
BIRMINGHAM ZOO

TEACHER PACKET 2016



Dear Teachers,

Dinosaurs were the dominant terrestrial life-form on the planet for over 165 million years and included some of the largest animals ever to walk the earth. Fascination with these ancient animals began with the first dinosaur fossil discoveries in the early 1800s and continues today. *Dino Discovery-They're Back!* is a chance for students to take a glimpse into the past. It provides an exciting opportunity to see the dinosaurs as they might have looked when alive, as well as a platform to teach the concepts of the scientific method, adaptation, change-over-time, extinction and conservation.

This packet has been designed to help you teach your students about dinosaurs and paleontology. The packet can be used to help prepare students before a class visit to the Zoo, or it can be used on its own if you are unable to visit the Zoo but still want to study dinosaurs.

The background information enclosed was designed to familiarize you with the topic of dinosaurs as it relates to the exhibit and to increase your understanding of the topic. It also can be used to help develop student lesson plans.

This teacher packet is intended for use with students in elementary and middle school, although it can be used for high school students. A variety of information and activities has been provided; however, not every fact and activity is appropriate for all ages. To further your understanding, please view the resources list at the end.

We hope this packet will help make learning about dinosaurs a rewarding and enriching experience.

Sincerely,
Birmingham Zoo, Inc. Education Department

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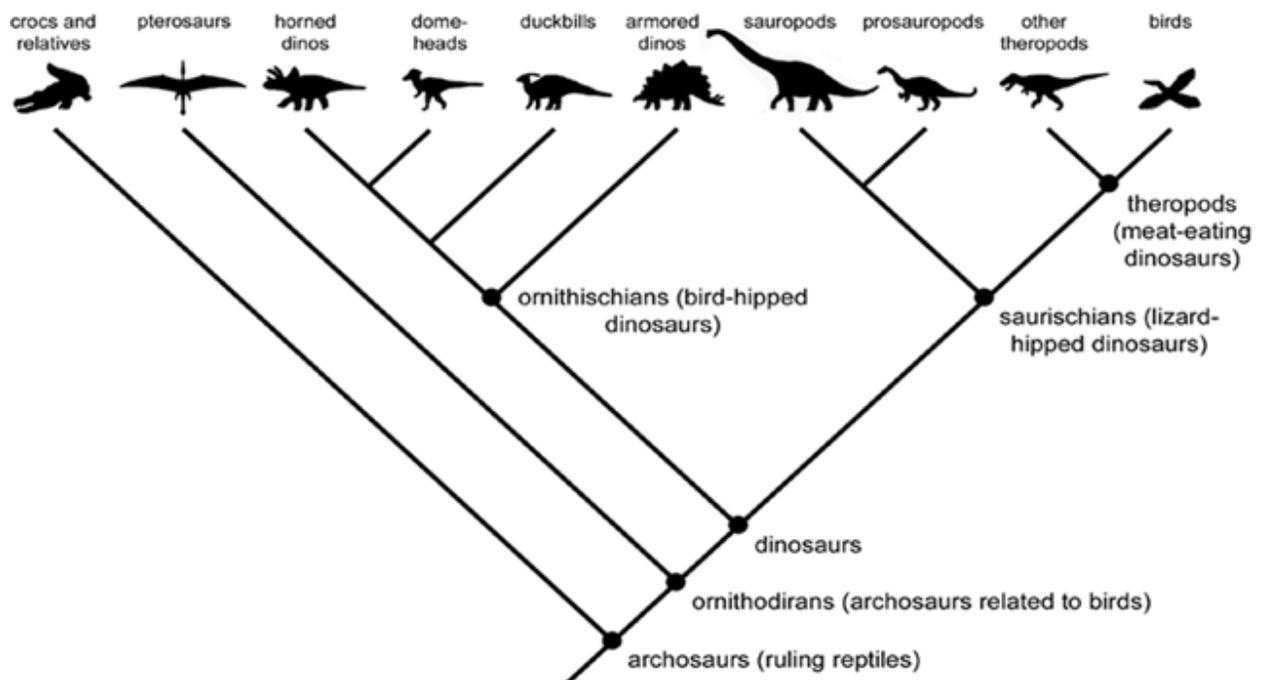
DINOSAURS DEFINED

What are Dinosaurs?

The word “dinosaur” refers to a group of shared traits rather than a specific definition. Upon discovering fossils, early scientists thought of dinosaurs as giant versions of modern-day reptiles, similar to lizards. For example, one of the first fossils identified by Dr. Gideon Mantell as a dinosaur was imagined to look like a giant iguana, hence the name *Iguanodon*. The word dinosaur means “**terrible lizard**”. Although they are a reptile descendant, scientists now think of them as a unique type of reptile. The shared characteristics of dinosaurs include:

- All dinosaurs have a special hip joint that allows their legs to be positioned directly under their body, giving the first dinosaurs an advantage over other reptiles with limbs on their sides.
- All dinosaurs lived during the Mesozoic Era (250 million to 65 million years ago).
- All dinosaurs lived on land.

These traits rule out many other animals that lived at the same time, including crocodilian ancestors, mosasaurs (marine reptiles) and pterosaurs (flying reptiles). The following is a family tree illustrating how all these groups are connected.



Source: http://www.ucmp.berkeley.edu/museum/events/bigdinos2005/images/dino_tree.gif

Birds

One of the surprising theories to gain support in recent years is the relationship between birds and dinosaurs: birds are the living descendants of some dinosaurs. Most scientists now include birds in the dinosaur family tree. So, modern birds are present-day dinosaurs!

For more information on how birds are connected to dinosaurs, visit UC Berkeley's Understanding Evolution: http://evolution.berkeley.edu/evolibrary/article/evograms_06

Record Holders

Around 700 different species of dinosaurs have been named and over 1,000 have been discovered. New dinosaurs are found all the time – an average of one new dinosaur every two weeks!

The **largest dinosaur** (based on weight) discovered thus far is called the ***Argentinosaurus***.

- Fossils were found in Argentina.
- It may have weighed 100 tons, as much as 20 elephants.
- A complete skeleton has not been discovered. Fossil remains include leg bones, vertebrae, and pelvic bones. The largest dinosaur known with a complete skeleton is the *Brachiosaurus*.

The **smallest dinosaur** is debatable.

