

Lesson 3 : Evolution

Students will learn the features that define dinosaurs. They will use that information along with 3D scans of modern and fossil organisms to determine the relationship between dinosaurs and birds based on anatomical features.

Student objectives:

Students will be able to:

- ▶ Construct an explanation for the similarities among modern birds and dinosaurs
- ▶ Analyze 3D datasets to determine relationships among living and extinct organisms
- ▶ Interpret data from the fossil record that document change in the dinosaur to bird lineage
- ▶ Describe the features that unite all dinosaurs

NGSS: MS-LS4-1, 4-2

Materials: Computers / tablets with access to the internet, Is it a Dinosaur? images, Are Dinosaurs Alive Today? lab

Time: 2 class periods

Information relevant to dinosaurs and evolution for teachers:

What is a Dinosaur?

Dinosaurs are a diverse group of reptiles that first appeared 230 million years ago in the Triassic Period and dominated the landscape until the end of the Cretaceous period. Many species of dinosaur went extinct 66 million years ago, but they do continue on today in the form of birds. Dinosaurs have several distinguishing features. They all laid eggs and, with the exception of some birds today, they all lived on land. Dinosaurs have an upright stance with an open hip socket (acetabulum), instead of the sprawling posture seen in lizards and other reptiles. They also have an S-shaped neck and an L-shaped thighbone.

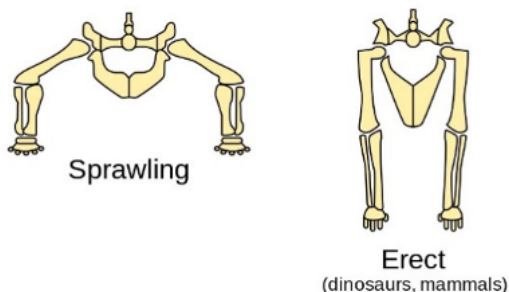


Figure 1 Sprawling vs Upright Stance
Adapted from an image by Fred the Oyster, via
Wikimedia Commons, licensed under CC BY-SA 4.0.

There are two main branches of dinosaurs based on the structure of their pelvis:

The Saurischia (sawr-ISH-ee-uh) are the group of dinosaurs most closely related to modern birds. Early saurischian retained the hip structure of their ancestors, which is why they are referred to as “lizard hipped” dinosaurs. Saurischia includes theropods (meat eating dinosaurs) and sauropods (large, long-necked dinosaurs).

The other group is the Ornithischia (or-nith-ISH-ee-uh) or “bird hipped” dinosaurs. This group is more closely related to Triceratops than birds. Note: “lizard hipped” and “bird hipped” are misnomers because birds evolved from Saurischia.

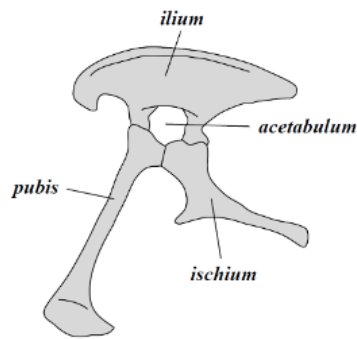


Figure 2 Saurischian Hip

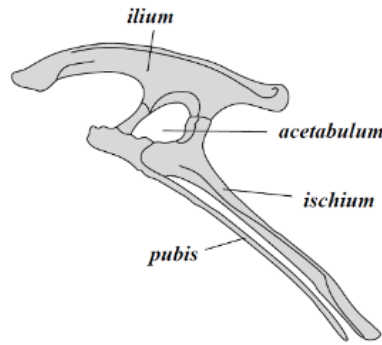


Figure 3 Ornithischian Hip

Adapted from an image by AdmiralHood, via Wikimedia Commons, licensed under CC BY-SA 3.0

Evolution

Evolution happens when there are a variety of traits in a population, such as hair/fur color, height, or feathers. These traits can be inherited from one generation to the next. Traits that are contained within DNA that can be passed down from one generation to the next are genetic traits. Some genetic traits can be harmful to an individual, while other traits can help individuals survive and reproduce. The more offspring produced by an individual, the more of that individual's genetic traits will survive in a population. This process where individuals that are best suited to their environment survive and pass down their genetic traits to future generations is called natural selection. Meanwhile individuals that are less well adapted to their environment might not survive or be able to produce as many offspring, which means fewer of their genetic traits are present in future generations.

