

# *Elements of Biology: Evolution*

## Teacher's Guide

**Grade Level:** 9–12

**Curriculum Focus:** Life Science

**Lesson Duration:** Three class periods

### **Program Description**

Charles Darwin first postulated in 1850 that plants and animals originated with a single cell and over time evolved into a complex number of species. Investigate Darwin's theory of evolution, which has become the organizational principle biologists use to explain the life sciences.

### **Lesson Plan Summary**

Students learn about the theory of evolution and research the controversies surrounding it. Based on their research and their understanding of scientific theory, students write an essay that assesses whether other ideas, such as intelligent design, should be taught alongside evolution in science class.

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### **Onscreen Questions**

- How do mutations and sexual reproduction help species adapt?
  - What environmental factors cause natural selection?
  - Why did Charles Darwin hesitate to publish the *Origin of Species*?
  - How has social Darwinism played a role in world history?
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### **Lesson Plan**

#### *Student Objectives*

- Demonstrate an understanding of the theory of evolution.
- Study how the theory of evolution has been received by society over time and consider why it has been so controversial.
- Compare the theory of evolution to other ideas about how different life forms emerged and assess which ideas should be taught in science class.

## Materials

- *Elements of Biology: Evolution* video
- Computer with Internet access
- Print resources about evolution

## Procedures

1. Begin the lesson by asking students to write down any controversies about evolution they may be familiar with. The controversies could be recent or historical. Tell those who are not familiar with controversies that it does not matter. Have students put away their papers until the end of the lesson.
2. Ask students to watch the segment entitled "The Work of Charles Darwin" in the program *Elements of Biology: Evolution*. Ask them to think about the following questions:
  - What are the basic principles behind the theory of evolution? (*The theory of evolution states that new species emerge from earlier forms of life and that species change as a result of a process called natural selection. Natural selection holds that only those organisms best suited to survive in their environment will grow and reproduce.*)
  - Why did Darwin finally decide to publish his findings? (*He discovered that other scientists had developed a similar theory, which made him realize that the time was right to publish his ideas.*)
  - Why was Darwin worried about how *Origin of the Species* would be received? (*Darwin understood that his ideas could be seen as a conflict with religious thinking. He was concerned that he would be condemned by the church.*)
  - What was the initial reaction to *Origin of the Species*? (*The book was praised by the scientific community and received the expected censure from the religious community.*)
3. Tell students that although the theory of evolution is more than one hundred years old, it continues to elicit a strong response. Some people think it is one of the strongest scientific ideas ever developed, and others are bothered by its discount of the ideas about creation expressed in the Bible. The notion of intelligent design has recently been developed; it states that Earth's variety of species could not have formed unless an intelligent, spiritual force was also involved. Some people believe this should be taught in science class as an alternative to the theory of evolution.
4. Explain to students that their assignment is to write an essay considering whether intelligent design should be taught in science class. As students prepare their essays, they should research the history of the response to the theory of evolution, including the Scopes trial, which was a challenge to evolution on religious grounds that took place 80 years ago; think about what a scientific theory is; and form an opinion about ideas that are appropriate for science classes.
5. Have students research this issue using print and Web resources. The Web sites below are a good starting point:

- Reaction to Origin of the Species after its Publication  
<http://www.answers.com/topic/reaction-to-darwin-s-theory>  
<http://www.lib.cam.ac.uk/Departments/Darwin/intros/vol7.html>
  - Scopes Trial  
<http://www.msnbc.msn.com/id/8358264/site/newsweek/>  
<http://tennesseencyclopedia.net/imagegallery.php?EntryID=S012>
  - Current Objections to the Theory of Evolution  
[http://whyfiles.org/216evolution\\_qu/index.php?g=2.txt](http://whyfiles.org/216evolution_qu/index.php?g=2.txt)  
[http://whyfiles.org/216evolution\\_qu/](http://whyfiles.org/216evolution_qu/)  
<http://www.discovery.org/scripts/viewDB/index.php?command=view&id=2396>  
<http://www.teach12.com/ttc/assets/coursedescriptions/174.asp?id=174>  
<http://www.creationists.org/media.html#id>  
<http://www.creationists.org/wcmh02.html>
6. Give students time in class to work on their essays; if necessary, have them finish the assignment as homework.
  7. During the next class period, ask volunteers to share their essays. Then hold a discussion about their ideas. What conclusions did students reach? What evidence did they include to support their ideas?
  8. Conclude the lesson by asking students to revisit the ideas they wrote down about controversies surrounding evolution at the beginning of the lesson. What did they learn about the theory of evolution? Did this activity clarify their thinking about evolution?