- Many small dinosaurs have been found but it is difficult to determine if some of them are small adults or juveniles of a larger species.
- For many years the *Compsognathus* was considered to be the smallest. They are the size of a turkey.
- Recent finds suggest that the smallest dinosaur may be a type of maniraptor found in England.
- The smallest dinosaur found in North America is thought to be a heterodontosaur named *Fruitadens haagarorum*.

The **smartest dinosaur** discovered thus far is thought to be the ***Troodon***.

- How in the world do scientists know how smart an animal was based on bones? The brain cavity in the skull! The *Troodon* had the the biggest brain for its body size- about the size of a golf ball.

The **biggest predatory dinosaur** discovered thus far depends on your definition of “big”:

- The heaviest was the ***Giganotosaurus***, weighing up to 3 tons.
- The longest was the ***Spinosaurus***, measuring up to 50 feet long.
- In the United States, the biggest predator was the ***Acrocanthosaurus***.
- What about the T-Rex? It was not the biggest, but it may have been the one you would least like to meet: its brain was twice as big as *Giganotosaurus*; it was faster than other predators, clocking in at up to 25 miles per hour; it had better vision; and it had powerful crushing jaws with razor-like teeth.

DINOSAURS CLASSIFIED

Classification

Classification means grouping animals into taxonomic groups according to shared observed similarities.

Dinosaurs can be grouped in many ways:

- **Diet:** plant-eater vs. meat-eater
- **Hips:** lizard-hipped vs. bird-hipped
- **Family:** shared characteristics

Dino Naming

Dinosaur names usually are based on a person associated with the finding, the location they were found, or by a distinct characteristic. The name usually is in Greek or Latin but can be in other languages like Sanskrit. For example, *Fruitadens haagarorum* was found in Fruita, Colorado by the Natural History Museum of Los Angeles County. The president of the board of trustees at the time was Dr. Paul Haaga.

Bird-hipped vs. Lizard-hipped

Dinosaurs can be divided into two groups: lizard-hipped dinosaurs (saurischians) that included the largest plant-eaters and the meat-eaters, and bird-hipped dinosaurs (ornithischians) that included most plant-eaters.

Web link to hip-comparison graphic:

http://higheredbcs.wiley.com/legacy/college/levin/0471697435/chap_tut/images/nw0323-nn.jpg

Dinosaur Family Groups

Dinosaurs are further divided into different family groups based on common features. Here are some examples of the type of dinosaurs in each group:

Saurischians: Lizard-hipped

Theropods

2-legged, sharp-clawed, some meat-eaters/some plant-eaters, all birds



Photo- DK Images: ©
Dorling Kindersley

Sauropods

4-legged, long-necked plant-eaters



Photo- DK Images: ©
Dorling Kindersley

Prosauropods

4-legged, semi long-necked plant-eaters



Photo- DK Images: ©
Dorling Kindersley

Ornithischians: Bird-hipped

Stegosaurus

4-legged, plate-backed plant-eaters



Photo- DK Images: ©
Dorling Kindersley

Ankylosaurus

4-legged, club-tailed plant-eaters



Photo- DK Images: ©
Dorling Kindersley

Hadrosaurs

4-legged, duck-billed plant-eaters



Photo- DK Images: ©
Dorling Kindersley

Iguanodons

4-legged plant-eaters



Photo- DK Images: ©
Dorling Kindersley

Ceratops

4-legged, horned-headed plant-eaters



Photo- DK Images: ©
Dorling Kindersley

Plant-eater vs. Meat-eater

Dinosaurs can be broken into meat-eaters and plant-eaters. Scientists look at fossil teeth, skulls and coprolite (fossilized animal dung), as well as hypothesize animal behavior, to determine if they ate plants or meat.

Iguanodon Cheek Teeth

Tough plants wore down teeth. The tooth on the left is before wear and the right is after wear.



Photo- DK Images: Natural History Museum, London

Megalosaurus Teeth

Curved teeth helped to slice flesh. New teeth grew to replace lost or worn teeth.



Photo- DK Images: © Dorling Kindersley

Psittacosaurus Skull

The beak of this dinosaur allowed it to cut plants. It used its flat-serrated teeth to grind.



Photo- DK Images: Natural History Museum, London

Allosaurus Skull

Strong jaws and muscles and rows of blade-like teeth are traits of a meat-eater.



DK Images: Staatliches Museum für Naturkunde Stuttgart

For more information on Dinosaur Classification, please visit the Smithsonian National Museum of Natural History Website at <http://paleobiology.si.edu/dinosaurs/info/everything/what.html>.

DINOSAUR WORLD

Mesozoic Era

Dinosaurs lived during the Mesozoic era, which lasted from 250 million to 65 million years ago.

The Mesozoic Era includes three periods:

- **Triassic:** 250 million to 200 million years ago
- **Jurassic:** 200 million to 145 million years ago
- **Cretaceous:** 145 million to 65 million years ago

The Mesozoic Era sometimes is called “the age of the dinosaurs.”

- Dinosaurs appeared around 230 million years ago and lived until 65 million years ago.
- Different families of dinosaurs can be found throughout the three periods. However, specific species predominantly lived in one of the three periods. Birds survived until modern times.
- The Mesozoic Era began with a mass extinction event and ended with a mass extinction event.

Climate and Habitats

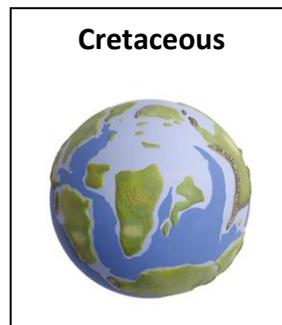
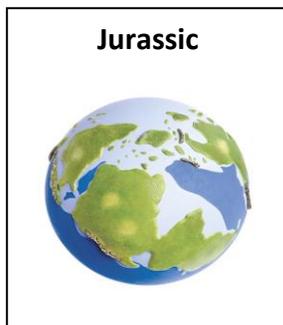
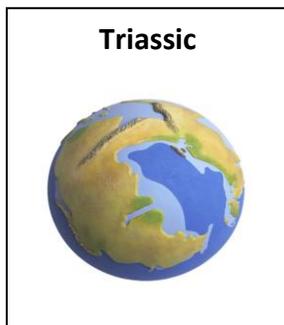
Dinosaurs lived in a variety of habitats, including forests, shores and deserts.