When an ancestral population is divided by a physical (such as a mountain range or body of water) or behavioral barrier, the subpopulations can diverge enough genetically that a new species arises when the groups are no longer able to interbreed. We cannot tell which organisms were able to interbreed by looking at the fossil record, so instead we look at the physical characteristics (morphology) of the fossil organisms. We can infer that organisms that have significant morphological differences represent different species.

Evolution is well supported via experiments and observations and widely accepted among the scientific community. As a scientific theory, it can be repeatedly tested and verified using the scientific method. Like all scientific theories, evolution has withstood rigorous scrutiny and can predict the behavior of the natural world.

Suggested procedure:

Engage

- ▶ Show the following video: *Marching Dinosaurs - Animated Size Comparison* (7m 3s) <https://youtu.be/rRiecAmGWHU>



- Ask the class:
- o What they think of when they hear the word dinosaur.
 - o What are features that all dinosaurs have in common?
 - o How are they different from other animals?

Explore

Part 1: What is a dinosaur?

- ▶ Give each student a copy of the Is it a Dinosaur? handout.
- ▶ Go over the criteria for defining a dinosaur with the class.
- ▶ Once the class understands the features that define dinosaurs, you can play the Is it a Dinosaur? game.
- ▶ Is it a Dinosaur? Rules
 - o Can be played by individuals or in small groups
 - o Show the class the images of prehistoric animals included with this lesson as well as the skulls included in the kit
 - o Students must decide whether or not an animal is a dinosaur.
 - o It is important that students not only indicate yes or no, but support their answer with evidence

Part 2: Are Dinosaurs Alive Today?

- ▶ Next, students will get the opportunity to examine multiple lines of evidence to determine whether dinosaurs are still alive today
- ▶ Pass out the Are Dinosaurs Alive Today lab or if possible, email each student a digital copy (this will make it easier for students to follow the links embedded in the lesson)
- ▶ Students may either work alone or in small groups
- ▶ In this lab, students will examine various 3D models of dinosaurs and other types of animals in order to make comparisons
- ▶ The goal is to allow students to arrive at the conclusion that dinosaurs are alive today in the form of birds
- ▶ Note: students are not expected to have detailed knowledge of anatomy before or after this lesson. They are only expected to make generalized comparisons to determine relationships.

Explain

Ask the class to explain their conclusions from the lab. Students should be able to back up their claims with evidence. If there is disagreement, allow students the opportunity to debate their positions.

Elaborate

- ▶ Show the following video: *The Origin of Birds — HHMI BioInteractive Video* (18m 59s) <https://youtu.be/z4nuWLd2ivc>
- ▶ After the video, ask the class what other types of evidence scientists use to determine birds are dinosaurs. Does this cause anyone to change their initial thoughts?

Evaluate

Students can be evaluated on their performance in class discussions, as well as the quality of their work on the lab.

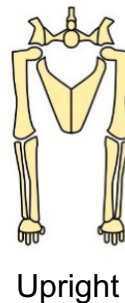
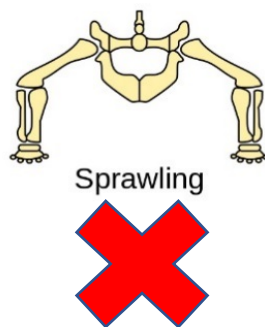
Is it a Dinosaur?

You will play a game where you have to decide whether or not an animal is a dinosaur. Use the following information to make your decision.

All dinosaurs lay eggs



Dinosaurs have an upright stance with their legs underneath their bodies.



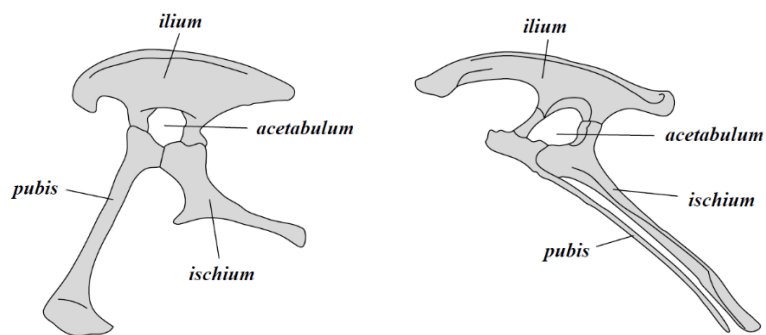
Dinosaurs live on land (or at least lay eggs on land)



