



Short Film  
***Great Transitions: The Origin of Birds***

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Educator Materials

## LIVING DINOSAURS: FACT OR FICTION?

### OVERVIEW

The *Living Dinosaurs: Fact or Fiction?* activity is designed to supplement the viewing of the short film *Great Transitions: The Origin of Birds* (<http://www.hhmi.org/biointeractive/great-transitions-origin-birds>). Students evaluate and discuss statements about the evolutionary relationship between birds and dinosaurs and other facts about these groups before and after watching the film. This activity can be used as an anticipation guide to focus students on several of the key concepts presented in the film. It also can serve as a pre- and post-assessment.

### KEY CONCEPTS AND LEARNING OBJECTIVES

- The fossil record provides a history of life on Earth. It includes some organisms with features that are intermediate, or transitional, between major groups.
- Evidence that birds are descended from theropod dinosaurs includes shared anatomical features, as well as inferred physiological and behavioral similarities.
- One way scientists infer evolutionary relationships is by exploring patterns in the presence or absence of certain morphological characters in different species.
- Feathers evolved before flight and therefore must have originally served other functions, such as insulation or communication.
- Today, dinosaurs are classified into two groups: avian and non-avian. The non-avian dinosaurs are extinct, whereas the avian dinosaurs are still with us and are called birds.

Students will be able to

- evaluate claims based on information and evidence provided in a film and
- participate in a collaborative discussion of their interpretations of the evidence with their classmates.

### CURRICULUM AND TEXTBOOK CONNECTIONS

Curriculum	Standards
NGSS (2013)	MS-LS4-1, MS-LS4-2, HS-LS4-1, HS-LS4-4
AP Biology (2012–2013)	1.A.1, 1.A.4, 1.C.1, 4.B.4
IB Biology (2016)	5.1, 11.2

Textbook	Chapter Sections
Miller and Levine, <i>Biology</i> (2010 ed.)	16.3, 16.4, 18.2, 19.1, 19.2, 26.2
Reece et al., <i>Campbell Biology</i> (AP ed., 9th ed.)	22.1, 22.2, 22.3, 25.2, 25.4, 25.6, 26.3, 34.6



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## KEY TERMS

*Archaeopteryx*, avian dinosaur, bird, *Deinonychus*, fossil record, non-avian dinosaur, reptile, theropod, transitional fossil

## TIME REQUIREMENTS

This activity is designed to be completed during one 50-minute class period, including watching the film. Depending on the amount of class discussion, the activity may take longer.

## SUGGESTED AUDIENCE

This activity is appropriate for middle school life science and all levels of high school biology.

## PRIOR KNOWLEDGE

It would be helpful for students to understand that all species evolve from preexisting species and to be familiar with the concepts of speciation and extinction. An understanding that groups within the tree of life form nested sets would also be helpful (for example, humans are primates, which are in turn mammals, which are one group of tetrapods, which are one group of animals, etc.). Students should be able to describe some characteristics of dinosaurs, reptiles, and birds.

## PROCEDURE

### *Before Viewing the Film*

1. Have students work in pairs to complete the “before” column of Table 1 on the student handout. Let your students know that they are not expected to know all the answers; they should just record their ideas at this point.
2. Have students watch the film with the objective of finding evidence that supports or refutes their responses in the handout.

### *After Viewing the Film*

3. Have students first work in pairs to discuss the accuracy of the statements based on information presented in the film, and then complete the “after” column in Table 1. Students should explain in one or two sentences why they now think each statement is true or false.
4. Conduct a class discussion to reach a consensus on the accuracy of each statement. As necessary, prompt students to cite evidence from the film that supports their claims.

## TEACHING TIPS

- Before watching the film, discuss and clarify any statements that seem confusing or ambiguous to students. After watching the film, if students are unsure about a statement, ask them what additional information they would need to reach a firm conclusion. Explain to students that the point of this exercise is not to get the “right” answer, but rather to be able to support a claim with evidence.



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- If time permits, have students discuss some additional thought-provoking questions, such as these:
  - What are transitional fossils, and why did Charles Darwin anticipate their discovery?
  - The fossil records of some groups of organisms, such as bats and turtles, lack transitional forms that link them to other groups. Does this mean that these forms never existed? Why or why not?
  - How could you best explain why the following statement is false? “Birds couldn’t have evolved from dinosaurs because birds and dinosaurs lived at the same time.”
  - How can scientists make claims about the behavior of extinct animals?
  - Dr. Julia Clarke says in the film that there are too many similarities between theropods and birds to be explained by anything except common ancestry. What does she mean? How does common ancestry explain the similarities between the two groups?
- The following is a list of films, videos, articles, and activities that provide additional information about evolution and transitional fossils:
  - *The Day the Mesozoic Died* (<http://www.hhmi.org/biointeractive/day-mesozoic-died>)
  - *How To Find a Dinosaur* (<http://www.hhmi.org/biointeractive/how-find-dinosaur>)
  - *Great Transitions: The Origin of Tetrapods* (<http://www.hhmi.org/biointeractive/great-transitions-origin-tetrapods>)
  - *Great Transitions: The Origin of Humans* (<http://www.hhmi.org/biointeractive/great-transitions-origin-humans>)
  - *Great Transitions Interactive* (<http://www.hhmi.org/biointeractive/great-transitions-interactive>)
  - “It’s a Fishapod!” (<http://www.hhmi.org/biointeractive/article-fishapod>)
  - *Young Students Recognize a Transitional Tetrapod* (<http://www.hhmi.org/biointeractive/young-students-recognize-transitional-fossil>)

## EXPLANATIONS

Each statement below is followed by information that may be helpful in guiding a class discussion.