- Climates changed as the Earth’s plates moved. Studying fossilized plants and pollen allows scientists to hypothesize about the habitat in a given area at a given time.
- Many of these plants are extinct as well, but some survived, like ferns and *Ginkgo biloba* trees.
- Some examples of climates that changed: the area now known as the Sahara desert was a forest, western America was an ocean and Australia was dark much of the year.

Moving and Shifting (Photos- DK Images: © Dorling Kindersley)

Because of the plates shifting under the earth, the land changed greatly during the time of the dinosaurs:

- Pangaea was a giant land mass composed of all the continents during the Triassic period.
- Two supercontinents existed during the Jurassic period- a northern supercontinent called Laurasia and a southern supercontinent called Gondwana.
- The land masses moved almost to their current positions during the Cretaceous period.



DINOSAUR FOSSILS

Fossils

A fossil is the remains, imprint, or trace of an organism that was once living.

Fossils are most often found in sedimentary rock. Sedimentary rocks are formed when layers of sediment (such as sand, mud and/or clay) are compressed and hardened into rock.

Fossil Formation

Usually a deceased animal, bones and all, disappears forever; the body and bones decay, get eaten by scavengers or are turned into dust by the wind and rain. Fossils need the right conditions to form. Very quickly after death, the body must be covered by sand, mud or dirt to limit oxygen exposure, which speeds decay. For a “body fossil,” minerals enter the tiny holes in spongy bones over the course of thousands of years. Increasing layers of sediment compress the minerals to create a fossil.



Photo- <http://jpostema.napsk12.org/earth-s-history-5-0>

Types of Fossils

- **Body Fossils:** bone replaced by minerals, which turns the bone into rock.
- **Imprint/Mold Fossils:** when an animal leaves an imprint (of its body or skeleton) on sediment that hardens. This is a “negative image” of the animal body or skeleton.
- **Cast Fossil:** when minerals fill the hollow part of a skeleton, like a clam, they create a “positive image” of the organism.
- **Trace Fossils:** traces of organisms in the rock, including tracks, burrows or trails.

Paleontology

Paleontology is a branch of science that is concerned with the prehistoric life of plants and animals. Paleontologists are scientists that use fossils to reconstruct the history of life as it existed in the past. Sometimes these scientists who specifically look for fossil dinosaurs are called “Dinosaur Hunters.”

Finding Fossils

Fossils can be found in many places, but sedimentary rock is the first place many scientists look. As layers of sediment are worn away by wind and rain, fossils are exposed. Environments where sedimentary rocks clearly show layers are deserts, cliffs, quarries and badlands.

It is up to the dinosaur hunter to have a keen eye to spot the fossil sticking up out of the rocks. In fact, 80% of dinosaur fossils are discovered by regular people who happen upon them by accident. Some dinosaurs have even been found by kids!

Once found, the fossils are excavated. The scientists map out the location, take pictures, carefully extract the fossil from the rock, wrap it in protective plaster and ship it back to a museum or lab for further study.

Rebuilding Dinosaurs

Fossils in the lab are carefully separated from rock and cleaned. Scientists use chisels, brushes, drills and even acid to clean the rock away. Then the bones are put together, or reconstructed, to create a skeleton, using basic anatomy and bone identification as a guide. Finally, model-makers use the skeleton as a basis for defining the dinosaur body shape, muscle and other tissue.

Learn more about dinosaur reconstruction:

<http://www.mnh.si.edu/exhibits/backyard-dinosaurs/reconstructing-animals.cfm>

What Fossils Can Tell Us

Fossils are the basis for all we know and think about dinosaurs. Scientists use the scientific method to come up with theories. This involves making observations, creating hypotheses and testing those hypotheses against current and future observations. Here is a short list of what scientists have discovered from the study of fossilized dinosaurs.

- **Diet:** based on fossils of teeth, coprolite (fossilized dung), stomach remains and other body parts.
- **Social Behavior:** based on tracks that show evidence of migration, and on multiple fossils found in the same location that suggest group dynamics of a pack or herd.
- **Speed:** fossil tracks can determine how fast an animal was moving at the time the tracks were made; body and bone structure also provide clues.

- **Age:** the rock layer where the fossil was found can be used to date the dinosaur, as well as Potassium-Argon dating. Several bones of the same species can be compared to discover juvenile vs. adult bones.
- **Skin and Body Covering:** fossils may include impressions of skin or feathers.
- **Color:** while most evidence of dinosaur coloration is lost, recent fossil discoveries of an *Anchiornis* in China was so well preserved that the feather color survived, showing a black and white feather pattern with a red head.

Fossils Commonly Found in Alabama

Much of Alabama was covered by ocean in the past. Many of the fossils found here are snails, clams, coral, and shark teeth. Other common fossils include:

- Crinoids stem sections- also known as sea lilies
- Ammonites- squid-like mollusks
- Brachiopods- clam-like organisms
- Trilobite- marine arthropod

State Fossil of Alabama

The state fossil of Alabama is the *Basilosaurus*, sometimes called the *Zeuglodon*. *Basilosaurus* is not a dinosaur, but rather, an early member of the whale family. It lived in Alabama 30 to 40 million years ago, after the age of the dinosaurs. A complete skeleton can be found at the McWane Science Center in Birmingham and the Alabama Museum of Natural History in Tuscaloosa. A replica fossil can be found at the Birmingham Zoo, buried for kids to uncover in the Fossil Dig, which is part of Dino Discovery- They're Back!



Photo- Ryan Somma

Basilosaurus imagined video: <http://www.youtube.com/watch?v=3EjvEFuoAwk>

Basilosaurus info: http://www.archives.alabama.gov/emblems/st_fossil.html

DINOSAUR ADAPTATIONS

Adaptations and Survival

Dinosaurs used adaptation to survive. An adaptation refers to an inherited physical or behavioral characteristic that helps it survive or reproduce.

How do we know about dinosaur adaptations?

- **The study of fossils:** diet, body structure and social behavior all can be used to build a hypothesis that describes dinosaur adaptations.
- **The study of present day animals:** by studying present-day animals' physical and behavioral adaptations, scientists can hypothesize about dinosaur adaptations.

