PRIMARY EDUCATION KIT

March 2 – September 8, 2024

OMSI™
Oregon Museum of Science and Industry

Evergreen Exhibitions

Exhibition created by
AUSTRALIAN MUSEUM

About the Exhibition

The exhibition tells the story of the tyrannosaurs: their evolutionary history, the habitats they evolved in, and their distribution in space and time – in other words, what makes them such fascinating and special creatures.

Tyrannosaurs – Meet the Family, is an innovative, multimedia experience showcasing the newly-revised tyrannosaur family tree. There are over 10 life-sized dinosaur specimens on display, including one of the oldest tyrannosaurs, *Guanlong wucaii*. Showcasing a dramatic array of fossils and casts of tyrannosaur specimens. The exhibition is designed to provide a snapshot of dinosaur life and show how this group became the world's top predators with their massive skulls, powerful jaws and bone-crunching teeth.

Key highlights of the exhibition:

- 30+ ft. video projection tunnel showing life-sized dinosaurs running amok in your city
- The first exhibition to showcase the revised tyrannosaur family tree
- A chance to meet *Guanlong wucaii* – the newly discovered feathery relative of *T. rex*
- Discover and learn how recent scientific findings confirm the links between dinosaurs and birds
- Use of multi-touch technologies to compare their own arm strength to that of a mighty *T. rex*
- Grasp the enormous scale of geological time in the context of human evolution

The exhibition is divided into five sections:

1. **What's a Tyrannosaur?** Explores the features that define a Tyrannosaur.
2. **Meet the Family**. There were many Tyrannosaurs and at least two families.
3. **Explore the Family**. Compares and contrasts Tyrannosaur's relatives.
4. **T-Rex – Alive!** Augmented reality experience.
5. **T-Rex – The Ultimate**. How T-Rex evolved as the top-end predator.
6. **T-Rex – Legacy**. Evolution, survival, and extinction.

Developed by the Australian Museum, touring with Evergreen Partners.

Background Information

What is a Dinosaur?

Dinosaurs are a group of animals that share the identifiable features in the diagram below.

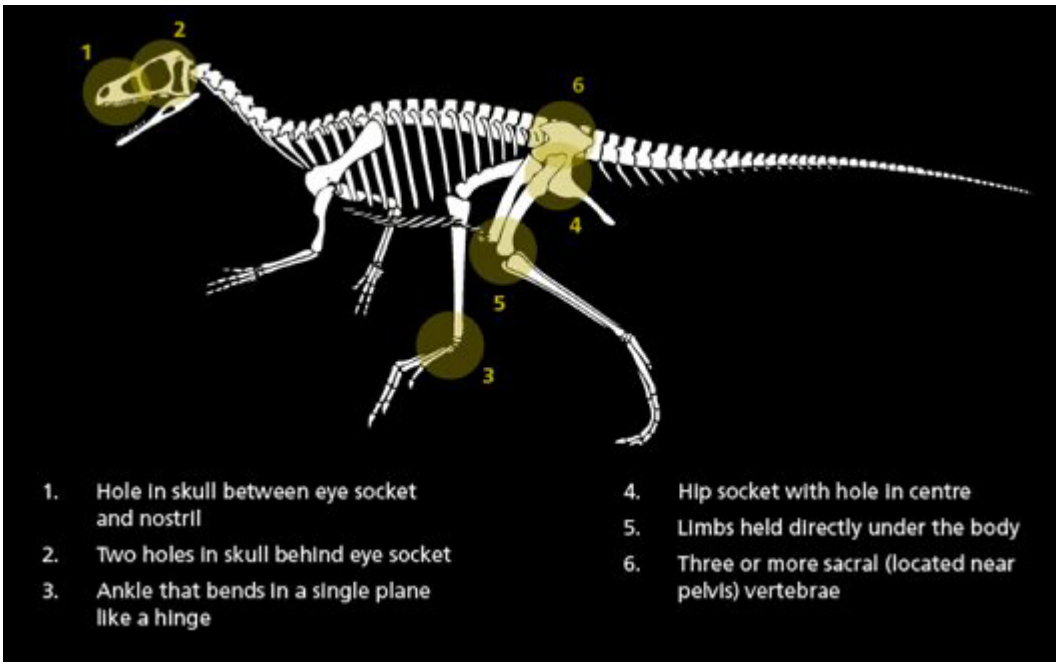


Diagram of *Eoraptor* skeleton showing the main physical features that all dinosaurs share.

