MOAS Training Manual 2025

How do we know these things about dinosaurs?

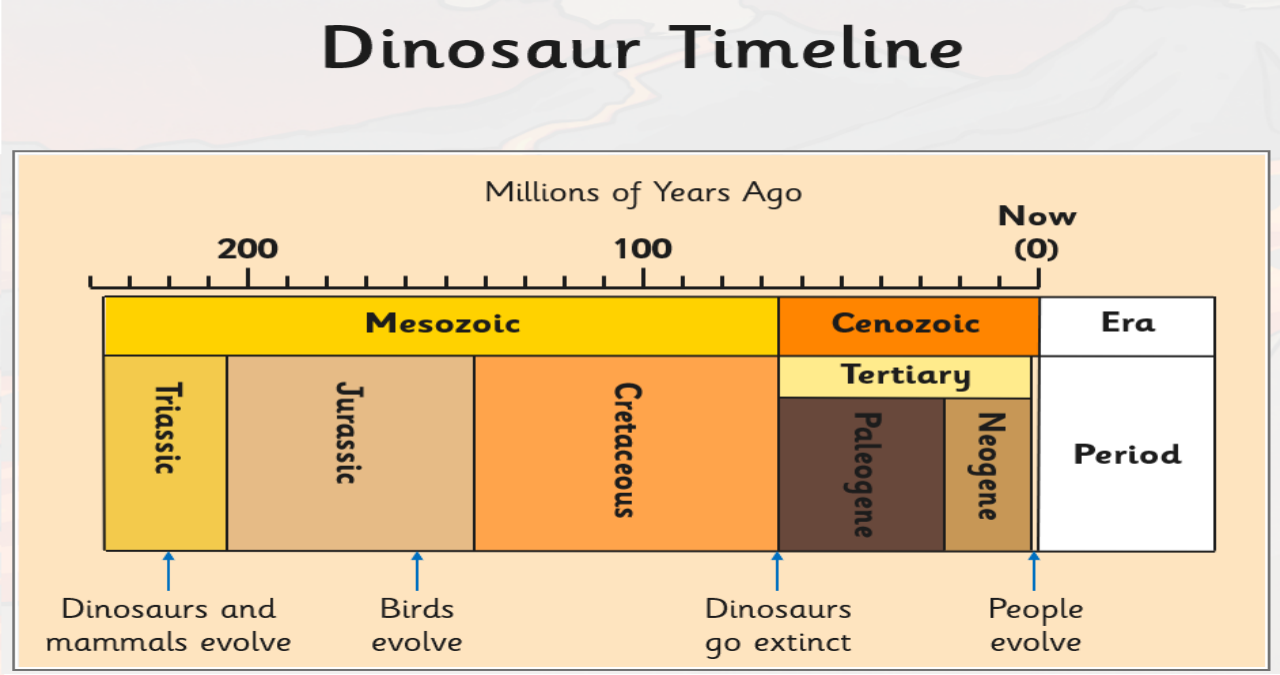
Paleontologists rely very heavily on the evidence from **fossils.** Fossils are the preserved remains or traces of ancient plants and animals. They typically are at least 10,000 years old to be considered a fossil. Fossils form when an organism, usually with hard parts like bones or shells, dies and is rapidly buried by sediment, such as mud or sand, which prevents decomposition and scavenging.

Ages of the Dinosaurs

The age of the dinosaurs took place during the **Mesozoic Era,** which can be split into three distinct periods: **Triassic, Jurassic, and Cretaceous.**

The **Jurassic** was considered the time in which dinosaurs ruled the Earth and by the late Cretaceous period (66 million years ago) they were wiped out by a mass extinction event known as the **K-Pg Event** (Cretaceous-Paleogene) or formerly known as the K-T Event (Cretaceous-Tertiary). This event is still ongoing with research, but it is thought to have been caused by an extraterrestrial impact event (a meteor) that crash landed in the Yucatan Peninsula. This led to the loss of major ecosystems and roughly 75% of all animal life on Earth. The impact disrupted major food chains, caused a period of prolonged darkness, and rapid cooling of the Earth.

Many of the dinosaurs featured in this exhibit are from the Jurassic and Cretaceous period.