Here is a short list of types of adaptations you can discuss with students as it relates to dinosaurs:

- **Food Chain:** herbivore, carnivore, omnivore; predator-prey; physical and behavioral adaptations to find and get food; scavengers.
- **Courtship and Mating:** physical characteristics (colors, crests and frills), behavioral characteristics (dances or displays to attract mate or battles between males).
- **Social Dynamics:** herding, migrating, pack-hunting, solitary hunting.
- **Rearing Young:** building and guarding nests, brooding eggs, raising and protecting young.
- **Defense:** physical adaptation (armor, horns, domes, claws or teeth), behavioral adaptations (speed, making sounds, huddling together, hiding, or evading).

For more on adaptations and dinosaur behavior:

<http://www.mnh.si.edu/exhibits/backyard-dinosaurs/how-did-dinosaurs-behave.cfm>

Zoo Exhibit Animals

Many animals at the Zoo can be used to illustrate possible adaptations of dinosaurs. Each dinosaur fact sheet lists an example of a connection between a dinosaur and a Zoo animal. These are a great way to incorporate the rest of the Zoo into your lesson and can be used to create fun scavenger hunts.

Dino Discovery Exhibit Birds

Dino Discovery also has 9 exhibit birds on display. Adaptations can be used to illustrate the connection between birds and dinosaurs.

- **Some adaptations shared by birds and some dinosaurs:** Feathers, hollow bones, beaks, egg laying, egg brooding, hip placement, wishbone, and nesting.
- **The following birds are on display in the exhibit:** screech owls, sandhill cranes, black vulture, red-tailed hawk, great-horned owls, eastern wild turkey and domestic chicken.

For more on how birds are connected to dinosaurs, visit the Museum of Natural History's website:

<http://www.amnh.org/explore/science-topics/birds-are-dinosaurs>

Extinction

About 65 million years ago, non-avian dinosaurs went extinct. While we don't know exactly what caused the extinction, there is evidence of large scale disasters happening around the same time:

- **Asteroid impact:** A large rock crashed into Earth from space near the modern day Yucatan Peninsula. It would have produced dust, smoke and gas that would change weather patterns. The dinosaurs would have had to adjust or perish. In addition to an undersea crater, other evidence of such an impact can be found in the presence of large amounts of Iridium, a common element in asteroids, but rare on earth.
- **Volcanic activity:** There is evidence that a large volcano erupted around the time of the end of the Mesozoic Era on the Indian continent. This eruption left volcanic deposits up to a mile thick in some places. The gas produced in this eruption could have caused a climate change to which most of the dinosaurs could not adapt.
- **Slow Climate Change:** Hotter summers and colder winters started to occur near the end of the Mesozoic Era. This could have caused population declines over time that ended in extinction.

For more on extinction:

1. [http://www.amnh.org/explore/amnh.tv/\(watch\)/dinosaurs-explained/how-did-all-dinosaurs-except-birds-go-extinct](http://www.amnh.org/explore/amnh.tv/(watch)/dinosaurs-explained/how-did-all-dinosaurs-except-birds-go-extinct)
2. <http://www.ucmp.berkeley.edu/diapsids/extinction.html>
3. <http://www.bbc.co.uk/programmes/p00l4mdl>

Conservation

One of the core values of the Birmingham Zoo is conservation. While a natural disaster killed the dinosaurs, humans are the largest threat to animals today. By understanding the concept of extinction in the Zoo's dinosaur exhibit, students can then learn about preventing it from happening to animals alive today. Major threats from humans include:

- Poaching
- Habitat loss
- Pollution

What can you and your students do?

- **Care:** build empathy in your students toward the Earth and all its life-forms.
- **Share:** create lesson plans that teach concepts related to environmental awareness.
- **Act:** take actions that make a difference, like energy conservation and recycling.

MEET THE ZOO'S DINOSAURS

Dino Discovery- They're Back! Presented by Vulcan Materials Company

At the Zoo, you will meet life-like models of some dinosaur species. Each dinosaur can be used to illustrate information listed in this packet. The dinosaurs move, make noise, and one even spits water!

Exhibit Graphics

Each dinosaur will have an interpretive graphic listing educational information including its diet, the period in which it lived, interesting facts, where the fossil was found and how to pronounce its name. Use these graphics with your student for scavenger hunts or to expand their knowledge. Additionally, each dinosaur on display will have a companion Zoo animal that shares similar characteristics or behaviors today.

Dinosaur List

There are thirteen dinosaur species represented in the exhibit. The following information includes the description that appears on the graphic. The pictures used are Billings Production, Inc. website models. The coloration of the dinosaurs may vary.

1. *Brachiosaurus*
2. *Deinonychus*
3. *Diabloceratops*
4. *Dilophosaurus*
5. *Edmontonia*
6. *Iguanodon*
7. *Pachycephalosaurus*
8. *Pachyrhinosaurus*
9. *Parasaurolophus*
10. *Quetzalcoatlus*
11. *Stegosaurus*
12. *Tyrannosaurus Rex*
13. *Utahraptor*

Brachiosaurus

Pronounced: ([brack-ee-o-sore-us](#))

Meaning of Name: “Arm lizard”

Family Group: Sauropods

Diet: Plant-eater

Period: Early to Late Jurassic

Fossil Found: United States (Utah, Oklahoma, Wyoming, Colorado), Europe, and Africa



Graphic Facts:

The *Brachiosaurus* was one of the largest dinosaurs. It was 85 feet long –the length of three school buses – and it could reach 50 feet above the ground. Scientists used to think that all dinosaurs were cold-blooded like reptiles. However, increasing evidence shows that animals the size of large dinosaurs were warm-blooded and ate a tremendous amount of food to provide enough energy to stay warm.

Discover the Connection – Zoo Animals and the dinos: Giraffe

The *Brachiosaurus* was a big eater. Like a giraffe, it travelled in herds, eating the leaves at the top of trees. Its teeth were designed for cutting, so it swallowed its food whole. It ate between 440 and 880 pounds of plants per day! By comparison, an adult giraffe eats about 75 pounds of browse each day.

