parts (auto = self, bio = life) from Greek and Latin and use this knowledge to analyze the meaning of complex words (autograph, autobiography, biography, biology).
Research and Technology
5.4.5 Use note-taking skills.
Speaking Applications
5.7.10 Deliver informative presentations about an important idea, issue, or event by the following means: frame questions to direct the investigation; establish a controlling idea or topic; develop the topic with simple facts, details, examples, and explanations.

Grade 6 Language Arts Standards
Expository (Informational) Critique
6.2.6 Determine the adequacy and appropriateness of the evidence presented for an author's conclusions and evaluate whether the author adequately supports inferences.
6.2.7 Make reasonable statements and conclusions about a text, supporting them with accurate examples.
6.2.8 Note instances of persuasion, propaganda, and faulty reasoning in text.
Organization and Focus
6.4.1 Discuss ideas for writing, keep a list or notebook of ideas, and use graphic organizers to plan writing.
Research and Technology
6.4.5 Use note-taking skills.
6.4.6 Use organizational features of electronic text (on computers), such as bulletin boards, databases, keyword searches, and e-mail addresses, to locate information.
6.4.7 Use a computer to compose documents with appropriate formatting by using word-processing skills.

Evaluation and Revision
6.4.9 Edit and proofread one's own writing, as well as that of others, using an editing checklist or set of rules, with specific examples of corrections of frequent errors.

Different Types of Writing and Their Applications
6.5.2 Write descriptions, explanations, comparison and contrast papers, and problem and solution essays.
6.5.3 Write research reports.
6.5.7 Write for different purposes and to a specific audience or person, adjusting tone and style as necessary.

Organization and Delivery of Oral Communication
6.7.5 Emphasize important points to assist the listener in following the main ideas and concepts.
6.7.6 Support opinions with researched, documented evidence and with visual or media displays that use appropriate technology.
6.7.7 Use effective timing, volume, tone, and alignment of hand and body gestures to sustain audience interest and attention.

Analysis and Evaluation of Oral and Media Communications
6.7.9 Identify persuasive and propaganda techniques used in electronic media (television, radio, online sources) and identify false and misleading information.
Speaking Applications
6.7.11 Deliver informative presentations.
6.7.13 Deliver persuasive presentations.
6.7.14 Deliver presentations on problems and solutions.

Grade 7 Language Arts Standards
Vocabulary and Concept Development
7.1.2 Use knowledge of Greek, Latin, and Anglo-Saxon roots and word parts to understand subject-area vocabulary.
Structural Features of Information and Technical Materials
7.2.2 Locate information by using a variety of consumer and public documents.
Expository (Informational) Critique
7.2.6 Assess the adequacy, accuracy, and appropriateness of the author's evidence to support claims and assertions, noting instances of bias and stereotyping.

Organization and Focus
7.4.1 Discuss ideas for writing, keep a list or notebook of ideas.
7.4.3 Support all statements and claims with anecdotes (first-person accounts), descriptions, facts and statistics, and specific examples.
7.4.4 Use strategies of note-taking, outlining, and summarizing to impose structure on composition drafts.
Research and Technology
7.4.5 Identify topics; ask and evaluate questions; and develop ideas leading to inquiry, investigation, and research.
7.4.7 Use a computer to create documents by using word-processing skills.
Evaluation and Revision
7.4.9 Edit and proofread one's own writing.

Different Types of Writing and Their Characteristics
7.5.3 Write research reports.
7.5.4 Write persuasive compositions.
7.5.5 Write summaries of reading materials.
Listening and Speaking Comprehension
7.7.1 Ask questions to elicit information, including evidence to support the speaker's claims and conclusions.
7.7.2 Determine the speaker's attitude toward the subject.

Organization and Delivery of Oral Communication
7.7.3 Organize information to achieve particular purposes and to appeal to the background and interests of the audience.
7.7.4 Arrange supporting details, reasons, descriptions, and examples effectively.
7.7.5 Use speaking techniques — including adjustments of tone, volume, and timing of speech; enunciation (clear speech); and eye contact — for effective presentations.