We know about dinosaurs from finding and examining their fossils.

What are fossils?

Fossils are the remains or traces of plants or animals preserved in rocks, soil, ice, or amber.

Fossilization is the process of forming a fossil. Fossilization of a whole plant or animal is very rare. Usually only the hard parts of plants such as seeds and wood and the bones and teeth of animals become fossilized.

What main types of fossils are there?

Imprints occur when specimens (animals or plants) die and leave impressions of their bodies or leave marks (such as footprints) in an area which is then covered by sediment. Over time the sediment sets to become rock, leaving imprints that are still there long after the original material has disappeared.
Raindrops and ripple marks can also make impressions in mud and sand which can be fossilized.

Mineralized fossils occur when specimens are encased in, replaced by or absorb minerals from the surrounding rock or underground water to fossilize them. Examples of mineralisation include fossilised bones and shells and petrified wood - where the original material is replaced by minerals, opalized fossils - where silica fossilises the specimen and limestone fossils - where calcium carbonate has replaced or filled porous gaps in the specimen.

How are fossils found?

- by accident
- by looking at the surface in a likely area
- by systematic searching with large digging equipment and explosives

How do you get bones out of stones?

- by chipping fossils out of rocks with chisels and hammers
- by dissolving rocks in acid baths, leaving the bones intact
- by splitting rocks open along their layers

How are fossils identified?

- by comparing them to something that is alive today
- by comparing them with other fossils
- by making educated guesses as to the relatives of the fossilized specimen and extrapolating
- by continually searching for new fossils of the same type to build up knowledge about them

How are fossils dated?

- by radiometric dating – a technique which measures the amount of a particular radioactive element in the rock or fossil
- by comparing the fossils in one layer of rock with the fossils in another layer of rock at the same site which have already been dated by radiometric dating
- by comparing the fossils at one site with similar fossils at another site which have already been dated by radiometric dating.

What are fossils used for?

- to find out about the plants and animals that lived a long time ago and are now extinct
- to find out about the world's environment a long time ago
- to date rocks by comparing with fossils found at other sites.

How do fossils form?

Most animals and plants that become fossilized either lived in water or were washed into it after they died, then:

1. the soft parts of the plant or animal rot away, leaving the woody parts or bones, teeth, or shell,
2. the hard parts are buried under layers of sediment, sand, mud, or lime usually in a lake, swamp, or cave.
3. the sand, mud, or lime that covered the plants and animals was turned into sandstone, shale, or limestone, and:
4. the layers became very deep and compressed to become rock over millions of years,
5. during rock formation, all parts of the plants or animals are replaced by minerals,
6. the rocks are uplifted during movements of the Earth's surface,
7. the rocks may be weathered by wind, rain, and sun,
8. the fossils may become exposed and able to be seen
9. the fossils may be dug out by a collector or a paleontologist

What is a Tyrannosaur?

There are 4 main features that distinguish tyrannosaurs from other dinosaurs.

Four features specific to Tyrannosaurs	
Fused nasal bones in skull	**Only tyrannosaurs had fused nasal bones in their skulls. This strengthened their snouts and gave them a stronger bite.**
Teeth	**Only tyrannosaurs had D-shaped teeth at the front of their upper jaws. These were good for scraping and pulling, while other teeth could slice, tear, and crush.**
Hip features	**Only tyrannosaurs had a rib of bone at the top of their hips, where their strong leg muscles attached.**
Hind limb	**Tyrannosaurs had relatively long hind limbs compared to other theropods (meat-eating dinosaurs).**

Features other dinosaurs shared	
Stands on two legs	**All tyrannosaurs stood on two legs but so did many other dinosaurs.**
Tail	**All tyrannosaurs had tails but so did every other dinosaur.**
Small arms	**Most tyrannosaurs had small arms but so did many other dinosaurs.**
Ribs and torso	**All tyrannosaurs had ribs but so did every other dinosaur.**