### Assessment

Use the following three-point rubric to evaluate students' work during this lesson.

- **3 points:** Students demonstrated a solid understanding of the theory of evolution; made accurate and insightful comparisons between the theory of evolution and other theories; and presented a persuasive argument about which theory or theories should be taught in science class.
- **2 points:** Students demonstrated an adequate understanding of the theory of evolution; made somewhat accurate and insightful comparisons between the theory of evolution and other theories; and presented a satisfactory argument about which theory or theories should be taught in science class.
- **1 point:** Students demonstrated a weak understanding of the theory of evolution; had difficulty making comparisons between the theory of evolution and other theories; and presented a weak argument about which theory or theories should be taught in science class.

## Vocabulary

### **adaptation**

*Definition:* A body structure or behavior that gives an organism a better chance of surviving and reproducing in its environment

*Context:* Charles Darwin observed different kinds of beaks on finches, which was an adaptation that enabled finches to survive in their environments with minimal competition for food.

### **Charles Darwin**

*Definition:* A British scientist who developed the theory of evolution in the 19<sup>th</sup> century

*Context:* After observing the tremendous variety of life forms on the Galápagos Islands, Charles Darwin developed his theory of evolution.

### **intelligent design**

*Definition:* An idea that has emerged in the 21<sup>st</sup> century that states that the variety of life-forms on Earth could not have developed without a spiritual force with a preconceived idea of what life should look like

*Context:* The reason many scientists object to having intelligent design taught in science class is that it is not a scientific theory, which is based on observations and experiments that can be replicated over time.

### **natural selection**

*Definition:* The process through which life-forms best suited to a particular environment survive and reproduce, while those less suited to a given environment die out

*Context:* According to Darwin, natural selection is set in motion by the fact that the world is a cruel place and can support only those creatures that are the strongest and best able to survive.

### **scientific theory**

*Definition:* Ideas that are based on observations and experiments that can be replicated by others and have held up over time

*Context:* Evolution is considered by many to be one of the best-supported scientific theories ever developed.

### **Scopes trial**

*Definition:* The 1925 trial between John Scopes and the state of Tennessee in which Scopes was tried for teaching evolution in his science classroom in violation of a recently passed law that forbade the teaching of any interpretation of the beginning of life other than the one found in the Bible

*Context:* During the Scopes trial, Clarence Darrow presented a powerful defense of John Scopes' actions; nonetheless, Scopes was still found guilty of violating Tennessee law.

### **theory of evolution**

*Definition:* Charles Darwin's theory about the development of diverse life-forms based on the premises that all life developed from a few very simple organisms and that natural selection is the mechanism that caused these changes to take place

*Context:* Although the theory of evolution is based on a great deal of scientific evidence, it continues to evoke debate.

## **Academic Standards**

### **National Academy of Sciences**

The National Science Education Standards provide guidelines for teaching science as well as a coherent vision of what it means to be scientifically literate for students in grades K-12. To view the standards, visit this Web site:

<http://books.nap.edu/html/nses/html/overview.html#content>.

This lesson plan addresses the following national standards:

- Life Science: Biological evolution; Behavior of organisms
- History and Nature of Science: Nature of scientific knowledge; historical perspectives

### **Mid-continent Research for Education and Learning (McREL)**

McREL's Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education addresses 14 content areas. To view the standards and benchmarks, visit

<http://www.mcrel.org/compendium/browse.asp> .

This lesson plan addresses the following national standards:

- Science: Life Sciences – Understands biological evolution and the diversity of life
- Language Arts: Viewing – Uses viewing skills and strategies to understand and interpret visual media; Writing: Uses the general skills and strategies of the writing process, Gathers and uses information for research purposes; Reading: Uses reading skills and strategies to understand and interpret a variety of informational texts

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## **DVD Content**

This program is available in an interactive DVD format. The following information and activities are specific to the DVD version.

### **How To Use the DVD**

The DVD starting screen has the following options:



**Play Video** – This plays the video from start to finish. There are no programmed stops, except by using a remote control. With a computer, depending on the particular software player, a pause button is included with the other video controls.

**Video Index** – Here the video is divided into sections indicated by video thumbnail icons; brief descriptions are noted for each one. Watching all parts in sequence is similar to watching the video from start to finish. To play a particular segment, press Enter on the remote for TV playback; on a computer, click once to highlight a thumbnail and read the accompanying text description and click again to start the video.