Dinosaurs have an L-shaped thigh bone



Dinosaur hips are generally one of two shapes:



The 2 types of dinosaur hips



Dimetrodon



Oviraptor



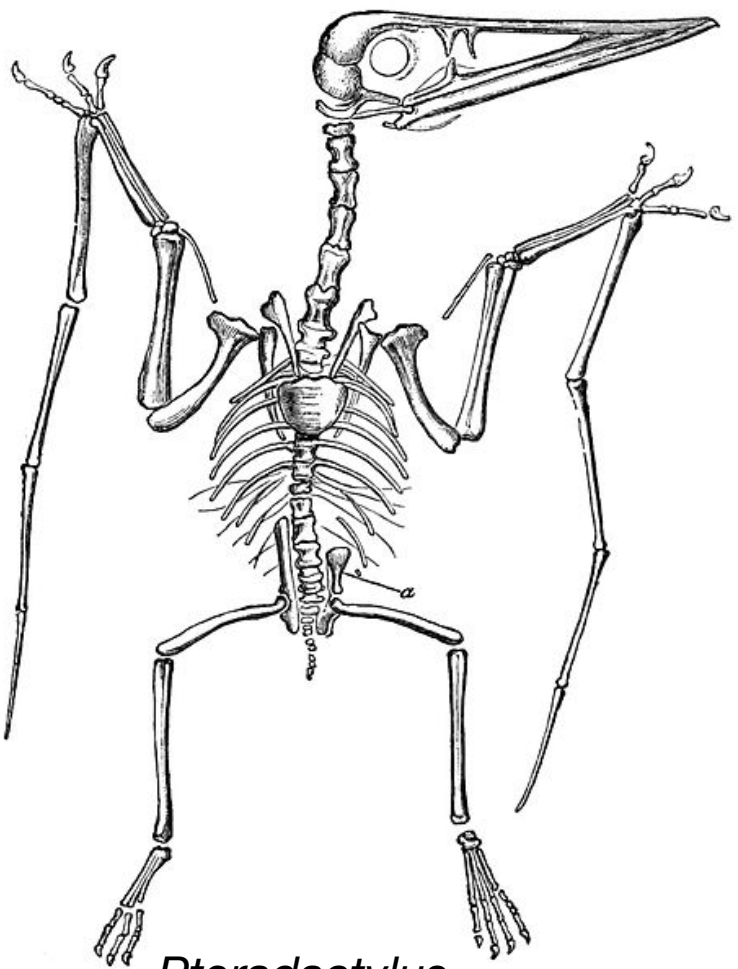
Gallimimus



Polycotylus



Triceratops



Pteradactylus



Mammoth and Mastodon



Mosasaurus



Is it a Dinosaur? Teacher Answer Key

Photo 1: *Dimetrodon* (pronunciation: dai-MEH-truh-daan) **This is not a dinosaur.** Students may notice the sprawling stance. This animal is more closely related to mammals than dinosaurs

Photo 2: *Oviraptor* (pronunciation: o-vih-RAP-tor) **This is a dinosaur.** Students may notice the L-shaped thigh bone and the fact that it is taking care of eggs in a nest.

Photo 3: *Gallimimus* (pronunciation: gal-uh-MY-mus). **This is a dinosaur.** Students may notice the L-shaped thigh bone, the dinosaur-shaped hip, and the fact that it is a land animal.

Photo 4: *Polycotylus* (pronunciation: POL-ee-COT-i-luhs) **This is not a dinosaur.** Students may notice that it lives in water and is giving birth to live young.

Photo 5: *Pteradactylus* (pronunciation: the-ruh-DAK-tl-us) **This is not a dinosaur.** Students may notice that the thigh bone is not L-shaped, nor does it have a dinosaur shaped hip.

Photo 6: *Triceratops* (pronunciation: try-SAIR-uh-tops) **This is a dinosaur.** Students may notice the dinosaur shaped hip, L-shaped thigh bone, and the fact that it is a land animal.

Photo 7: *Mosasaurus* (pronunciation: MOW-suh-saw-ruhs) **This is not a dinosaur.** Students may notice that it does not live on land.