Analysis and Evaluation of Oral and Media Communications
7.7.6 Provide helpful feedback to speakers concerning the coherence and logic of a speech's content and delivery and its overall impact upon the listener.

Speaking Applications
7.7.10 Deliver research presentations.
7.7.11 Deliver persuasive presentations.
Indiana Math Standards

Kindergarten Math Standards
K.1.1 Match sets of objects one-to-one.

Algebra and Functions
K.3.1 Identify, sort, and classify objects by size, number, and other attributes. Identify objects that do not belong to a particular group.

Geometry
K.4.1 Identify and describe common geometric objects: circle, triangle, square, rectangle, and cube.

Measurement
K.5.1 Make direct comparisons of the length, capacity, weight, and temperature of objects and recognize which object is shorter, longer, taller, lighter, heavier, warmer, cooler, or holds more.

Problem Solving
K.6.2 Use tools such as objects or drawings to model problems.

Grade 1 Math Standards

Number Sense
1.1.10 Represent, compare, and interpret data using pictures and picture graphs.

Computation
1.2.5 Understand the meaning of the symbols +, -, and =.

Geometry
1.4.6 Arrange and describe objects in space by position and direction: near, far, under, over, up, down, behind, in front of, next to, to the left or right of.

Measurement
1.5.5 Compare and order objects according to area, capacity, weight, and temperature, using direct comparison or a nonstandard unit.

Problem Solving
1.6.2 Use tools such as objects or drawings to model problems.

Grade 2 Math Standards

Number Sense
2.1.9 Recognize, name, and compare the unit fractions: , , , , , , , , and .

2.1.1 Collect and record numerical data in systematic ways.

Geometry
2.4.3 Investigate and predict the result of putting together and taking apart two-dimensional and three-dimensional shapes.

Measurement
2.5.1 Measure and estimate length to the nearest inch, foot, yard, centimeter, and meter.

2.5.2 Describe the relationships among inch, foot, and yard. Describe the relationship between centimeter and meter.

2.5.3 Decide which unit of length is most appropriate in a given situation.

Problem Solving
2.6.2 Use tools such as objects or drawings to model problems.

Grade 3 Math Standards

Measurement
3.5.2 Add units of length that may require regrouping of inches to feet or centimeters to meters.

3.5.5 Estimate or find the volume of objects by counting the number of cubes that would fill them.

Grade 4 Math Standards

Number Sense
4.1.4 Order and compare whole numbers using symbols for “less than” ( ), “equal to” (=), and “greater than” ( ).

Geometry
4.5.2 Subtract units of length that may require renaming of feet to inches or meters to centimeters.

4.5.8 Use volume and capacity as different ways of measuring the space inside a shape.

Data Analysis and Probability
4.6.1 Represent data on a number line and in tables, including frequency tables.

4.6.2 Interpret data graphs to answer questions about a situation.
Culminating Experience

Resource Materials

Grade 5 Math Standards
Number Sense
5.1.3 Arrange in numerical order and compare whole numbers or decimals to two
decimal places by using the symbols for less
than (<), equals (=), and greater than (>)
Measurement
5.5.4 Find the surface area and volume of
rectangular solids using appropriate units.
Data Analysis and Probability
5.6.1 Explain which types of displays are
appropriate for various sets of data.

Indiana Science Standards

Kindergarten Science Standards
The Nature of Science and Technology
K.1.1 Raise questions about the natural world.
K.1.2 Begin to demonstrate that everybody
can do science.
Scientific Thinking
K.2.2 Draw pictures and writes words to
describe objects and experiences.
The Physical Setting
K.3.1 Describe objects in terms of the mate-
rials they are made of, such as clay, cloth,
paper, etc.
K.3.2 Investigate that things move in
different ways, such as fast, slow, etc.
The Living Environment
K.4.1 Give examples of plants and animals.
K.4.2 Observe plants and animals,
describing how they are alike and how they
are different in the way they look and in the
things they do.
Common Themes
K.6.1 Describe an object by saying how it is
similar to or different from another object.