Tyrannosaurs featured in the Tyrannosaurs exhibition

Tyrannosaur Common Name	Tyrannosaur Genus Name (species when known)	Time Period	Time (Million Years Ago)	Body length (metres)	Region
Proceratosaurus	*Proceratosaurus bradleyi*	Mid Jurassic	168-166 mya	2-3 m	Europe
Kileskus	*Kileskus aristotocus*	Mid Jurassic	168-166 mya	3 m	Asia
Guanlong	*Guanlong wucaii*	Late Jurassic	163-158 mya	4 m	Asia
Aviatyrannus	*Aviatyrannus jurassica*	Late Jurassic	157-152 mya	1 m	Europe
Stokesosaurus	*Stokesosaurusclevelandi*	Late Jurassic	152-148 mya	3 – 4 m	North America
Juratyrant langhami	*Juratyrant langhami*	Late Jurassic	152-148 mya	4 – 5 m	Europe
Yutyrannus	*Yutyrannus huali*	Early Cretaceous	131-120 mya	9 m	Asia
Dilong	*Dilong paradoxus*	Early Cretaceous	138-129 mya	1.6 – 2 m	Asia
Raptorex	*Raptorex kriegsteini*	Early Cretaceous	131-113 mya	3 m	Asia
Xiongguanlong	*Xiongguanlong baimoensis*	Early Cretaceous	113-100 mya	4 – 5 m	Asia
Eotyrannus	*Eotyrannus lengi*	Early Cretaceous	131-126mya	4 m	Europe
Sinotyrannus	*Sinotyrannus kazuoensis*	Early Cretaceous	121-119mya	9 – 10 m	Asia
Appalachiosaurus	*Appalachiosaurus montgomeriensis*	Late Cretaceous	80-76 mya	7 - 8 m	North America
Daspletosaurus	*Daspletosaurus torosus*	Late Cretaceous	77-74mya	9 m	North America
Gorgosaurus	*Gorgosaurus libratus*	Late Cretaceous	76.5-75 mya	8 – 9 m	North America
Bistahieversor	*Bistahieversor sealeyi*	Late Cretaceous	76-72 mya	9 m	North America
Teratophoneus	*Teratophoneus curriei*	Late Cretaceous	76-72 mya	6 m	North America
Zhuchengtyrannus	*Zhuchengtyrannus magnus*	Late Cretaceous	80-76 mya	10 – 12 m (est)	Asia
Tarbosaurus	*Tarbosaurus bataar*	Late Cretaceous	72-68mya	10 – 12 m	Asia
Albertosaurus	*Albertosaurus sarcophagus*	Late Cretaceous	74-70 mya	10 m	North America

Alioramus	*Alioramus altai*	Late Cretaceous	72-66 mya	6 m	Asia
Dryptosaurus	*Dryptosaurus aquilunguis*	Late Cretaceous	72-66 mya	6.5- 7.5 m	North America
Nanotyrannus	*Nanotyrannus lancensis*	Late Cretaceous	68-66 mya	5 – 6 m	North America
T-Rex	*Tyrannosaurus rex*	Late Cretaceous	68-66 mya	12.5 m	North America

Elementary School Pre-visit Activities

To make the most of your visit to the exhibition we recommend that you prepare your students before their excursion with some of the following suggested activities.

1. What is a museum?

Discuss with students:

- What is a museum?
- What type of museum is the Oregon Museum of Science and Industry?
- What do they expect to see there?
- Why do museums collect cultural objects and natural science specimens?

2. Characteristics of dinosaurs

Provide students with pictures or models of dinosaurs. In groups have the students choose one dinosaur and discuss the following questions:

- What do you think it is? How do you know?
- Have you seen one before?
- How do you think this animal moved?
- Did this animal have senses like you?
- What features does this creature have that makes you think it could taste, see, smell, and hear (mouth, eyes, nose, ears)?
- What did it eat?
- How did it find its food?
- What type of habitat would you find this animal?
- How many years ago did this dinosaur live?
- Did this dinosaur lay eggs? Did it care for its young?
- How did this animal protect itself – with a bite, speed, or camouflage? Did it hide? Did it try to make itself look bigger?

3. What is a Tyrannosaur?

What was a Tyrannosaur? What features make Tyrannosaurs different from other known dinosaurs? See the 'Background Information' section for detailed information.

