Overview

Teachers not receiving a guided tour of the Dinosaurs under the Big Sky (DUBS) exhibit are encouraged to review the following talking points for their self-guided tour of the Siebel Dinosaur Complex. Information included in this packet is a summary of the most important and interesting features of the exhibit. This guide was created to help teachers answer student questions without reading exhibit panels. Detailed information about each of these talking points can be found on exhibit panels within the Dinosaurs under the Big Sky exhibit.

Exhibit Themes

1. Science is a process through which we can learn more about the natural world by observing physical evidence, testing our ideas about what the physical evidence is telling us, and learning from our mistakes.
2. We find evidence that dinosaurs and birds are related.
3. We find evidence of dinosaur behaviors – how they lived, ate, bred, and died – in their fossils.
4. Different dinosaurs lived at different times and in different places. Not all dinosaurs lived at the same time in the same place.
5. Dinosaurs grew relatively fast and a dinosaur’s features changed as it grew.

Vocabulary

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HALL OF GIANTS
VIEWING LAB
HALL OF GROWTH & BEHAVIOR
MESOZOIC MEDIA CENTER
HALL OF HORNS & TEETH: Part 1
HALL OF HORNS & TEETH: Part 2

DINOSAURS under the BIG SKY
Siebel Dinosaur Complex

Enter Here

VIEWING LAB
HALL OF GIANTS
MESOZOIC MEDIA CENTER
HALL OF GROWTH & BEHAVIOR
HALL OF HORNS & TEETH: Part 1
HALL OF HORNS & TEETH: Part 2

Self-Guided Tour | 2
Tour Introduction and Viewing Lab

- Paleontology is the study of extinct life. Some paleontologists study dinosaurs.
- Geology is the study of rock, the earth's origin, history, and structure.
- Dinosaurs were the only group of reptiles that walked with their legs directly under their bodies, not sprawled to the side. They lived on land (terrestrial).
- Fossils are preserved remains or traces of once-living animals, plants, and other organisms.
- These fossils present physical evidence from which scientists can make inferences about life in the past.
- Preparators take fossils from the plaster field jackets, remove debris and rock from around the fossil, and prepare the fossil for scientific study or display.

This process is on display at the Viewing Lab.
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Introduction Panels

- Physical evidence is the most important component of science.
- A Hypothesis is an idea or educated guess supported by evidence that scientists find or through experimentation.
- A theory, in science, is much more than a guess – it is a collection of hypotheses that explain a system or process, and has not been disproved by new evidence.
  * Theories can change – if new information is discovered, scientists work to develop a better explanation, a better theory.
- Montana is a great place for fossils because the right age of rock is exposed in many areas.
- (Non-Avian) Dinosaurs and humans didn’t live at the same time. Dinosaurs lived 230-65 million years ago.

3

Sauropod Growth Series

- The three leg bones shown here are of a Sauropod, or long-necked dinosaur, called a Diplodocus.
  * Baby femur (2 weeks old): Dinosaur weighed less than 20 lbs.
  * Juvenile hind leg: Dinosaur measured 25 feet long and weighed 2 tons (4,000 lbs).
  * Adult hind leg (20+ years old): Dinosaur measured 70 feet long and weighed 20 tons (40,000 lbs) or as much as three elephants.
- If you were proportioned like a Sauropod, you would have a body the size you do now, but your head would be the size of a peanut stuck on the end of a neck the size of a three-foot-long straw!
- Apatosaurus rib (9 feet long) = one of the largest ribs from any land animal!

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A Muddy Diplodocus Grave

- Only the legs of juvenile Sauropods were discovered at this site, buried in mudstone. What happened?
- Paleontologists hypothesize that the juvenile Sauropods got stuck in the mud as they were crossing an ancient river.
- These fossils provide evidence that sauropods traveled in herds.
- Paleontologists hypothesize that the body parts above the mud were disturbed and scattered by scavengers or water currents.
Livingston Sauropod

• This Sauropod (long-necked dinosaur) is about 10 years old.
• This Sauropod was found near Livingston, Montana, and may be a new species of Sauropod.
• MOR Paleontologists uncovered more of this animal during the summers of 2014 and 2015, but the bones are not yet on display.