Three Major Groups of Dinosaurs

Theropods

- Classic bipedal carnivorous dinosaurs – can also include birds. Includes Tyrannosaurs, Allosaurs, Velociraptors, and more.

Sauropods

- Quadrupedal (four-legged), herbivorous, long-necked, long tailed. Includes Brachiosaurs, Apatosaurs, Diplodocus, and more.

Ornithischians

- Several different groups, but they all shared the same special "beak bone" at the tip of their lower jaw. Includes Ankylosaurs, Pachycephalosaurs, Stegosaurs, and more.

Featured Dinosaurs

Albertosaurus

- Lived 70 million years ago during the Late Cretaceous period.
- Hunted in packs.
- Originally found in 1884 in Alberta, Canada, giving it the name "Albertosaurus" meaning "Alberta Lizard."
- Bipedal (two-legged) predator with short arms, strong sense of smell, binocular vision, and powerful bite force.
- Thought to have been the apex predator of its ecosystem.
- Smaller than a T-Rex but just as deadly.
- Fossils typically dated the dinosaur's age to about 14 years or older. This means their lifespans were most likely about 14-20 years old.
- Thought to have been rather quick dinosaurs due to their leg physiology.

Carnotaurus

- Lived 72 – 66 million years ago during the Late Cretaceous period.
- Only carnivorous dinosaur known to have horns. Thought to have been used for fighting with others of its species.
- Adapted for running – lightly built, bipedal. One of the fastest theropods reaching about 20 mph.
- Found in the Southern Hemisphere (South America – Argentina).
- Due to preserved skin impressions, we know that they did not have feathers and instead were entirely scaly.

Dilophosaurus

- Lived 186 million years ago during the Early Jurassic period.
- Found in North America, commonly in Northern Arizona.
- 23 feet long, 10 feet tall, and about 880 lbs., the Dilophosaurus was the earliest large predatory dinosaur and largest known land-animal in NA at the time.
- Their crests were thought to have been used for thermoregulation, species recognition, or even just ornamentation.
- Unlike how it was shown in Jurassic Park, *Dilophosaurus* probably did not have a frill and could not spit venom.

Amargasaurus

- Lived 129-122 million years ago during the Early Cretaceous period.
- Found in the Amarga Formation in Argentina, South America in 1984, leading to its name of Amargasaurus.
- Sauropod – four legged and herbivorous.
- Grew to about 30-43 feet long with two rows of tall spines down its neck and back – taller than any other known sauropod spines. Believed to have possibly been scaffolding for a skin sail used for display, combat, and/or defense.
- They were rather small compared to other sauropods.

Kentrosaurus

- Lived 152 million years ago during the Late Jurassic period.
- Found in Tanzania, Africa in 1909 by a German expedition.
- Closely related to Stegosaurus from the North American Morrison Formation, located in primarily in Wyoming and Colorado.
- Classified as a small stegosaur with a small head, long neck, short forelimbs, long hindlimbs, and a long muscular tail. They also had spikes running along the top midline of their body.
- Reached about 13-15 feet long and weighed about 1,500-3,500lbs.
- Had extensive bony structures that created an "armor" on their body. The spikes on their tails were used for defense as well.
- Herbivorous and mostly ate low-lying plants such as grass, bushes, small trees, etc. However, they could also rear-up on their hindlegs to reach higher vegetation.

Pachycephalosaurus (x2)

- Lived 72.1 – 66 million years ago during the Late Cretaceous period.
- Most fossils discovered of the pachycephalosaurus include only the remnants of their skulls. Paleontologists are able to hypothesize that they were bipedal due to the remains of other species of pachycephalosaurs.
- They have thick, dome-like skulls with spikes and bumps around the edges. The head domes are thought to have been used for head-butting/ramming, while others believe it was used for display.
- Found in North America, primarily in Montana, South Dakota, Wyoming, and Alberta.
- Herbivorous; mostly ate leaves, fruits, and seeds. Due to their front teeth looking similar to carnivorous dinosaurs, it has been hypothesized that they may have eaten meat as well.
- Reached about 15 feet long and weighed about 820-990lbs.
- One adolescent pachycephalosaurus that was discovered was given the name *Dracorex hogwartsia* ("dragon king of Hogwarts") due to its reminiscence to a dragon skull from *Harry Potter*. It was discovered in 2007 that the skull was from the same species.