Links for Photos:

[Skeleton](#)- drawing

[Skeleton](#)- fossil reconstruction

[Rendered](#)

[Size comparison](#)

Links for Additional Facts:

Learn more about [Sauropod Dinosaurs](#)

Learn more about the [Jurassic Period](#)

[Brachiosaurus: Facts about the Giraffe-like Dinosaur](#)

Discovery Channel: Clash of the Dinosaurs – [Sauropod Super Stomachs](#)

Deinonychus

Pronounced: (die-non-ih-kuss)

Meaning of Name: “terrible claw”

Family Group: Dromaeosaurs

Diet: Meat-eater

Period: Early to Mid Cretaceous

Fossil Found: United States (Montana, Utah, Wyoming, Oklahoma, Arkansas, Maryland)



Graphic Facts:

One of the most striking features of this dinosaur is the enormous talon on the second toe of each foot. These large, agile theropods used their large claws to incapacitate their prey, which was sometimes much larger than themselves. Measuring up to 9 feet long, *Deinonychus* was a top predator of the time with around 60 blade-like teeth.

Model: This *Deinonychus* model features an adult feeding upon a *Parasaurolophus*

Discover the Connection – Zoo Animals and the dinos: African Lion

Lions are one of today’s top predators. One key to their success in the wild is the pack-hunting strategy that ensures an entire pride has the food it needs. Several *Deinonychus* skeletons have been found together near a large herbivore dinosaur, *Tenontosaurus*, which suggests that *Deinonychus* was a pack hunter.

Links for Photos:

[Skeleton](#)- drawing

[Skeleton](#)- fossil reconstruction

[Rendered](#)

[Size comparison](#)

Links for Additional Facts:

Learn more about [Dromaeosaur Dinosaurs](#)

Learn more about the [Cretaceous Period](#)

Melbourne Museum - [Deinonychus](#)

Diabloceratops

Pronounced: (dee-ob-low-sarah-tops)

Meaning of Name: “Devil horn face”

Family Group: Ceratopsians

Diet: Plant-eater

Period: Late Cretaceous

Fossil Found: United States (Utah)



Graphic Facts:

The *Diabloceratops* is part of a large group of dinosaurs with serious headgear. *Triceratops* may be a close relative you're familiar with. What was the purpose of all the diversity in skull shapes? Perhaps the male with the largest frill and horns was the dominant individual - like the bull elk with the largest antlers. Maybe, they were a defensive weapon against predators. Scientists are still putting the pieces of evidence together to find an answer.

Discover the Connection – Zoo Animals and the dinos: African Elephants

Today, elephants use their large size and herding behavior to protect small young. Groups of horned dinosaurs like *Diabloceratops* have been found fossilized together in the bone beds of the Western United States. This tells paleontologists that they may have lived together in social groups and, maybe, defended their young in much the same way.

Links for Photos:

[Skeleton](#)- drawing

[Skeleton](#)- fossil reconstruction

[Rendered](#)

[Size comparison](#)

Links for Additional Facts:

Learn more about [Ceratopsian Dinosaurs](#)

Learn more about [Ceratopsians](#)

Learn more about the [Cretaceous Period](#)

Natural History Museum – [Diabloceratops](#)

Dilophosaurus

Pronounced: ([die-lof-o-sore-us](#))

Meaning of Name: “Double-crested reptile”

Family Group: Ceratosaurians

Diet: Meat-eater

Period: Early Jurassic

Fossil Found: United States (Arizona), China



Graphic Facts:

Notice the large frill on the head of the *Dilophosaurus*? This is one of the few things that movie depictions got correct. The internal structures of these frills were much too delicate to be used for anything other than display. Different species may have used them to recognize each other. Males may have used them to attract mates and they may have had an intimidation factor when these animals felt threatened.

Discover the Connection – Zoo Animals and the dinos: Common Basilisk

The common basilisk is a lizard found throughout Central and South America. The name refers to a serpent in Greek mythology with a crowned head and the ability to kill you at a glance. Although these lizards don't have that deadly ability, the males of this species do have large crests on their head that are used for territorial displays and mate attraction, possibly similar to the extinct *Dilophosaurus*.

Movie Myth:

Remember *Dilophosaurus* from Jurassic Park? It was depicted as smaller, with a colorful frill, and with the ability to spit poison. All of these are movie alterations! There is no evidence that this dinosaur had a fleshy frill or that it spit poison, and the fossils show that it was much larger.

Links for Photos:

[Skeleton](#)- drawing

[Skeleton](#)- fossil reconstruction

[Rendered](#)

[Size comparison](#)

Links for Additional Facts:

Learn more about [Theropod Dinosaurs](#)

Learn more about [Ceratosaurians](#)

Learn more about the [Jurassic Period](#)

University of California Museum of Paleontology – [Dilophosaurus: A Narrated Exhibition](#)

Edmontonia

Pronounced: ([ed-mon-toe-nee-ah](#))

Meaning of Name: “From Edmonton, Canada”

Family Group: Thyreophorans

Diet: Plant-eater

Period: Late Cretaceous

Fossil Found: Canada and United States (Montana, Wyoming, Utah)



Graphic Facts:

Edmontonia was part of the large group of “armored dinosaurs”. These large herbivores developed bony plates and hard scutes (scales) to help protect them from predators of the time. Like the more commonly known *Ankylosaurus*, *Edmontonia* had a small head and a very small brain. It also sported small teeth and weak jaws. Instead of chewing its food, it more than likely digested its food by fermentation, like a cow.

Discover the Connection – Zoo Animals and the dinos: American Alligator

Massive body plates, called osteoderms, covered the *Edmontonia*'s back - just like a modern alligator. The spikes on its neck and shoulders were for defense. When threatened, it may have hunkered down on the ground to protect its belly until the predator gave up - like an armadillo.

Links for Photos:

[Skeleton](#)- drawing

[Skeleton](#)- fossil reconstruction

[Rendered](#)

[Size comparison](#)

Links for Additional Facts:

Learn more about [Ankylosaur Dinosaurs](#)

Learn more about the [Cretaceous Period](#)

Learn more about [Edmontonia](#)

Iguanodon

Pronounced: (i-gwan-oh-don)

Meaning of Name: "iguana tooth"

Family Group: Ornithopods

Diet: Herbivore

Period: Cretaceous

Fossil Found: United States (South Dakota), Europe, and Africa



Graphic Facts:

The *Iguanodon* was the second species of dinosaur to be discovered and the first to be named, before the word "dinosaur" had even been created. British naturalist, Gideon Mantell, discovered fossil teeth which he identified as belonging to a giant, plant-eating reptile, hence the name "iguana tooth". Since it was discovered so early, this genus became what is known as a trash genus, meaning that any dinosaur discovered that even remotely resembled *Iguanodon* was lumped together. Today, there are 3 distinct species in this genus found across the world.