Big Al – The Allosaurus

• Allosaurus was probably the primary predator of Jurassic sauropods like Diplodocus and Apatosaurus.
• “Big Al” has 15 abnormal bones that show this animal survived multiple injuries. Some of these injuries became infected. The infected bones are the ones with the strange knobs and lumps. If you broke a bone but didn’t go to a doctor, that’s what your bones would look like!
• All these injuries together probably combined to kill “Big Al” before he was fully grown.
• “Big Al” is estimated to be 13-15 years old. Allosaurus’ lifespan was 25-30 years.
• Does Big Al look like another large dinosaur predator? (T. rex)
  *Allosaurus and Tyrannosaurus lived during different time periods.

Dinosaurs and Birds

• Birds and dinosaurs share the following characteristics:
  * They have a wishbone, hollow bones, extra-long digit (finger) of the hand, oblong hard-shelled eggs, wrist bone that allows a bird wing to fold to the side of the arm, a three-toed foot, and they sat on eggs to hatch (egg brooding).
  * Feathers: Many new feathered dinosaurs are being discovered every year, including juvenile tyrannosaurs. It is likely that ALL two-legged dinosaurs had feathers at some point in their lives.
• It is widely accepted by paleontologists that birds are the descendants of small, two-legged, feathered (Theropod) dinosaurs with some new features like a beak instead of a toothed jaw and the “loss” of some fingers.
• Due to new standards in animal classification, it would be correct to say that birds ARE dinosaurs.
• This is like a human saying “My great-grandparents were German, so I am German as well.” A bird could say “My great-great…grandparents were dinosaurs, so I am a dinosaur as well.”
Raptor Attack!
- The Tenontosaurus skeleton is surrounded by 11 teeth of the small meat-eater Deinonychus
- Deinonychus is closely related to the more well known Velociraptor
- Deinonychus replaced its teeth every 300 days (about one new set a year)
  * How many Deinonychus attacked this Tenontosaurus? Is it likely that one dinosaur lost 11 teeth or that there were several Deinonychus?
- MOR Paleontologists hypothesize that 6-8 Deinonychus fed on this dinosaur. This provides evidence that Deinonychus and other raptor-type dinosaurs hunted in groups.

Tenontosaurus for Dinner
- These are full-scale sculptures of what the Tenontosaurus and Deinonychus may have looked like.
- Scientists don’t know the colors of dinosaurs. They make hypotheses about their color based on other reptiles and birds.
- Skin texture is based on the skin impressions of duck-billed dinosaurs.
- Deinonychus has feathers on the areas of the body where feathers are found on other closely related species.

Oryctodromeus – the Burrowing Dinosaur
- MOR Paleontologists discovered a fossil burrow that had been filled in during a flood
- MOR Paleontologists discovered fossils of a small duckbill-type dinosaur buried within the burrow, Oryctodromeus.
- Why would a dinosaur want to dig a burrow?
  * For the same reasons animals today dig burrows – to protect their young, provide shelter from bad weather, and hide from predators.
  * For every ecological niche today, there is likely to be an equivalent dinosaur that filled that niche.
- This was the first fossil evidence of burrowing dinosaurs.
Plesiosaurs and Marine Crocodiles

• Plesiosaurs are marine (ocean-dwelling) reptiles and therefore not true dinosaurs. Don’t let the “-saur” in the name fool you.
• True dinosaurs were terrestrial (land-dwelling) animals.
• This plesiosaur is an Edgarosaurus found in Montana near the Wyoming border.
• Unlike most marine reptiles, plesiosaurs did not use their tail to move, but instead relied on two sets of paddle-like limbs.
• Plesiosaurs lived in the Western Interior Seaway, a shallow inland sea that split North America in two during the middle to Late Cretaceous and covered portions of Montana.
• Ocean life was also very diverse: There were long- and short- necked varieties of Plesiosaurs, plus dolphin-like Ichthyosaurs, Mosasaurs with long tails, and our most recent addition, Marine (ocean-dwelling) Crocodiles.
Media Center and Histology