Stegosaurus

- Lived 155 – 145 million years ago during the Late Jurassic period.
- Found in the western United States and Portugal.
- Three officially recognized species of Stegosaurus exist.
- First discovered during the Bone Wars as fragmented and scattered remains.
- Large, heavy, herbivorous quadrupeds with large plates on their backs and a spiked tail held high in the air. Their tails were most likely used for defense while their plates were used for display and thermoregulation.
- Stegosaurus means, “roofed lizard,” which was in reference to their plates.
- Their front teeth were replaced by a beak. Stegosaurus did not chew their food and rather chopped and swallowed foliage.
- When using its tail for defense, it would often turn its back to the predator and swing its head around to see where it was hitting.

Triceratops

- Lived 68 – 66 million years ago during the Late Cretaceous period.
- One of the last known non-avian dinosaurs and lived until the KP-G Event.
- Triceratops means “three-horned face.”
- Triceratops had a large bony frill, three horns, and a large four-legged body similar to rhinoceroses.
- Paleontologists have long debated over the purpose of their frills and horns and it is most recently believed that they were used for species identification, courtship, and dominance displays, much like antlers/horns of modern deer.
- Reached about 26-30 feet long and was one of the largest Ornithischia dinosaurs.
- Herbivorous; mainly ate low-lying plants but could knock down higher plants.
- Lived in the same era and environment as the Tyrannosaurus Rex.

Velociraptor (x2)

- Lived 75 – 71 million years ago during the Late Cretaceous period.
- Found typically in Asia. Particularly China and Mongolia.
- Were much smaller than depicted in *Jurassic Park,* typically were the size of a turkey.
- Carnivorous dinosaurs that typically hunted in packs. They were hunters and scavengers.
- One of the types of dinosaurs that evolved into modern day birds. Paleontologists know they had feathers because a fossil discovered in 2007 had the remains of quill knobs. Despite having feathers, they could not fly and were most likely used for display or to keep it warm.
- Had a long-curved claw that was originally thought to have been used for piercing vital organs but eventually was thought to have been used for capture and restraining prey.

The Bone Wars

Beginning in the 1870s, the Bone Wars is defined by a period of intense fossil hunting led by two rich male paleontologists: Othniel Charles Marsh and Edward Drinker Cope. Marsh was based in New Haven, Connecticut, as his uncle – George Peabody – donated the money to Yale College to establish the Peabody Museum. He was the first professor of paleontology in the United States and worked for free at Yale, focusing on research and building a fossil collection. He was the first to describe Stegosaurus, Triceratops, and many other dinosaurs. Cope was based in Philadelphia, working for the Academy of Natural Sciences, also for free. His father intended for him to work on the family farm, but he attended a lecture at the Academy by Joseph Leidy – known as the father of vertebrate paleontology – and was later offered a position.

The competitive nature of these two men gave the Bone Wars its name. In fact, Leidy was embarrassed by their immature attacks in scientific papers and how they made fossil collecting a money game. While before naturalists would have been offered work based on their reputation and knowledge, Marsh and Cope began offering unbeatable, large sums of money for access to fossils, giving them an advantage. As a result, Marsh and Cope hired teams of fossil hunters to set up quarries all over the Morrison Formation. Quarries were mostly focused in Colorado, Nebraska, and Wyoming. As a way of sabotaging each other, the hired fossil hunters were instructed to use dynamite on their own quarries when they

were finished with them to make sure fossil hunters from the opposite team couldn't swoop in and use it. They were also instructed at times to throw fossils they didn't want off the sides of cliffs to make them inaccessible.

At this time, the United States was "behind" in studying dinosaurs, as the British Museum already existed. In fact, the term "Dinosauria" was coined by a British man named Richard Owens. By the end of the Bone Wars, they had together described over one hundred new species of dinosaurs, as well as numerous other prehistoric animals. Marsh had a passion for horse evolution.

Both men completely depleted their funds and reputations in their attempt to outdo the other. For example, where Cope held pride for his work at the Academy of Natural Sciences, Marsh later became president of the Academy to spite him.