Grade 1 Science Standards
The Nature of Science and Technology
1.1.1 Observe, describe, draw, and sort objects
carefully to learn about them.
1.2.1 Use whole numbers up to 100 in
counting, identifying, measuring and
describing objects and experiences.
1.2.2 Use sums and differences of single digit
numbers in investigations and judge the
reasonableness of the answers.
1.2.3 Explain to other students how to go
about solving numerical problems.
1.2.4 Demonstrate that magnifiers help
people see things they could not see
without them.
1.2.5 Describe and compare objects in terms
of number, shape, texture, size, weight, color
and motion.
1.2.7 Write brief informational descriptions
of a real object, person, place or event using
information from observations.
The Living Environment
1.4.2 Observe and describe that there can be
differences, such as size or markings, among
the individuals within one kind of plant or
animal group.
1.4.3 Observe and explain that animals eat
plants or other animals for food.
1.4.4 Explain that most living things need
water, food and air.
Mathematical World
1.5.1 Use numbers up to 10 to place objects
in order, such as first, second and third, and
to name them, such as bus numbers or
phone numbers.
1.5.2 Make and use simple picture graphs to
tell about observations.
1.5.3 Observe and describe similar patterns,
such as shapes, designs and events that
may show up in nature, such as honey-
combs, sunflowers or shells. See similar
patterns in the things people make, such as
quilts, baskets or pottery.
Common Themes
1.6.1 Observe and describe that models, such
as toys, are like the real things in some
ways but different in others.
Constancy and Change
1.6.2 Observe that and describe how certain
things change in some ways and stay the
same in others, such as in their color, size,
and weight.

Grade 2 Science Standards
The Nature of Science and Technology
2.1.1 Manipulate an object to gain additional
information about it.
2.1.2 Use tools, such as thermometers,
magnifiers, rulers or balances, to gain more
information about objects.
2.1.3 Describe, both in writing and orally,
objects as accurately as possible and
compare observations with those of other
people.
2.1.4 Make new observations when there is
agreement among initial observations.
2.1.5 Demonstrate the ability to work with a
team but still reach and communicate one's
own conclusions about findings.
2.1.6 Use tools to investigate, observe,
measure, design and build things.
Scientific Thinking
2.2.1 Give estimates of numerical answers to
problems before doing them formally.
2.2.2 Make quantitative estimates of familiar
lengths, weights and time intervals and
check them by measurements.
2.2.3 Estimate and measure capacity using
cups and pints.
2.2.4 Assemble, describe, take apart and/or
reassemble constructions using such things
as interlocking blocks and Erector sets.
Sometimes pictures or words may be used
as a reference.
2.2.5 Draw pictures and write brief descrip-
tions that correctly portray key features of an
object.
The Physical Setting
2.3.1 Investigate by observing and then
describe that some events in nature have a
repeating pattern such as seasons, day and
night, and migrations.
2.3.5 Investigate that things can be done to
materials, such as freezing, mixing, cutting,
heating, wetting, etc., to change some of
their properties and observe that not all
materials respond in the same way.
The Living Environment
2.4.1 Observe and identify different external
features of plants and animals and describe
how these features help them live in
different environments.
2.4.2 Observe that and describe how
animals may use plants, or even other
animals, for shelter and nesting.
2.4.3 Observe and explain that plants and
animals both need to take in water, animals
need to take in food, and plants need light.
2.4.4 Recognize and explain that living things are found almost everywhere in the world and that there are somewhat different kinds in different places.

The Mathematical World
2.5.1 Recognize and explain that, in measuring, there is a need to use numbers between whole numbers, such as 2 1/2 centimeters.
2.5.2 Recognize and explain that it is often useful to estimate quantities.
2.5.4 Begin to recognize and explain that people are more likely to believe ideas if good reasons are given for them.
2.5.6 Explain that sometimes a person can find out a lot (but not everything) about a group of things, such as insects, plants or rocks, by studying just a few of them.

Common Themes
2.6.1 Investigate that most objects are made of parts.
2.6.2 Observe and explain that models may not be the same size, may be missing some details or may not be able to do all of the same things as the real things.
2.6.3 Describe that things can change in different ways, such as in size, weight, color, age and movement. Investigate that some small changes can be detected by taking measurements.