Ask students to:

a) Find pictures of 5 Tyrannosaurs and 5 dinosaurs that are not Tyrannosaurs.
b) Discuss the differences between Tyrannosaurs and other dinosaurs.
c) Draw a scaled (or sketch) drawing of each of the Tyrannosaurs. Scale is 1cm: 1m. Cut them out. Color or paint them.
d) Find out where the Tyrannosaur fossils have been found in the world and mark on a world map.
e) Decorate the classroom with the scale cut-out Tyrannosaur drawings and the map.
f) Read the book. 'Tyrannosaurs Drip' by Julie Donaldson and David Roberts. What does this book say about Tyrannosaurs? Identify the rhyming words.

4. What do students want to find out?

Ask students to write a list of questions of all the things they would like to find out about Tyrannosaurs when they visit the exhibition.

Elementary School Post-Visit Activities

After your visit to the exhibition, we recommend the following post-visit activities.

1. My Tyrannosaur Party

Prepare for a party for all the Tyrannosaurs. Divide the class in to groups. During the event planning, each group can consider where to host the party, who to invite and what food to provide. Prepare an invitation for the party guests. Would an invite to all these species be possible?

Below is a list of the species showcased in the exhibition. Do some background reading on these to help make decisions. Look at www.australianmuseum.net.au/Dinosaurs-and-their-relatives to find out more about Tyrannosaurs and other dinosaur species

Albertosaurus	Eotyrannus	Sinotyrannus
Alioramus	Gorgosaurus	Stokesoaurus
Appalachiosaurus	Guanlong	Tarbosaurus
Aviatyrannus	Juratyrant Langhami	Teratophoneus
Bistahieversor	Kileskus	Tyrannosaurus
Daspletosaurus	Nanotyrannus	Xiongguanlong
Dilong	Proceratosaurus	Yutyrannus
Dryptosaurus	Raptorex	Zhuchengtyrannus

Have the groups present the details of their party to the rest of the class.

2. My trip to OMSI

Write a short journal entry about the trip to the museum. What were the two highlights of the excursion? Include any photos of your visit.

3. Big and Small

Have each student choose one of the following pairs of tyrannosaur species. Create a table to compare each using the table headings: size, hunting techniques, habitat, treatment of young, eggs or live births.

Is bigger better? Why or why not?

Aviatyrannus vs Tyrannosaurus
Guanlong vs Yutyrannus
Dilong vs Sinotyrannus
Xiongguanlong vs Bistahieverson
Aviatyrannus vs Tarbosaurus

4. Review students understanding of fossils.

Discuss with the class what they have learnt about fossils.
Write a list of words relating to fossils eg. **eggs, nests, tracks, coprolites, impressions, bones, amber, footprints, mineralised, petrified, opalised, palaeontology, gastrolith, dinosaur.**
Use graph paper to create a find-a-word or crossword with these words.

4. Make a fossil

Make a cast of a fossil. Use a hand or footprint or another object like a shell and press into modeling clay or plasticine. You could also use chocolate and plastic moulds. Write and follow a scientific procedure.

5. Build a dinosaur!

Use recycled materials to make a 3D model of a dinosaur or a diorama of several dinosaurs.

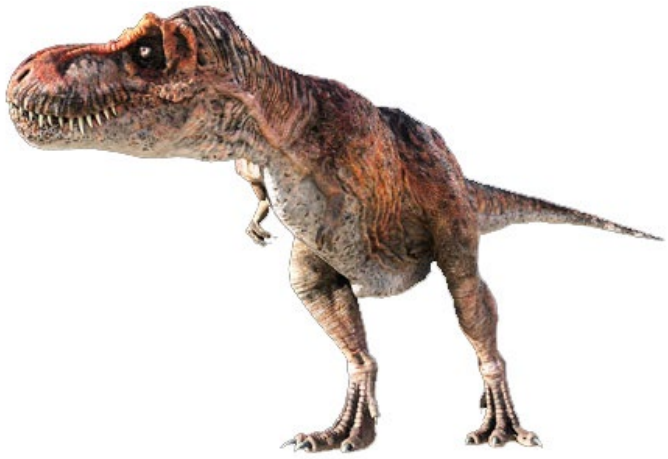
6. Word fun!