After Cope's finances hit a rock bottom, Marsh tried to claim that Cope's fossils were collected with government funds. If they had been, he'd have to surrender them to the government. In retaliation, Cope spent two weeks publishing in *The New York Herald* accusations towards Marsh, who worked for the U.S. Geological Society, that *his* fossils were collected with government funds. It was proven to be true, and Marsh had to surrender a large chunk of his collection to the government.

But at the end of all this, who won the Bone Wars? Marsh described more dinosaurs, but Cope described more species if you include those that weren't dinosaurs. It's also important to note that this includes *descriptions*. These men benefited off the hard work of their underpaid fossil hunters that would spend months at a time in the field. During their lifetimes, they weren't terribly liked as people, but their scientific achievements were praised. Charles Darwin wrote in a letter to Marsh that his collection proved to be "the best support of the theory of evolution," as he took credit for a discovery from Benjamin Mudge – the bird with teeth.

Land of the Dinosaurs

Pangea was a supercontinent that existed during the late Paleozoic and early Mesozoic eras. It assembled about 335 million years ago and began to break apart about 200 million years ago, during the beginning of the Jurassic period. Later, after millennia of slow shifting tectonic plates, we come to the state of our world and continents as we know it today. However, today, Pangea still has not entirely finished its process of separation and we are able to see the evidence of further breakage in the Red Sea Rift and East African Rift.