- Touch Screen Computers can access the Museum’s Paleo Video Library, “News from the Field,” and Paleo games.
- Touch Screens in the hallway compare histology images— the study of bone growth in animals
- MOR is the leader in dinosaur histology. Microscopic clues in the structures of bones can tell us whether an animal is warm- or cold-blooded, how fast an animal grew, and how long it lived.
- HAVE PATIENCE: These touch-screen computers are aging, and will probably be replaced with iPad-like devices in the near-future.
Dinosaur Nests

- Dinosaurs laid hard-shelled eggs in nests or clutches just like birds.
- Dinosaur eggs come in a variety of sizes, shapes, and textures.
- Not all dinosaurs sat on their eggs. Some covered their eggs with plant debris to keep them warm.
- Field crews from Museum of the Rockies collected the first clutches of dinosaur eggs in the Western Hemisphere.

Maiasaura

- Maiasaura, Montana’s state fossil, is a duck-billed dinosaur whose name means “good mother lizard.”
- Baby Maiasaura leg bones were too weak for a nestling to walk or run, so scientists hypothesize that adult Maiasaura cared for their young.
- Maiasaura grew very fast.
  * At birth, it was only 16 inches long and weighed about one-and-a-half pounds.
  * An adult could be 30 feet long and weigh 4,000 pounds.
  * A one-year-old Maiasaura was about 9 feet in length.
- Scientists have found VERY rare embryos of Maiasaura (and other dinosaurs) in unhatched egg fossils. Jack Horner, MOR’s retired Curator of Paleontology, found the first dinosaur embryos in the world.

Achelosaurus horneri Holotype

- This is a Holotype specimen – which is the first found specimen used to describe and name a new species of animal.
- This dinosaur species was named after MOR’s Jack Horner
- This is a ceratopsian-type dinosaur, like Triceratops.
- Not all ceratopsians have forward pointing horns, like Triceratops. The Achelosaurus here has knobs instead of horns, and two side-facing horns on top of his frill, plus those large holes in the frill.
  * Do you think Achelosaurus could have used his head for protection against predators? Or was there another purpose for these horns and knobs?
16 Saurornitholestes (saur-ornith-o-lest –ease)
- Saurornitholestes and Troodon were the top predatory dinosaurs in Montana 75 million years ago. Both were small raptor-like predators.
- Both of these dinosaurs may have hunted in groups and both were probably able to take down large plant-eaters.
- Troodon remains are often found on Maiasaura nesting grounds.
  * The fossil evidence supports the idea that Troodon may have preyed on Maiasaura nestlings.

17 Peck’s Rex becomes Montana’s T. rex
- Peck’s Rex is owned by the United States Army Corps of Engineers, but MOR has had it on display since April 2015. It was discovered near Fort Peck Reservoir.
- Peck’s Rex is not the largest T. rex, or the most complete T. rex, but it is both very large and complete.
- Peck’s Rex is the ONLY T. rex in the world with gastralia “belly ribs,” and a partial third finger, making it a very unique animal.
  * Gastralia are almost never preserved, they’re rather fragile bones and easily lost by scavengers
  * The third finger is very unique for a T. rex. MOR Paleontologists are still studying this unique feature.
- In 2015, “Peck’s Rex” was renamed “Montana’s T. rex.” It is the only actual T. rex skeleton on display in the state. These are the ACTUAL fossils on display. Many of our other fossils on display are actually replicas of fossils in our collections warehouse. This allows MOR scientists to study the fossils and the public to enjoy them at the same time.

18 Tyrannosaurus Growth Series
- These skulls show several different growth stages of T. rex
- Juveniles had larger eyes and more teeth than adults. The skull grew larger and changed shape as the T. rex got older.
- Juvenile T. rex teeth were small, sharp and blade-shaped to cut flesh.
- Adults had more powerful jaws but fewer teeth than juveniles.
- Adult T. rex teeth were large, blunt and rounded for crushing bone.
- Changes in the T. rex teeth are fossil evidence that supports the hypothesis that T. rex adults were bone-crushing scavengers. MOR’s Curator of Paleontology Jack Horner conducted this research.
Tyrannosaurus Rex ate a LOT of things

- This Triceratops pelvis has T. rex bite marks (see red arrows).
- The absence of any healing around the holes leads scientists to believe that this Triceratops was already dead when T. rex fed on it. The very thick pelvis bones would have been the very last part of the Triceratops to be scavenged.
- This is another piece of fossil evidence that T. rex was a scavenger.
- Along the Montana’s T. rex display are another set of panels describing other animals T. rex ate. T. rex had a wide diet.
- Do you think T. rex was a predator (actively hunted live animals), scavenger (fed on animals that had already died), or an opportunist (something in-between)?