Grade 3 Science Standards
The Nature of Science and Technology
3.1.1 Recognize and explain that a scientific investigation is repeated, a similar result is expected.
3.1.2 Participate in different types of guided scientific investigations such as observing objects and events and collecting specimens for analysis.
3.1.3 Keep and report records of investigations and observations using tools, such as journals, charts, graphs, and computers.
3.1.4 Discuss the results of investigations and consider the explanations of others.
3.1.5 Demonstrate the ability to work cooperatively while respecting the ideas of others and communicating one’s own conclusions about findings.

Scientific Thinking
3.2.1 Add and subtract whole numbers mentally, on paper, and with a calculator.
3.2.2 Measure and mix dry and liquid materials in prescribed amounts, following reasonable safety precautions.
3.2.3 Keep a notebook that describes observations and is understandable weeks or months later.
3.2.4 Appropriately use simple tools, such as clamps, rulers, scissors, hand lenses, and other technology, such as calculators and computers, to help solve problems.
3.2.5 Construct something used for performing a task out of paper, cardboard, wood, plastic, metal, or existing objects.
3.2.6 Make sketches and write descriptions to aid in explaining procedures or ideas.
3.2.7 Ask “How do you know?” in appropriate situations and attempt reasonable answers when others ask the same question.

The Physical Setting
3.3.5 Give examples of how change, such as weather patterns, is a continual process occurring on Earth.

The Children's Museum of Indianapolis © 2005

Resource Materials

Grade 4 Science Standards
The Nature of Science and Technology
4.1.1 Observe and describe that scientific investigations generally work the same way in different places.
4.1.2 Recognize and describe that results of scientific investigations are seldom exactly the same. If differences occur, such as a large variation in the measurement of plant growth, propose reasons for why these differences exist. Using recorded information about investigations.
4.1.3 Explain that clear communication is an essential part of doing science since it enables scientists to inform others about their work, to expose their ideas to evaluation by other scientists, and to allow scientists to stay informed about scientific discoveries around the world.
4.1.4 Describe how people all over the world have taken part in scientific investigation for many centuries.
4.1.5 Demonstrate how measuring instruments, such as microscopes, telescopes, and cameras, can be used to gather accurate information for making scientific comparisons of objects and events. Note that measuring instruments, such as rulers, can also be used for designing and constructing things that will work properly.

Scientific Thinking
4.2.1 Judge whether measurements and computations of quantities, such as length, area, volume, weight, or time, are reasonable.
4.2.2 State the purpose, orally or in writing, of each step in a computation.
4.2.4 Use numerical data to describe and compare objects and events.
4.2.5 Write descriptions of investigations, using observations and other evidence as support for explanations.
4.2.6 Support statements with facts found in print and electronic media, identify the sources used, and expect others to do the same.
4.2.7 Identify better reasons for believing something than “Everybody knows that …” or “I just know” and discount such reasons when given by others.
Resource Materials

The Physical Setting
4.3.5 Describe how waves, wind, water, and glacial ice shape and reshape the Earth’s land surface by the erosion of rock and soil in some areas and depositing them in other areas.

The Living Environment
4.4.2 Investigate, observe, and describe that insects and various other organisms depend on dead plant and animal material for food.
4.4.3 Observe and describe that organisms interact with one another in various ways, such as providing food, pollination, and seed dispersal.
4.4.4 Observe and describe that some source of energy is needed for all organisms to stay alive and grow.
4.4.6 Explain how in all environments, organisms are growing, dying, and decaying, and new organisms are being produced by the old ones.

The Mathematical World
4.5.3 Illustrate how length can be thought of as unit lengths joined together, area as a collection of unit squares, and volume as a set of unit cubes.

Common Themes
4.6.3 Recognize that and describe how changes made to a model can help predict how the real thing can be altered.