Figure 1 – 250MYA | Figure 2 – 170MYA | Figure 3 – 120MYA

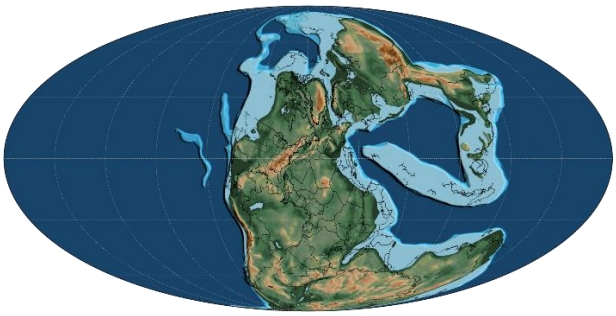


Figure 1

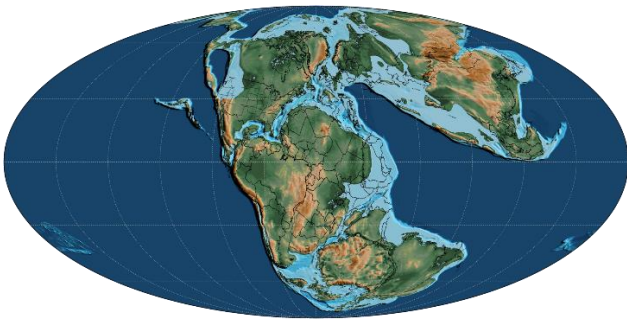


Figure 2

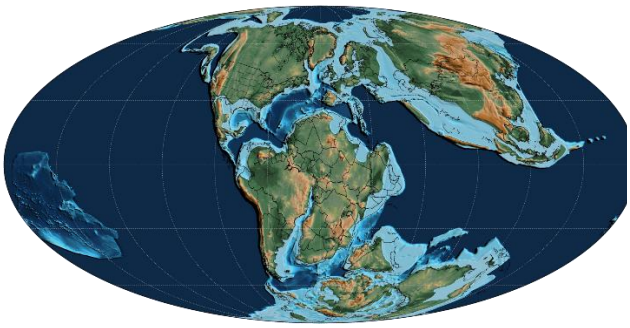


Figure 3

Figure 4 – 85MYA | Figure 5 – 60MYA | Figure 6 – 30MYA

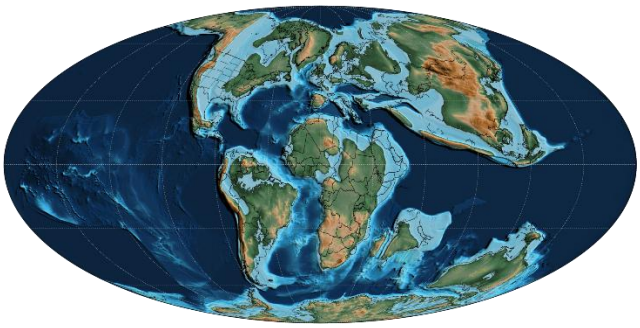


Figure 4

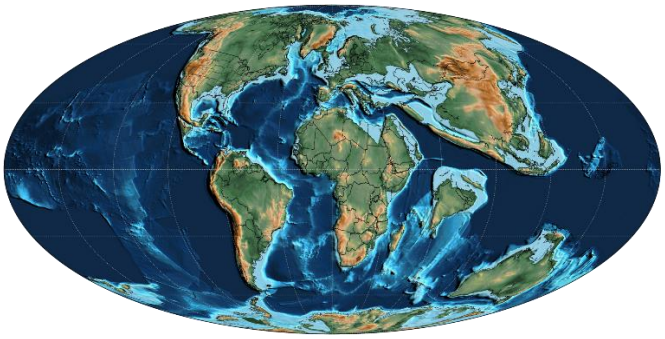


Figure 5

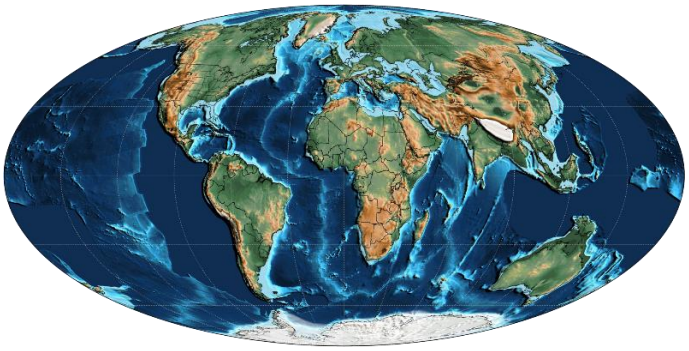
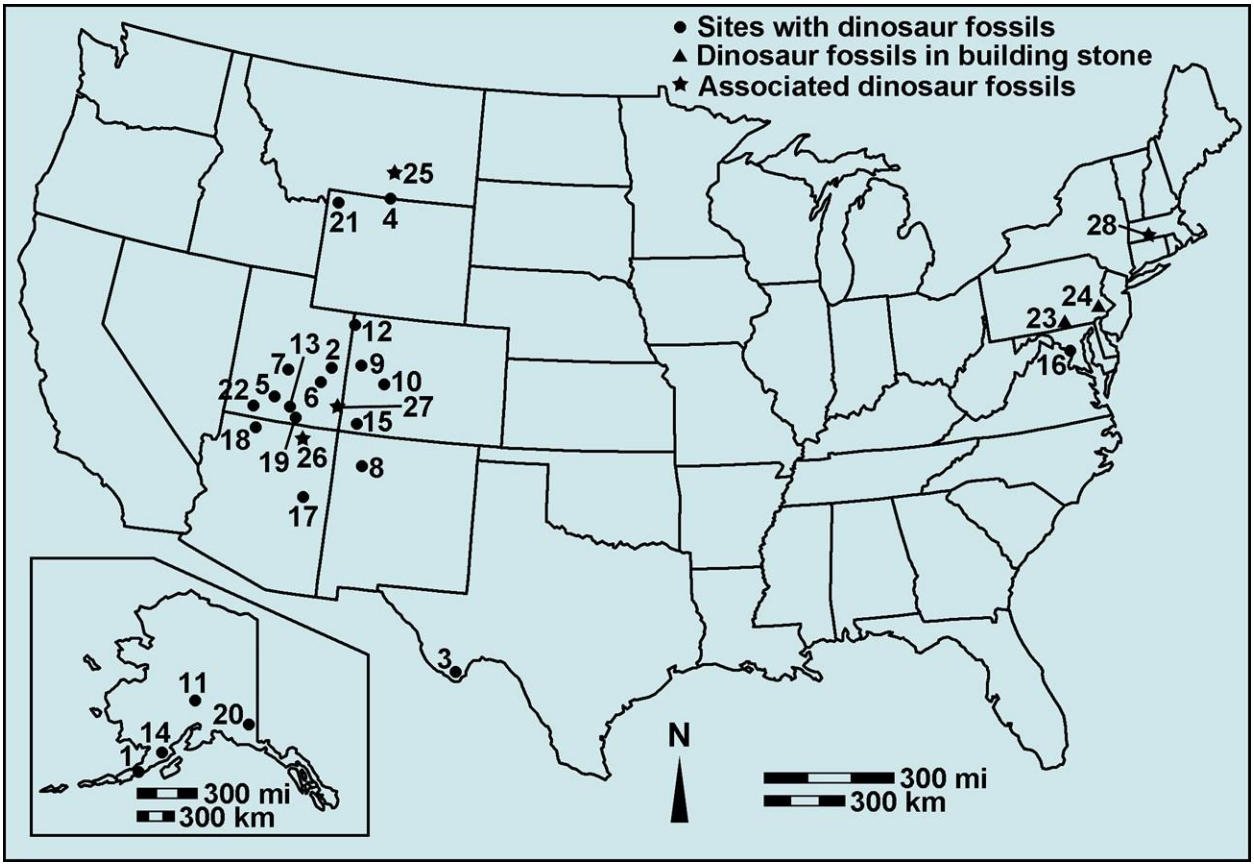