1. **The discovery of the fossil of *Archaeopteryx* provided evidence that birds evolved from mammals.**

This statement is false. When the first complete fossil of *Archaeopteryx* was described in 1861, it was clear that birds were closely related to some group of reptiles. In 1872, the sixth edition of *On the Origin of Species* included this paragraph on *Archaeopteryx*, which clearly identifies its common characteristics with reptiles—not mammals:

*Not long ago, palaeontologists maintained that the whole class of birds came suddenly into existence during the eocene period; but now we know, on the authority of Professor Owen, that a bird certainly lived during the deposition of the upper greensand; and still more recently,*



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*that strange bird, the Archeopteryx [sic], with a long lizard-like tail, bearing a pair of feathers on each joint, and with its wings furnished with two free claws, has been discovered in the oolitic slates of Solenhofen. Hardly any recent discovery shows more forcibly than this, how little we as yet know of the former inhabitants of the world. (Charles Darwin, On the Origin of Species, 6th ed., 1872, 444, emphasis added)*

2. **Flight evolved once in the history of life—in birds.**

This statement is false. In the film, Dr. Clarke talks about pterosaurs, a group of reptiles, which seemed like an obvious candidate to be a close relative of birds because they had light, hollow bones and were capable of flight. However, the wings of birds and pterosaurs have very different structures, so scientists concluded that flight evolved independently in both groups. Today, there are flying mammals (bats) and many thousands of flying insects, which are not closely related to birds.

3. **All dinosaurs were large and slow moving.**

This statement is false. As shown in the film, the discovery of *Deinonychus* by Dr. John Ostrom in 1963 set off a revolution in how scientists think about dinosaurs. *Deinonychus*'s large claws were clearly used for slashing at prey—a hunting strategy not associated with slow-moving animals. The large claws and *Deinonychus*'s lightly built and agile body led Dr. Ostrom to propose that some dinosaurs may have had a higher metabolic rate than a typical living reptile.

4. **Like birds, some dinosaurs laid eggs and cared for their young.**

This statement is true. In the film, Dr. Jack Horner talks about his 1978 discovery of a large dinosaur nesting ground at “Egg Mountain,” Montana. The dinosaurs associated with this nest were given the name *Maiasaura*, meaning “caring mother lizard.” Vegetation found near the nests suggests that dinosaurs covered the eggs, a practice employed by some species of modern birds. Baby *Maiasaura* up to 1 meter long were found associated with the nests, suggesting that the young remained for some time after hatching, likely being fed by their parents—again, a characteristic of many living birds. Further, nests were found at different layers at the site, suggesting that *Maiasaura* returned to the site year after year to lay their eggs.

5. **The skeleton of a *T. rex* has many similarities to the skeleton of a chicken.**

This statement is true. Although a *Tyrannosaurus rex* and a chicken are different in size, they have many anatomical similarities. In the film, Dr. Julia Clarke compares the foot of a *T. rex* to that of a chicken, and they both have three forward-facing digits and a smaller digit in the back. Similarities include the presence of a wishbone, an S-shaped neck, and many others.

6. **The fossil record shows that some dinosaur species had feathers nearly identical to those found on birds today.**

This statement is true. Earlier in the fossil record, dinosaurs, such as *Sinosauropteryx*, referred to in the film as a “fuzzy dinosaur,” had wispy, feather-like structures and could not fly. Later in the fossil record, scientists found theropods with feathers that looked more like the variety of feathers we see in birds today, from fluffy down feathers to asymmetrical flight feathers.



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**7. Birds evolved feathers on wings so that they could fly.**

This statement is false. Traits do not appear on demand because an organism needs them to do something. Although it may seem logical to assume that feathers first evolved in connection with flight, it is now clear that feathers long predate the first flying birds. Dinosaurs with wispy, feather-like structures, such as *Sinosauropteryx* seen in the film, could not fly. What advantages might a primitive feather-like structure give an organism? Looking at living birds offered two strong hypotheses—early feathers may have helped keep the dinosaurs warm and/or they may have helped the dinosaurs communicate.

**8. *Archaeopteryx* is the direct ancestor to all living birds.**

This statement is false. *Archaeopteryx* is sometimes described as “a missing link” between dinosaurs and birds. This phrasing can give the impression that evolution proceeded in a straight line. But non-avian dinosaurs did not morph into *Archaeopteryx*, which then morphed into modern birds. Indeed, as the film emphasizes, all kinds of feathered dinosaurs and birds lived at the same time.

**9. The first birds appear in the fossil record about 66 million years ago after the extinction of the dinosaurs.**

This statement is false. Scientists widely agree that a mass extinction occurred approximately 66 million years ago after a large asteroid smashed into Earth (see the HHMI short film *The Day the Mesozoic Died*, <http://www.hhmi.org/biointeractive/day-mesozoic-died>, about the evidence for the asteroid hypothesis). Before the impact, feathered and nonfeathered dinosaurs coexisted with birds and all kinds of other animals.

**10. Dinosaurs are alive today.**

This statement is true. Students may, however, point out that we don’t call them dinosaurs, which is a valid point. In modern taxonomy, groups form nested sets. Birds are dinosaurs, which are in turn reptiles, which are in turn tetrapods, which are in turn chordates . . . and so on. Tell your students that calling birds dinosaurs does not mean there is no such thing as birds. The point of calling birds dinosaurs is to emphasize their evolutionary origin within the dinosaur clade. Birds are dinosaurs just as humans are primates.

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