Discover the Connection – Zoo Animals and the dinos: Gopher Tortoise

Tortoises use their sharp keratinous beaks to tear plant matter into small pieces when they eat. Duckbill dinosaurs, like *Iguanodon*, also had beaks made out of keratin that allowed them to eat in a similar fashion. Because keratin, the substance that makes up beaks, hair, and fingernails, doesn't fossilize very well, early paleontologists usually only found the bony support structure. This made the skulls look very duck-like. So, maybe a better name for this group would be the "beaked dinosaurs".

Links for Photos:

[Skeleton](#)- drawing

[Skeleton](#)- fossil reconstruction

[Rendered](#)

[Size Comparison](#)

Links for Additional Facts:

Learn more about [Iguanodon Dinosaurs](#)

History of the Iguanodon: [Reconstruction of a dinosaur](#)

Learn more about the [Cretaceous Period](#)

Pachycephalosaur

Pronounced: ([pack-ee-sef-uh-low-sore-us](#))

Meaning of Name: “Thick headed lizard”

Family Group: Pachycephalosaurids

Diet: Possibly Omnivorous

Period: Late Cretaceous

Fossil Found: Western United States (Montana, South Dakota, Wyoming)



Graphic Facts:

Pachycephalosaur was among the last and largest of the dome-headed dinosaurs, with skulls up to 10 inches thick. They may have used these thick heads to butt each other in shows of dominance. Fossil evidence shows that as these animals matured, their domes got larger and their spikes got smaller. The spikes probably got smaller due to breakage and wear as the animal aged.

Discover the Connection –Zoo Animals and the dinos: Dwarf Nigerian Goat

Much like *Pachycephalosaur* in the Mesozoic, lots of herbivores, like goats, show dominance by butting heads. Sometimes they have even been known to charge at reflections of themselves in windows and car doors. Imagine a 15 foot, 1,000 pound *Pachycephalosaurs* ramming into your vehicle or through a window today!

Links for Photos:

[Skeleton](#)- drawing

[Skeleton](#)- fossil reconstruction

[Rendered](#)

[Size comparison](#)

Links for Additional Facts:

Learn more about [Pachycephalosaurs](#)

Learn more about the [Cretaceous Period](#)

Smithsonian Magazine – [How to Bring Dinosaurs Back to Life](#)

Pachyrhinosaurus

Pronounced: (pack-ee-rye-no-sore-us)

Meaning of Name: “thick nosed lizard”

Family Group: Ceratopsians

Diet: Plant-eater

Period: Late Cretaceous

Fossil Found: Alaska and Canada



Graphic Facts:

Pachyrhinosaurus used its strong cheek teeth to chomp on tough fibrous plants and its sharp beak to slice vegetation. Packed tightly together to form a cutting surface, its teeth were continually replaced by new ones - just like shark's teeth. This adaptation made it a more efficient feeder, especially since some plant material can wear down teeth very quickly.

Discover the Connection – Zoo Animals and the dinos: Southern White Rhinoceros

Pachyrhinosaurus may have used the bony growth, or boss, on its nose to butt other herd members for dominance and mating, much like modern rhinos. Like other ceratopsians, the function of the neck frill and horns is debatable. Perhaps they could be flushed with blood to create bright colors or they may have helped to protect the sensitive areas around the neck.

Links for Photos:

[Skeleton](#)- drawing

[Skeleton](#)- fossil reconstruction

[Rendered](#)

[Size comparison](#)

Links for Additional Facts:

Learn more about [Ceratopsian Dinosaurs](#)

Learn more about [Ceratopsians](#)

Learn more about the [Cretaceous Period](#)

Natural History Museum - [Pachyrhinosaurus](#)

Parasaurolophus

Pronounced: ([para-sore-AH-luf-us](#))

Meaning of Name: “Like crested lizard”

Family Group: Hadrosaurs

Diet: Plant-eater

Period: Late Cretaceous

Fossil Found: U.S. (New Mexico and Utah),
Canada



Graphic Facts:

The *Parasaurolophus* was a herding dinosaur, which ranged over much of North America. They were one of the few dinosaurs that could walk on either two legs or four. This allowed them to reach food higher up in trees and also support their heavy weight when moving across the landscape. One characteristic that sets this species apart from other hadrosaurs is a slightly more narrow mouth- a sign that they may have had specialized diets.

Discover the Connection – Zoo Animals and the dinos: White Handed Gibbon

White handed gibbons are famous for their loud calls and “morning songs” that can be heard throughout the Zoo. The large bony crest of the *Parasaurolophus* may have been used as a resonating chamber that allowed this species to call to other herd members over very long distances.

Model: This dinosaur model is shown as the prey of a *Deinonychus* dinosaur

Links for Photos:

[Skeleton](#)- drawing

[Skeleton](#)- fossil reconstruction

[Rendered](#)

[Size comparison](#)

Links for Additional Facts:

Learn more about [Hadrosaurian Dinosaurs](#)

Learn more about the [Cretaceous Period](#)

New Mexico Museum of Natural History and Science – [Parasaurolophus Nest](#)

Discovery Channel: Clash of the Dinosaurs – [Duckbill Sound Machine](#)

Quetzalcoatlus

Pronounced: (ket-zal-koh-ah-tlus)

Meaning of Name: “Feathered Serpent God”

Family Group: Pterosaur

Diet: Meat-eater

Period: Late Cretaceous

Fossil Found: United States (Texas)



Graphic Facts:

Although *Quetzalcoatlus* was a flying reptile (not a dinosaur), it would have been a terror for small land dwellers of the time. These large animals used their long, toothless beaks much like storks of today to catch and eat small dinosaurs and mammals. From fossilized trackways, we know that *Quetzalcoatlus* walked on all fours. Scientist’s believed they used an awkward gallop to pick up speed before taking off because they were so heavy.

Discover the Connection – Zoo Animals and Dinos: Kori Bustard

The *Quetzalcoatlus* was one of the largest known flying animals of all time. It weighed about 400 pounds with a wingspan of 30 feet. Today, the Kori Bustard is the largest flighted bird - weighing in at up to 40 pounds. As omnivores, these birds eat both plant and animal material. Here at the Zoo, whole mice seem to be their favorite.

What’s in a name?