Figure 6

Dinosaurs in Florida

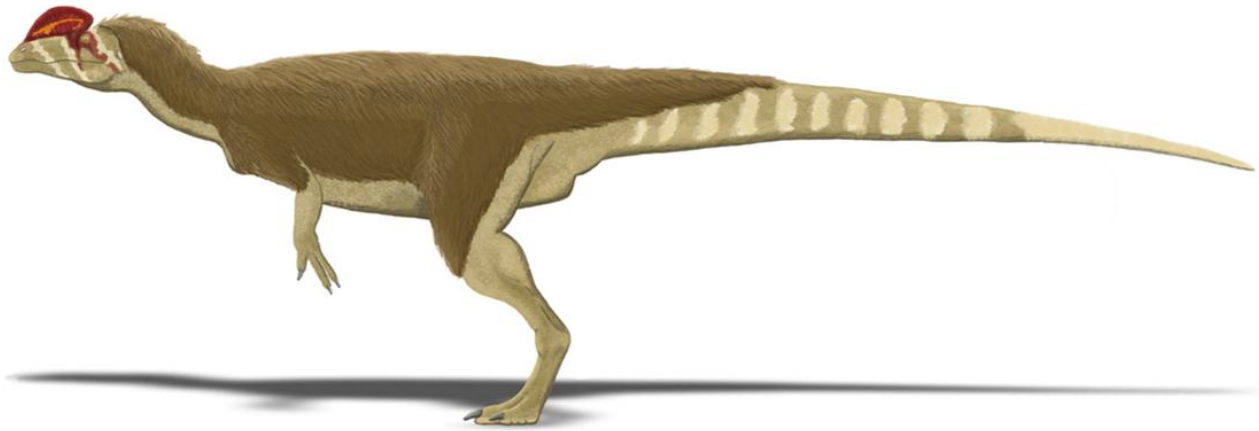
The unfortunate reality is that dinosaurs did not live in Florida at any point in time. During the height of Pangea and the eventuality of its separation, Florida was entirely underwater. In the state of Florida, we can find evidence of marine mammals such as primitive whales, sharks such as the *Megalodon*, amphibians, crocodilians, turtles, and more. We also have extensive prehistoric land mammals such as the giant ground sloth, mastodons, mammoths, ancient lions and bears, and even more.

Fossils of creatures that existed during the Mesozoic Era, like dinosaurs and such, are not found in Florida. They are typically discovered in the mid-western side of the US in states such as, and not limited to, Alaska, Utah, Texas, Wyoming, Arizona, Colorado, New Mexico, Montana, and the occasional discoveries in the northeastern states such as Pennsylvania and Virginia. They are also found on every continent, including Antarctica, but most are found in deserts and badlands of North America, China, and Argentina.