Grade 5 Science Standards
The Nature of Science and Technology
5.1.1 Recognize and describe that results of similar scientific investigations may turn out differently because of inconsistencies in methods, materials, and observations.
5.1.2 Begin to evaluate the validity of claims based on the amount and quality of the evidence cited.
5.1.3 Explain that doing science involves many different kinds of work and engages men, women, and children of all ages and backgrounds.
5.1.4 Give examples of technology, such as telescopes, microscopes, and cameras, that enable scientists and others to observe things that are too small or too far away to be seen without them and to study the motion of objects that are moving very rapidly or are hardly moving.

Scientific Thinking
5.2.3 Choose appropriate common materials for making simple mechanical constructions and repairing things.
5.2.4 Keep a notebook to record observations and be able to distinguish inferences from actual observations.
5.2.5 Use technology, such as calculators or spreadsheets, in determining area and volume from linear dimensions. Find area, volume, mass, time, and cost, and find the difference between two quantities of anything.
5.2.6 Write instructions that others can follow in carrying out a procedure.
5.2.7 Read and follow step-by-step instructions when learning new procedures.
5.2.8 Recognize when and describe that comparisons might not be accurate because some of the conditions are not kept the same.

The Living Environment
5.4.4 Explain that in any particular environment, some kinds of plants and animals survive well, some do not survive as well, and some cannot survive at all.
5.4.5 Explain how changes in an organism’s habitat are sometimes beneficial and sometimes harmful.
5.4.7 Explain that living things, such as plants and animals, differ in their characteristics, and that sometimes these differences can give members of these groups (plants and animals) an advantage in surviving and reproducing.
5.4.8 Observe that and describe how fossils can be compared to one another and to living organisms according to their similarities and differences.

Common Themes
5.6.3 Recognize and describe that almost anything has limits on how big or small it can be.

Grade 6 Science Standards
The Nature of Science and Technology
6.1.1 Explain that some scientific knowledge, such as the length of the year, is very old and yet is still applicable today. Understand, however, that scientific knowledge is never exempt from review and criticism.
6.1.2 Give examples of different ways scientists investigate natural phenomena and identify processes all scientists use, such as collection of relevant evidence, the use of logical reasoning, and the application of imagination in devising hypotheses and explanations, in order to make sense of the evidence.
6.1.3 Recognize and explain that hypotheses are valuable, even if they turn out not to be true, if they lead to fruitful investigations.
6.1.4 Give examples of employers who hire scientists, such as colleges and universities, businesses and industries, hospitals, and many government agencies.
6.1.5 Identify places where scientists work, including offices, classrooms, laboratories, farms, factories, and natural field settings ranging from space to the ocean floor.

Scientific Thinking
6.2.5 Organize information in simple tables and graphs and identify relationships they reveal. Use tables and graphs as examples of evidence for explanations when writing essays or writing about lab work, fieldwork, etc.
6.2.7 Locate information in reference books, back issues of newspapers and magazines, CD-ROMs, and computer databases.
6.2.8 Analyze and interpret a given set of findings, demonstrating that there may be more than one good way to do so.

The Living Environment
6.4.3 Describe some of the great variety of body plans and internal structures animals and plants have that contribute to their being able to make or find food and reproduce.
6.4.8 Explain that in all environments, such as freshwater, marine, forest, desert, grassland, mountain, and others, organisms with...
similar needs may compete with one another for resources, including food, space, water, air, and shelter. Note that in any environment, the growth and survival of organisms depend on the physical conditions.

6.49 Recognize and explain that two types of organisms may interact in a competitive or cooperative relationship, such as producer/consumer, predator/prey, or parasite/host.

**Grade 7 Science Standards**

**The Nature of Science and Technology**

7.1.1 Recognize and explain that when similar investigations give different results, the scientific challenge is to judge whether the differences are trivial or significant, which often takes further studies to decide.

7.1.3 Explain why it is important in science to keep honest, clear, and accurate records.

7.1.4 Describe that different explanations can be given for the same evidence, and it is not always possible to tell which one is correct without further inquiry.

7.1.5 Identify some important contributions to the advancement of science, mathematics, and technology that have been made by different kinds of people, in different cultures, at different times.

7.1.6 Provide examples of people who overcame bias and/or limited opportunities in education and employment to excel in the fields of science.