The name of this ancient animal comes from Quetzalcoatl- the Aztec god depicted as a large feathered serpent.

Links for Photos:

[Skeleton](#)- drawing

[Skeleton](#)- fossil reconstruction

[Rendered](#)

[Size comparison](#)

Links for Additional Facts:

Learn more about [Pterosaurs](#)

Learn more about the [Cretaceous Period](#)

Learn more about [Quetzalcoatlus](#)

Stegosaurus

Pronounced: (steg-oh-sore-us)

Meaning of Name: “Roofed lizard”

Family Group: Thyreophorans

Diet: Plant-eater

Period: Late Jurassic

Fossil Found: United States (Colorado, Wyoming, and Utah) and Portugal



Graphic Facts:

Made from a bony material, the 17 plates, called dermal plates, running down its back had blood vessels within them. They grew from the skin not the spine. They most likely were used for display, recognition and attracting mates. They may have also acted as radiators, releasing body heat to a cooler environment. Conversely, the plates could have worked as solar panels collecting heat.

Discover the Connection – Zoo Animals and Dinos: Eastern Wild Turkey

Eastern Wild Turkeys show high sexual dimorphism- meaning that males and females look very different. Males are unmistakable from females, especially when they are displaying for dominance. The larger, more colorful males fan out their large tail feathers during the display. The brightly colored exposed skin around the head becomes filled with blood- intensifying the red and blue hues. Many scientists now believe that *Stegosaurus* may have used their bony plates to do the same. Because the shapes and sizes varied so much between these dinosaur species, it’s doubtful they were developed for protection.

Model: The color for this model was determined through a coloring contest for students in K-6th grade. The winner of the competition, Jesse Crisswell, designed this brightly colored version that shows some of the variation that might have been possible in these large animals.

Links for Photos:

[Skeleton](#)- drawing

[Skeleton](#)- fossil reconstruction

[Rendered](#)

[Size comparison](#)

Links for Additional Facts:

Learn more about [Stegosaurian Dinosaurs](#)

Learn more about the [Jurassic Period](#)

Learn more about [Stegosaurus](#)

Tyrannosaurus rex

Pronounced: ([tye-ran-o-sore-us](#) rex)

Meaning of Name: “Tyrant lizard king”

Family Group: Tyrannosaurids

Diet: Meat-eater

Period: Late Cretaceous

Fossil Found: North America (Western U.S. and Canada)



Graphic Facts:

Tyrannosaurus rex was one of the last dinosaurs to walk the Earth. The fossils of this mighty predator have been found in rocks that are 65 million to 85 million years old. This means that *T. rex* probably saw the large extinction event that wiped out all non-avian dinosaurs. The loss of these dominant animals meant that other types of animals were able to conquer the land. Mammals and birds became the top land vertebrates over the next 65 million years.

Discover the Connection – Zoo Animals and Dinos: Malayan Tiger

The Malayan tiger is one of the world’s most endangered predators. Like *Tyrannosaurus rex*, their massive teeth are able to grab and hold onto a variety of prey items. Carnivores like tigers and *T. rex* are and were vital to their local ecosystems. These big cats help to keep the number of herbivores in check to prevent over-grazing of grasslands and forests. The loss of these majestic animals would completely alter the landscape- similarly to the loss of the dinosaurs at the end of the Mesozoic.

Links for Photos:

[Skeleton](#)- drawing

[Skeleton](#)- fossil reconstruction

[Rendered](#)

[Size comparison](#)

Links for Additional Facts:

Learn more about [Theropod Dinosaurs](#)

Learn more about the [Cretaceous Period](#)

National Geographic – [Tyrannosaurus Rex](#)

Discovery Channel: Clash of the Dinosaurs – [Extreme Survivors](#)

Utahraptor

Pronounced: (yoo-tah-rap-tor)

Meaning of Name: "Robber from Utah"

Family Group: Dromaeosaurs

Diet: Meat-eater

Period: Early Cretaceous

Fossil Found: United States (Utah)



Graphic Facts:

Utahraptor is one of the largest species of raptors. It was the size of the "velociraptors" depicted in Jurassic Park movies- which, in reality were about the size of a modern turkey. Skin impressions and feather outlines around fossil bones now tells us that theropod dinosaurs looked more like modern birds than we originally imagined. Like some modern birds, the talons were especially important in taking down prey items.

Discover the Connection – Zoo Animals and Dinos: Cassowary

Cassowaries use their powerful legs and sharp claws to deliver a hard kick when defending themselves from potential predators. *Utahraptor*, had a large, curved "killing claw" that was covered with a sheath of keratin- the same substance that makes up skin and fingernails. With the sheath, the claws of these dinosaurs could have reached a terrifying 9.4 inches long, or more!

Links for Photos:

[Skeleton](#)- drawing

[Skeleton](#)- fossil reconstruction

[Rendered](#)

[Size comparison](#)

Links for Additional Facts:

Learn more about [Dromaeosaur Dinosaurs](#)

Learn more about the [Cretaceous Period](#)

Learn more about [Utahraptor](#)

Lessons- In the Classroom

Here are some activities you can do in the classroom to prepare for your visit.

- **Whatsasaurus?**- Using Greek and Latin prefixes, have students think up a dinosaur, name it, and then draw it based on their name.
 - Activity Link:
 - <http://teacher.scholastic.com/lessonrepro/reproducibles/whatasaurus.htm>
 - Expanded Latin Root list:
<http://www.enchantedlearning.com/subjects/dinosaurs/allabout/Nameroots.shtml>

- **Links to lesson plans**- Use these online lesson plans on dinosaurs, paleontology, and fossils.
 - Grade 4k-1: Dinosaur Train lesson plans- PBS/Jim Henson Co.
 - <http://www.pbs.org/parents/dinosaurtrain/activities/>
 - Grade k-5: Discovering Dinosaur lesson plan- Discovery Education
 - <http://www.discoveryeducation.com/teachers/free-lesson-plans/discovering-dinosaurs.cfm>
 - Grade 6-8: When Dinosaurs Ruled lesson plan- Discovery Education
 - <http://www.discoveryeducation.com/teachers/free-lesson-plans/when-dinosaurs-ruled.cfm>
 - Grade 6-8: What's New with Dinosaurs lesson plan- Discovery Education
 - <http://www.discoveryeducation.com/teachers/free-lesson-plans/whats-new-with-dinosaurs.cfm>
 - Grade 6-8: Dinosaur Detectives lesson plan- Discovery Education
 - <http://www.discoveryeducation.com/teachers/free-lesson-plans/dinosaur-detectives.cfm>

Lessons- At the Zoo

Here are some field trip add-on activities to ensure that your students get the most learning out of their trip to the Zoo!