Photo 8: Mammoth and Mastodon (pronunciation: MA-muhth; MA-stuh-daan) **These are not dinosaurs.** They are mammals. Mammals have hair and give birth to live young.

Photo 9: *Deinosuchus* (pronunciation: DIE-noe-SOOK-us) **This is not a dinosaur.** Students may notice the sprawling posture.

Photo 10: Cassowary (pronunciation: KA-suh-weh-ree) This is a modern flightless bird. Students might notice its upright stance, eggs, that it lives on land, and has a dinosaur like hip. **Allow students to reason whether they think the cassowary is a dinosaur or not but do not give them an answer.** In part two, they will look at more evidence to determine if birds are dinosaurs.

Are Dinosaurs Still Alive Today?

Now that you know what a dinosaur is and isn't, your job is to figure out if there are any animals alive today that could be considered dinosaurs.

Remember:

- ▶ Dinosaurs have an upright stance (no sprawling)
- ▶ Dinosaurs lay eggs
- ▶ Dinosaurs live on land and/or have to lay eggs on land
- ▶ Dinosaurs have special hip shapes
- ▶ Dinosaurs have an L shaped thigh bone

Form a hypothesis: Can you think of any animals today that might be considered dinosaurs based on what you learned?

You will get the opportunity to test your hypothesis by looking at the physical features of dinosaurs and other animals alive today. Just like you look similar to the people in your family, dinosaurs will share similarities with their relatives.

First we will look at feet. Compare the feet on this skeleton of the meat-eating dinosaur *Allosaurus* (pronounced: AL-uh-SAWR-us) <https://skfb.ly/6HCYy> with the following animals. If an animal walks on four legs, only look at the hind feet.

Cat	https://skfb.ly/6lyR6
Crocodile	https://skfb.ly/6HOKY
Emu	https://skfb.ly/6lpYX
Salamander	https://skfb.ly/6LAUH

Which animal's feet look most dinosaur-like?

Do any of the other animals' feet look similar to each other? What do you think this means?

Next let's look at hip bones. Examine the hip bones of the *Tyrannosaurus* and *Triceratops* in this model: <https://skfb.ly/6KHtS> You should be able to see the two different hip types that dinosaurs have. In the space below, draw them:

Now, compare the dinosaur hips with the following animals? Do any of these animals have hips that are similar to either the *Triceratops* or *Tyrannosaurus*?

Frog	https://skfb.ly/6HA6r
Mule	https://skfb.ly/6LAWP
Ostrich	https://skfb.ly/6HqLs
Wall lizard	https://skfb.ly/6LAXr

Hands are next. Let's compare the hands of this *Utahraptor* <https://skfb.ly/6GYET> with some other animals. If the animal walks on four legs, be sure to only look at the front legs/hands.

Chameleon	https://skfb.ly/6HA6X
Eagle	https://skfb.ly/6HADR
Grizzly Bear	https://skfb.ly/6LAZR
Salamander	https://skfb.ly/6LAZz

What animal has the most dinosaur-like arms and hands?

Next, let's look at the skull of this *Deinonychus* (pronunciation: dye-NON-ik-us) <https://skfb.ly/6HASE>. Do any of the animals below have a similar looking skull?

Alligator	https://skfb.ly/6lyvu
Black vulture	https://skfb.ly/6HFMz
Sea lion	https://skfb.ly/6MxBU
Salamander	https://skfb.ly/6LAZX

Sometimes it helps to look at the ancestors of modern animals to understand how they are related to each other. Let's make some comparisons with other types of fossils. First, look at the skeleton of

Velociraptor: <https://skfb.ly/6l6GT>

Now compare it with the following fossil animals:

Archaeopteryx (pronunciation: ar-kee-OP-ter-ix) one of the first birds:

<https://skfb.ly/6HvTw>

Carpolestes (pronunciation: car-po-LESS-tees) is an early primate

<https://skfb.ly/6LBUA>

Eryops (pronunciation: EAR-ee-ops) is an early amphibian

<https://skfb.ly/6KtoO>

Steneosaurus an extinct crocodile

<https://skfb.ly/6LosN>

What similarities and differences do you notice when you compare these animals with the *Velociraptor*?

Based on the evidence, do you think dinosaurs are still alive today? What group of animals (amphibians, birds, mammals, reptiles) might be considered dinosaurs? Use evidence to back up your claims.