**Scientific Thinking**

7.2.7 Incorporate circle charts, bar and line graphs, diagrams, scatterplots, and symbols into writing, such as lab or research reports, to serve as evidence for claims and/or conclusions.

7.2.8 Question claims based on vague attributes, such as "Leading doctors say ...." or on statements made by celebrities or others outside the area of their particular expertise.

7.3.1 Describe how climates sometimes have changed abruptly in the past as a result of changes in Earth's crust, such as volcanic eruptions or impacts of huge rocks from space.

7.3.8 Describe how sediments of sand and smaller particles, sometimes containing the remains of organisms, are gradually buried and are cemented together by dissolved minerals to form solid rock again.

**The Living Environment**

7.4.1 Explain that similarities among organisms are found in external and internal anatomical features, including specific characteristics at the cellular level, such as the number of chromosomes. Understand that these similarities are used to classify organisms since they may be used to infer the degree of relatedness among organisms.

7.7.2 Use different models to represent the same thing, noting that the kind of model and its complexity should depend on its purpose.

**Grade 8 Science Standards**

**The Nature of Science and Technology**

8.1.1 Recognize that and describe how scientific knowledge is subject to modification as new information challenges prevailing theories and as a new theory leads to looking at old observations in a new way.

8.1.2 Recognize and explain that some matters cannot be examined usefully in a scientific way.

8.1.4 Explain why accurate record keeping, openness, and replication are essential for maintaining an investigator's credibility with other scientists and society.

8.1.8 Explain that humans help shape the future by generating knowledge, developing new technologies, and communicating ideas to others.

**Scientific Thinking**

8.2.6 Write clear, step-by-step instructions (procedural summaries) for conducting investigations, operating something, or following a procedure.

8.2.7 Participate in group discussions on scientific topics by restating or summarizing accurately what others have said, asking for clarification or elaboration, and expressing alternative positions.

8.2.8 Use tables, charts, and graphs in making arguments and claims in, for example, oral and written presentations about lab or fieldwork.

8.2.9 Explain why arguments are invalid if based on very small samples of data, biased samples, or samples for which there was no control sample.

8.2.10 Identify and criticize the reasoning in arguments in which fact and opinion are intermingled or the conclusions do not follow logically from the evidence given, an analogy is not apt, no mention is made of whether the control group is very much like the experimental group, or all members of a group are implied to have nearly identical characteristics that differ from those of other groups.

**Indiana Social Studies Standards**

**Kindergarten Social Studies Standards**

**Economics**

K.4.2 Identify different kinds of jobs that people do.

**Individuals, Society, and Culture**

K.5.2 Identify individuals who are important in students’ lives — such as parents, grandparents, guardians, and teachers — and give examples of how families cooperate and work together.

**Grade 1 Social Studies Standards**

**Economics**

1.4.2 Identify services that people do for each other.

**Individuals, Society, and Culture**

1.5.2 Identify groups to which people belong.

**Grade 2 Social Studies Standards**

**Geography: The World in Spatial Terms**

2.3.2 Identify the absolute and relative locations of places in the school and community setting using a simple grid map.

**Individuals, Society, and Culture**

2.5.5 Identify people of different ages, cultural backgrounds, traditions, and careers and explain how they contribute to the community.

**Grade 3 Social Studies Standards**

**Geography: Physical Systems**

3.3.5 Explain how climate affects the vegetation and animal life of a region and describe the physical characteristics that relate to form an ecosystem*.

**Grade 4 Social Studies Standards**

**Geography: The World in Spatial Terms**

4.3.2 Estimate distances between two places on a map, using a scale of miles, and use cardinal * and intermediate * directions when referring to relative location.
Physical Systems
4.3.6 Explain how glacial periods shaped Indiana’s landscape and environment.
4.3.7 Describe Earth’s atmosphere, lithosphere, hydrosphere, and biosphere and explain how these systems affect life in Indiana.

Grade 5 Social Studies Standards
Geography: Physical Systems
5.3.5 Map and describe the characteristics of climate regions of the United States.

Grade 7 Social Studies Standards
Geography: Physical Systems
7.3.7 Explain how physical processes have shaped Earth’s surface.