- **Auditorium Program**

- 30 minutes, \$2/participant
- ***Amazing Adaptations: The Dinosaur Adventure***
 - **Meet the dinos featured at the Zoo before seeing them in person! This interactive auditorium program will provide you with background information on the Zoo's dinos! Discover what present-day animals at the Zoo share similar characteristics to the Zoo's dinos!**

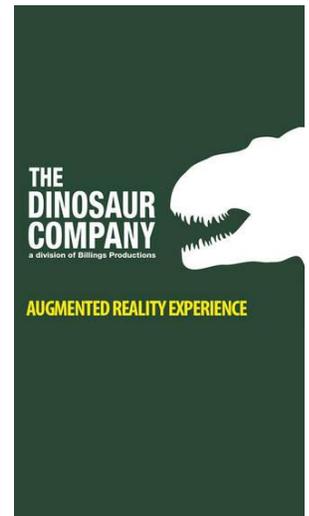
- **Field Experiences**

- 45 minutes, \$4/student
- ***Jurassic Journey***
 - **Compare present-day animals to the dinos at the Zoo. This field experience will be an add-on to the Dino Discover-They're Back! exhibit. Students will explore the similarity and differences between present-day animals and the dinos featured at the Zoo. Are there any adaptations that have been around since prehistoric times? Find out on the Jurassic Journey Field Experience!**

The Dinosaur Company AR App

- **What is the Dinosaur Company AR App?**

- This Augmented Reality (AR) application is for use at the Birmingham Zoo’s Dino Discovery - They’re Back! exhibit. Download this app and point it at signage around the Zoo to view dinosaurs in stunning augmented reality complete with full animations and interactivity. You can also learn about their fossil record, scientific names and more!

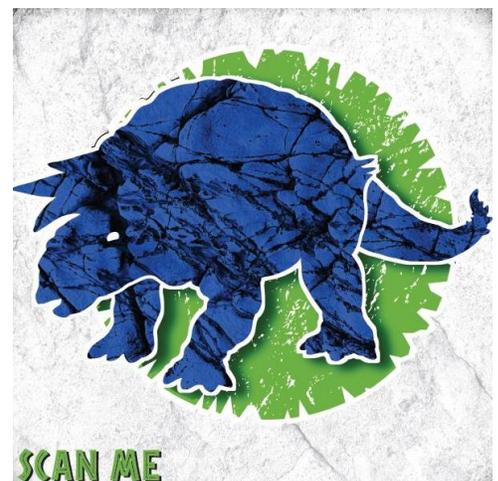


- **Where can I download the App?**

- We highly suggest that students download the app **BEFORE** they arrive at the Zoo.
- In the event that students need to download the app at the Zoo, there will be a ***Dino Discovery App Download Station*** near the entrance of the ***Dino Discovery - They’re Back!*** exhibit.
- This application was created and designed for both Apple iOS and Android operating system. The app is available at the Apple App Store and Google Play Store.

- **How can I use the app at the Birmingham Zoo?**

- Ten dinosaurs featured at the Zoo will have an “AR target” sign (pictured to the right). Once the app is downloaded on to your smart device, you can point your smart device towards the “AR target sign” and an interactive activity will pull up on your device specifically about the dinosaur you pointed at.



- The app will keep track of all the dinosaurs your device “collected” so that information about that specific dinosaur can be revisited later.
- This is a great tool to coordinate an educational scavenger hunt during a field trip to the Zoo’s Dino Discovery-They’re Back! exhibit. (Scavenger Hunt provided on page 32).

- **How can I use the app when I return home or to the classroom?**
 - Teachers and students who use the app are encouraged to use it for extension activities.
 - Students who collect dinosaurs on their app will have access to generic information about that dinosaur.
 - We suggest the following activities
 - Research and presentation project on a specific dinosaur collected.
 - Create a food chain using the dinosaurs collected.
 - Practice measuring by using a tape measure in a large area to compare the size of the dinosaurs collected.
 - Write an argumentative essay to explain the existence of a specific dinosaur collected.

Scavenger Hunt Answers

1. Brachiosaurus
2. Edmontonia
3. Dilophosaurus
4. Pachyrhinosaurus
5. Quetzalcoatlus
6. Stegosaurus
7. Tyrannosaurus rex
8. Utahraptor
9. Diabloceratops
10. Deinonychus

Scavenger Hunt



- To complete the scavenger hunt, a smart device with the Dinosaur Company AR App downloaded on it must be used
- You will need to read the graphic signs in order to identify the correct dinosaur
- Once you have identified the dinosaur, use your smart device and point at the “AR Target Sign” – this will “collect” the dinosaur



1. Collect the dinosaur that is as long as three school buses
2. Collect the dinosaur classified as an “armored dinosaur”
3. Collect the dinosaur that shares similar adaptations with the modern Common Basilisk
4. Collect the dinosaur whose teeth are continually replaced – just like shark’s teeth!
5. Collect the flying reptile! It is actually not classified as a dinosaur
6. Collect the dinosaur with 17 dermal plates along its back
7. Collect the dinosaur whose name means “Tyrant Lizard King”
8. Collect the dinosaur that shares similar adaptations with the modern Cassowary
9. Collect the dinosaur with serious headgear!
10. Collect the dinosaur with an enormous talon on the second toe of each foot

RESOURCES

Here are some additional resources to expand your knowledge of dinosaurs.

Books

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TV Programs/Movies

NATIONAL GEOGRAPHIC

Bizarre Dinosaurs

Dinosaur Hunters: Secrets of the Gobi Desert

I Love Dinosaurs

Really Wild Animals: Dinosaurs and Other Creature Features

BBC

Allosaurus: A Walking with Dinosaurs Special

Chased by Dinosaurs

Walking with Dinosaurs

DISCOVERY

Clash of the Dinosaurs

Dinosaur Planet

Dinosaurs: Inside and Out

JANSON MEDIA

Dinosaur: Eggs and Babies

PBS

American Experience: Dinosaur Wars

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