

## actionbioscience.org lesson

To accompany the peer-reviewed article by Michael Benton, Ph.D.

“Evidence of Evolutionary Transitions” (Apr. 2000)

<http://www.actionbioscience.org/evolution/benton2.html>

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### Evolution: Are There Really Missing Links? (Mar. 2002)

Lesson by John Ausema, biology teacher  
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Educator's section: p. 1-2
Student handout 1: p. 3
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#### Grades & Levels:

- **Handout 1:** high school (general)
- **Handout 2:** high school (advanced/AP) – undergraduate (year 1)

#### Time Recommendations:

- **Handout 1:** up to 1 week for projects
- **Handout 2:** 1-3 weeks for projects

#### NSES (USA) Content Standards, 9-12:

- NSES 1.2. Unifying Concepts & Processes: evidence, models & explanation
- NSES 2.2. Science as Inquiry: understanding about scientific inquiry
- NSES 4.3. Life Sciences: biological evolution
- NSES 8.2. History & Nature of Science: nature of scientific knowledge
- NSES 8.3. History & Nature of Science: historical perspective

#### Learning Objectives: Students will...

- understand the concept of missing links
- apply the concept of missing links to the general theory of evolution
- be able to provide and interpret other possible examples of missing links
- understand the role of molecular and morphological evidence in supporting evolution

#### Key Words Include:

missing link, evolution, paleontology, protein, DNA, mammal, bird, reptile, geologic time, fossil, morphology, molecular biology, evolutionary trees

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## Preparation

### Article Discussion

- Students should have studied basic genetics, basic evolution theory, and vertebrate characteristics.
- Ask students to read the article “Evidence of Evolutionary Transitions” online at <http://www.actionbioscience.org/evolution/benton2.html> or print and distribute copies of the article. You can use the “Article Discussion” questions (on page 2) in one of three ways: 1) student research/writing activity, 2) class discussion activity, or 3) both of the above (content questions answered orally, extension questions assigned).

### Student Handouts 1 or 2:

- After reading the article, student teams choose a research project. Explain how much time students have for completion of the projects and assign a due date.

## For Educators: Article Discussion

About the article by Michael Benton, Ph.D.: “Evidence of Evolutionary Transitions”  
<http://www.actionbioscience.org/evolution/benton2.html>

### Content Questions

1. According to the author, what is one of the most startling discoveries of the past 200 years?
2. What is meant by the term “missing link”?
3. What is *Archaeopteryx*? Describe its characteristics.
4. Describe the recent evidence that supports evolution of birds from dinosaurs.
5. What evidence suggests that mammals descended from reptiles?
6. Compare reptile and mammal jaws.
7. Describe Darwin’s observations in South America.
8. What support for evolution comes from DNA and proteins?
9. How do molecular and fossil evidence for evolution compare?

### Extension Questions

1. Does the writer claim to speak for all scientists? How can you verify his views?
2. Why does evolution require the billions of years suggested at the end of the article?
3. How could ancient reptilian jawbones have shifted to ancestral mammalian earbones without mammals losing their ability to move their jaw?
4. How would Darwin’s views have changed if molecular evidence had been available in his lifetime?
5. Why was Darwin’s trip to the Galapagos important for our understanding of how nature works?
6. What does the author mean by “shared characteristics”? List several examples.
7. Why is it important to find missing links?
8. What is the author’s main point? Does he successfully argue his point? What other evidence, if any, would make his argument more convincing?

# Evolution: Are There Really Missing Links?

## Student Handout 1

### Projects

Choose one of the projects listed below. Present your findings in class and be prepared to answer questions on your presentation.

#### I, the Paleontologist

You are working as a paleontologist and find a vertebrate fossil with 2 jaw joints. Create a presentation that answers these questions:

- How do you classify the creature?
- If you could find DNA in the fossil, how would you expect it to compare to that of reptiles and mammals?
- What other features do you expect such a creature would have?

#### Similar but Different

Choose an animal in one country that has a cousin in another country. For example, the West Indian manatee and the West African manatee or the Bengal tiger of India and the Siberian tiger.

- Compare these related animals, looking for similarities and differences.
- Describe how you think these animals evolved their differences over time.
- Trace their common ancestry and illustrate it on a geologic time chart.
- Explain your chart to the class and describe what you discovered about these animals.

#### Missing Links in Time

Find at least five missing links other than those mentioned in the article you have read. Create a geologic time chart and indicate where these missing links fit in your chart. In your presentation to the class, explain why each fossil is considered a transitional form and which “transition” is illustrated by this fossil. Use books and Internet resources for your research.

#### Virtual Museum

Take a trip to an online natural history museum that has dinosaurs and other extinct vertebrate fossils on display. Create a marketing brochure, magazine ad, or web page that describes the museum and some of the creatures on display. Make sure you identify any missing links.

#### Missing Link Art Gallery

Choose one missing link and draw its anatomical features. Label all features but provide a full description of those features that indicate the organism is a missing link. Explain your sketch to the class. Also describe what the creature may have looked like in real life. You and your classmates may want to create a “Missing Link Art Exhibit” for the school library.

## Evolution: Are There Really Missing Links?

### Student Handout 2

#### Projects

Choose *one* of the projects listed below and follow the instructions for each project. Your instructor will explain how much time you have and assign a due date.

#### Darwin's Finches

Research what Darwin discovered about the finches in the Galapagos. Then illustrate and describe how finches could have evolved in *one* of the fictional island settings below. These islands have been visited but not inhabited by humans.

- **Tropical Island:** This mountainous island is in the tropics where the vegetation is lush and rainstorms are frequent. There are many varieties of flowering and fruit-bearing trees. Predators on land include feral cats, tree snakes, and some raptors. The island is dotted with caves along the shore, which house an ecosystem of algae, crustaceans, and other small marine organisms. Sandy beaches, with tall grasses, are home to a variety of crabs, geckos, and small turtles. Waterfalls flow down the mountains to the ocean.
- **Rocky Island:** This island's geography consists mostly of rocky cliffs. Thick scrub and grasses grow among the boulders. Small, pebbly coves and tidal pools can be found along the base of the cliffs. The island is visited by migratory birds that come to nest on the cliffs and seals that come to feed on the abundant fish in the ocean. The tidal pools house a marine ecosystem of small marine organisms.
- **Flat Island:** The island is fairly flat and half of it is a sandy beach. The strong ocean currents churn up all kinds of crustaceans, jellyfish, and salt water plants and deposit them on the beaches. A variety of grasses grow along the beaches. Taller vegetation grows on the other half of the island, where freshwater can be found. There, a species of low, thorny tree produces a fruit that resembles a hard nut. Several species of birds, some of them fish-eaters, live on the island. The beaches are visited by a species of horseshoe crab. The only land mammals are small rodents. The island experiences a mild winter and warm summers.

#### Missing Links

Research the evolutionary history of *one* of the transitions listed below. Create a visual presentation that describes the geologic time when these organisms lived, the fossil record of these missing links, and anatomical diagrams that illustrate shared characteristics as additional evidence of the transition.

- From primitive fish to bony fish
- From amphibians to first reptiles
- From reptiles to first birds
- From reptiles to first mammals