Grade 8 Social Studies Standards
Foundations of Government
8.2.4 Define and explain the importance of individual and civic responsibilities.
Geography: Physical Systems
8.3.4 Name and describe processes that build up the land and processes that erode it.

National Standards for Science Education (Grades K – 4)

Content Standard A — Scientific Inquiry (Grades K – 4)
Fundamental concepts and principles that underlie this standard include:
- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.

Content Standard B — Physical Science (Grades K – 4)
Fundamental concepts and principles that underlie this standard include:
- Properties of objects and materials — Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools, such as rulers, balances, and thermometers.
- Positions of motion of objects — Objects are made of one or more materials, such as paper, wood, and metal. Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials.
- Science and technology have greatly improved food quality and quantity, transportation, health, sanitation, and communication. These benefits of science and technology are not available to all of the people in the world.

Content Standard G — History and Nature of Science (Grades K – 8)
Fundamental concepts and principles that underlie this standard include:
- People have practiced Science and technology for a long time.
- Men and women have made a variety of contributions throughout the history of science and technology.
- Although men and women using scientific inquiry have learned much about the objects, events, and phenomena in nature, much more remains to be understood. Science will never be finished.
- Many people choose science as a career and devote their entire lives to studying it. Many people derive great pleasure from doing science.

National Standards for Science Education (Grades 5 – 8)

Content Standard A — Scientific Inquiry
As a result of activities in grades 5 – 8, all students should develop:
- Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects, organisms, or events; some involve collecting specimens; some involve experiments; some involve seeking more information; some involve discovery of new objects and phenomena; and some involve making models.
- Current scientific knowledge and understanding guide scientific investigations. Different scientific domains employ different methods, core theories, and standards to advance scientific knowledge and understanding.
- Mathematics is important in all aspects of scientific inquiry.
- Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations.
Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories. The scientific community accepts and uses such explanations until displaced by better scientific ones. When such displacement occurs, science advances.

Science advances through legitimate skepticism. Asking questions and querying other scientists’ explanations is part of scientific inquiry. Scientists evaluate the explanations proposed by other scientists by examining evidence, comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations.

Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data. All of these results can lead to new investigations.

Content Standard C — Life Science
As a result of their activities in grades 5–8, all students should develop understanding of:

Regulation and behavior
- All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment.
- Regulation of an organism’s internal environment involves sensing the external environment and changing physiological activities to keep conditions within the range required to survive.
- Behavior is one kind of response an organism can make to an internal or environmental stimulus. A behavioral response requires coordination and communication at many levels, including cells, organ systems, and whole organisms. Behavioral response is a set of actions determined in part by heredity and in part from experience.
- An organism’s behavior evolves through adaptation to its environment. How a species moves, obtains food, reproduces, and responds to danger are based in the species’ evolutionary history.

Populations and ecosystems
- A population consists of all individuals of a species that occur together at a given place and time. All populations living together and the physical factors with which they interact compose an ecosystem.
- Populations of organisms can be categorized by the function they serve in an ecosystem. Plants and some microorganisms are producers—they make their own food. All animals, including humans, are consumers, which obtain food by eating other organisms. Decomposers, primarily bacteria and fungi, are consumers that use waste materials and dead organisms for food.
- Food webs identify the relationships among producers, consumers, and decomposers in an ecosystem.
- For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis. That energy then passes from organism to organism in food webs.
- The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition. Given adequate biotic and abiotic resources and no disease or predators, populations (including humans) increase at rapid rates. Lack of resources and other factors, such as predation and climate, limit the growth of populations in specific niches in the ecosystem.

Diversity and adaptations of organisms
- Millions of species of animals, plants, and microorganisms are alive today. Although different species might look dissimilar, the unity among organisms becomes apparent from an analysis of internal structures, the similarity of their chemical processes, and the evidence of common ancestry.
- Biological evolution accounts for the diversity of species developed through gradual processes over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations. Biological adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive success in a particular environment.
- Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival. fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on the earth no longer exist.
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Dino Diary

Written by:

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