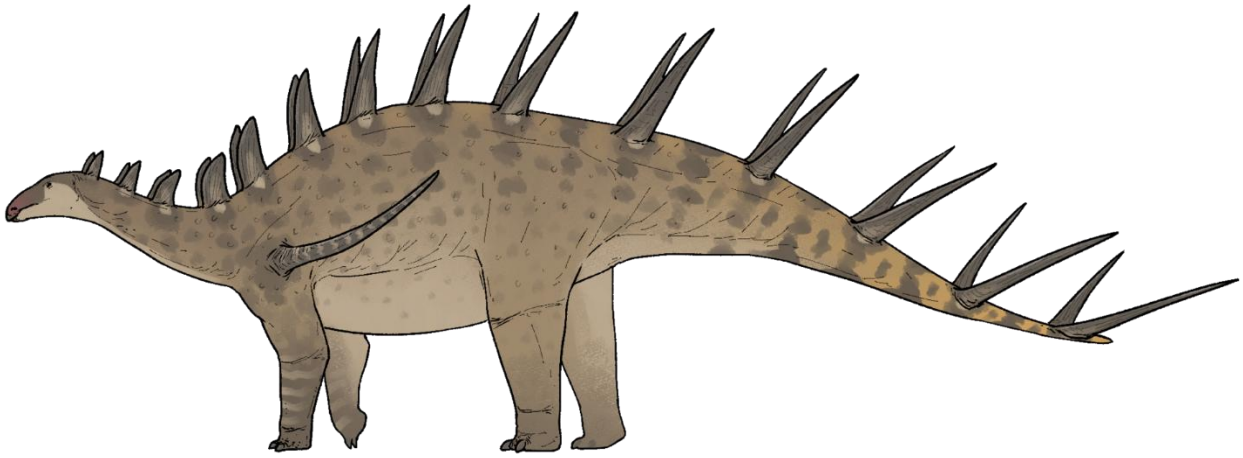
Albertosaurus

Carnotaurus



Dilophosaurus

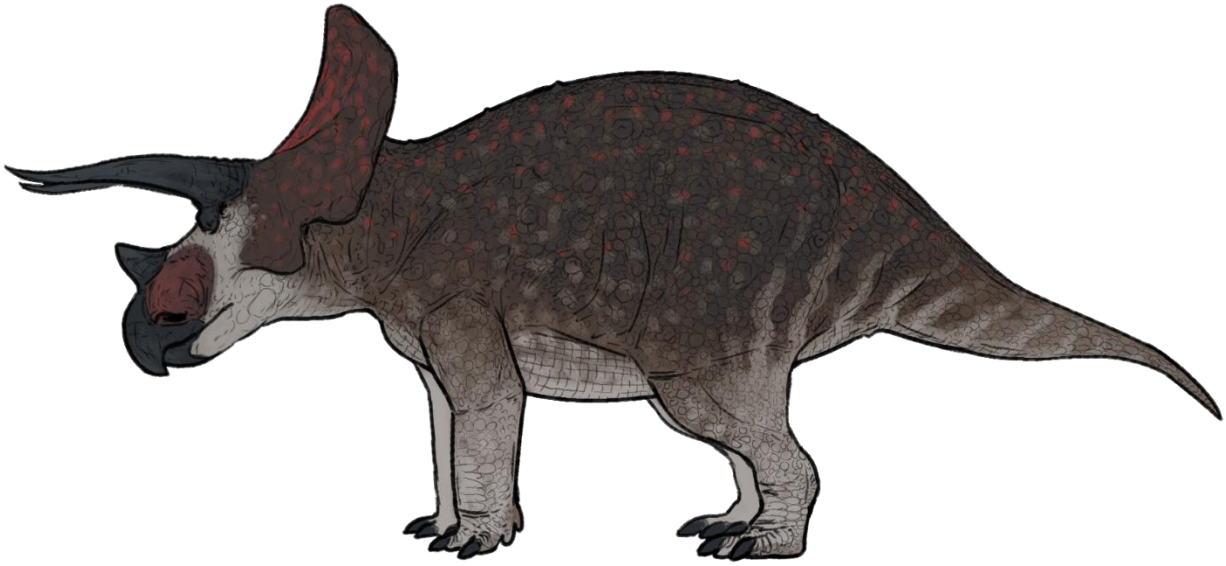
Amargasaurus



Kentrosaurus

Pachycephalosaurus

Stegosaurus



Triceratops

Velociraptor