Triceratops Growth Series

- This is the world’s most complete Triceratops growth series.
- The shield and horns changed shape as the Triceratops grew.
- The baby is less than one year old.
- For many years, scientists thought different shaped skulls were from different species.
- Research shows these skulls all represent Triceratops at different growth stages, from baby to adult.

Edmontosaurus

- Edmontosaurus was a very large duck-billed type of dinosaur, like Maiasaura.
- Edmontosaurus herds were very common in the late Cretaceous.
- This tail represents one of the largest duck-billed skeletons found in North America, and is special because skin impressions have been preserved. We don’t know the color, but we do know the texture of dinosaur skin.
- The tail is 26 feet long. The whole skeleton would have been nearly 50 feet in length if preserved. (Ten feet longer than Montana’s T. rex)
- The Edmontosaurus skull is near the tail in a display case. There are
- rex bite marks!
Other Interesting Montana Dinosaurs

- The Cretaceous was a very diverse time for Dinosaurs.
- There were thousands of different species of dinosaurs, and they can be categorized in 5 main “families” – the theropods, sauropods, ceratopsians, ornithopods, and thyreophores.
- Another way to remember the dinosaur families are: two-legged, long-necked, frilled, duck-billed, and armored dinosaurs.
- These cases show a few additional types of dinosaurs that we’d love to have more space to show:
  * The heavy Ankylosaur, ostrich-like Ornithomimus, and the bumpy-headed Pachycephalosaurus (pictured).
  * The three Pachycephalosaurus skulls were thought to be three separate species, but MOR paleontologists believe they are a growth series.
- What dinosaur families do you think they belong to?

A Pair of Triceratops

- Triceratops skulls are very common, but Triceratops body skeletons are very rare and only a few in the world are on display.
- The smaller juvenile skeleton was discovered in Montana in 2008. Its skull is one of the most complete juvenile Triceratops skulls ever found. MOR Paleontologists estimate it was probably 2-3 years old.
- The large subadult skeleton was found in Montana in 2010. Scientists know it was still growing very quickly and its horns were getting longer and thicker. Research continues to determine its age.
- The darker bones are replicas of the actual fossils in our paleontology collections. The lighter bones are reconstructed from other triceratops fossils.

B. rex – An Extraordinary Specimen

- B. rex is a Tyrannosaurus that was discovered by MOR Paleontologist Bob Harmon. Many of our fossils get nicknames in the field and this one became known as B. rex, for Bob’s rex.
- Excavators broke this T. rex femur in pieces to get it out of the field.
- After studying the broken pieces, Mary Schweitzer discovered soft tissue, blood vessels, and cells. Later she discovered a protein called collagen.
- It was the first discovery of soft tissue in a fossilized organism. It does not contain ancient DNA, but the iron in the blood acted as a preservative for these other soft tissues.
- Soft tissue has also been found in other T. rex femurs, other theropods, and duck-billed dinosaurs. It may be more common than we thought, but no one wanted to break fossils to find out.
- Not only this, but specialized tissue in the femur, called medullary bone, showed that this dinosaur was about to or was laying eggs, making it a girl!
Not Just Dinosaurs

- Crocodiles, alligators, many varieties of lizards, turtles, and even a few snakes lived with the dinosaurs.
- Mammals and birds also lived with the dinosaurs at the end of the cretaceous period.
- Even the smallest fossils from microsites help scientists study ancient ecosystems and get a complete idea of the diversity of life.
- Mollusks and clams inhabited the freshwater streams, rivers, and lakes.

Extinction and Birds Video

- Why did all the dinosaurs die out? Was it due to a meteor or comet impact? Increasing volcanic activity, climate change, disease, or competition from mammals? Perhaps it was a combination of all of these.
- One group of dinosaurs – birds – survived whatever caused the mass extinction 65 million years ago.
- BIRDS ARE LIVING DINOSAURS!