Choose 2 of the dinosaur names from the exhibition and create a character and write a story or poem.

7. Play a game!

Have students go to the app store on their mobile devices and download the **Tyrannosaur** app to have fun with Tyrannosaurs. Play the game; hatch your dinosaur eggs and collect them all! Hunt for clues and reveal the secret behind the formidable dinosaurs that make up the tyrannosaurs group.

Created by the Australian Museum and Eye Candy



Middle/High School Pre-Visit Activities

To make the most of your visit to the exhibition we recommend that you prepare your students before their excursion with some of the following suggested activities.

1. Putting the excursion into context

Provide students with a context for their excursion including the reasons for visiting the Museum, the task you would like them to complete, and the expected outcomes.

Introduce or revise concepts related to:

- What a fossil is.
- What a dinosaur is.
- Adaptations, natural selection, and evolution.
- Extinction and that, over time, many Australian animals have become extinct.
- Organisms are classified using physical features and those with similar features tend to be more closely related.

2. What is a museum?

Discuss with students:

- What is a museum?
- What type of museum is the Oregon Museum of Science and Industry?
- What do they expect to see there?
- Why museums collect cultural objects and natural science specimens.

3. Characteristics of dinosaurs

Using secondary sources, find out the names of 5 species of dinosaurs. For each species record in a table its name, size, age, sites of fossil discoveries, habitat in which it lived, and the food it ate.

4. What is a Tyrannosaur?

Produce a mind map of things already known about Tyrannosaurs.

5. What would students like to find out?

Ask students to write a list of questions they would like to investigate in the exhibition.

Middle/High School Post-Visit Activities

After your visit to the exhibition, we recommend the following post-visit activities.

1. Reconstruct the family tree including a geological time scale.

Add the dinosaurs below (featured in the exhibition) on to a geological time scale. Use the table in the background information or https://australian.museum/learn/dinosaurs/fact-sheets/ to assist you. Can any generalised statement be made about changes in the size and form of the tyrannosaurs over time?

Albertosaurus	Eotyrannus	Sinotyrannus
Alioramus	Gorgosaurus	Stokesoaurus
Appalachiosaurus	Guanlong	Tarbosaurus
Aviatyrannus	Juratyrant	Teratophoneus
Bistahieverson	Kileskus	Tyrannosaurus
Daspletosaurus	Nanotyrannus	Xiongguanlong
Dilong	Proceratosaurus	Yutyrannus
Dryptosaurus	Raptorex	Zhuchengtyrannus

2. Who do you think you are?

In groups choose one of the dinosaurs represented in the exhibition. For this dinosaur create an episode for 'Who do you think you are?' This would mean collecting information about the family tree of the dinosaur and 'family' photos etc. Record a short video of your story.

3. Bird or Tyrannosaur?

List the reptile-like and bird-like features of a Tyrannosaur. Explain why birds were included in an exhibition on Tyrannosaurs.

4. Tyrannosaur adaptations

Have each student choose one of the following pairs of tyrannosaur species:

Aviatyrannus vs Tyrannosaurus
Guanlong vs Yutyrannus
Dilong vs Sinotyrannus
Xiongguanlong vs Bistahieverson
Aviatyrannus vs Tarbosaurus

For each pair compare the likely hunting techniques of these very different tyrannosaurs.
How would the habitat of each have helped or hindered their survival?
What special adaptations did each have that helped them survive?

5. Dinosaur Profiles

Choose a dinosaur from the list and use the web pages provided on the Australian Museum website to investigate and build a profile of that dinosaur.
What do we know about this dinosaur? Information should include statistics about:

- How much fossil material was found?
- How big the skull is
- Size of teeth
- Where their fossils were found?
- Running speed
- Habitat
- Likely hunting method
- Where it lived
- Any inconsistencies in the findings

6. Extinction

Discuss, using current scientific research why the dinosaurs became extinct.

7. Play a game!

Have students go to the app store on their mobile devices and download the Tyrannosaur app to have fun with Tyrannosaurs. Play the game; hatch your dinosaur eggs and collect them all! Hunt for clues and reveal the secret behind the formidable dinosaurs that make up the tyrannosaurs group.

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