**Curriculum Units** – These are specially edited video segments pulled from different sections of the video (see below). These nonlinear segments align with key ideas in the unit of instruction. They include onscreen pre- and post-viewing questions, reproduced below in this Teacher's Guide. Total running times for these segments are noted. To play a particular segment, press Enter on the TV remote or click once on the Curriculum Unit title on a computer.

**Standards Link** – Selecting this option displays a single screen that lists the national academic standards the video addresses.

**Teacher Resources** – This screen gives the technical support number and Web site address.

## Video Index

### I. A New Look at an Old World (3 min.)

Discover how Charles Darwin revolutionized science with *The Origin of Species* and learn about the scientific explanation for the emergence of life on planet Earth.

### II. From a Single Cell (4 min.)

Explore the history of life on Earth from its earliest beginnings as prokaryotic cells to the development of large, multicellular eukaryotic organisms.

### III. Evidence for Evolution (4 min.)

Examine evidence for the theory of evolution while learning how genetic mutations produce characteristics that help maintain a population's diverse gene pool.

### IV. Evolution in Action (3 min.)

The theory of evolution holds that change is a part of life itself. Explore the natural factors and circumstances that allow a species to adapt and change over time.

### V. The Origin of Species (27 min.)

Charles Darwin presented revolutionary theories on evolution and natural selection in the *Origin of Species*. Investigate his life and work and examine the debates that still rage over Darwinian ideas.

## Curriculum Units

### 1. Earthly Beginnings of Life

Pre-viewing question

Q: What is a fossil?

A: Answers will vary.

Post-viewing question

Q: According to scientific theory, what events led to the creation of life on Earth?

A: Most scientists agree that life began on Earth about 3.8 billion years ago with a tiny prokaryotic cell, when conditions allowed the formation of complex molecules, including amino acids, glucose, ribose, and dioxide ribose molecules. These molecules combined randomly for millions of years. Some scientists believe that life first developed in shallow seawater, and others think it developed near hydrothermal vents on the ocean floor. About one billion years earlier, around 4.6 billion years ago, the Earth formed from dust and debris into a hot molten sphere. Asteroids colliding with Earth introduced matter and released energy that further heated the planet and eventually allowed life-creating conditions.

### 2. From Cells to Organisms

Pre-viewing question

Q: What do you think the first living creatures on Earth were like?

A: Answers will vary.

Post-viewing question

Q: How and when did eukaryotic organisms come about?

A: One byproduct of cell photosynthesis is the release of oxygen. As it was released from the reproduction of cyanobacteria, Earth's atmosphere changed. Over hundreds of millions of years, cells adapted to use greater amounts of oxygen. One scientific theory suggests that some prokaryotic cells engulfed others inside their membrane; gradually becoming part of the host cell, taking on specialized functions of some organelles and creating eukaryotic cells. These cells were about 10 times larger than prokaryotic cells and first appear in the fossil record about 1.8 billion years ago. About 1 billion years later, roughly 800 million years ago, some eukaryotic cells grouped together and became simple multicellular organisms.

### 3. Creating Diversity

Pre-viewing question

Q: What do you know about the theory of evolution?

A: Answers will vary.

Post-viewing question

Q: Why aren't sexually produced offspring an exact replica of their parents?

A: Hereditary information is contained in the nucleus of cells as DNA, and segments of DNA produce genes. Organisms that reproduce sexually randomly reshuffle their genes as they pass down through generations.



#### 4. Adaptations and Genetic Differences

Pre-viewing question

Q: What examples of adaptations and mutations have you seen in nature?

A: Answers will vary.

Post-viewing question

Q: Describe how an animal or plant species can evolve to become two species.

A: Environmental factors such as mountain ranges and islands can isolate a species so that it develops different characteristics over many generations. In time, it will also accumulate a different genetic makeup. When the differences are so great that individuals can no longer interbreed, they are considered two species.

#### 5. Research Aboard the *Beagle*

Pre-viewing question

Q: What kinds of animals live in the Galápagos Islands?

A: Possible answers include tortoises, penguins, and iguanas.

Post-viewing question

Q: What did Charles Darwin bring back from his journey aboard the *HMS Beagle*?

A: Darwin increased his beetle collection and collected 1,500 species preserved in alcohol; 4,000 skins, bones, and dried specimens; and many crates of fossils. He returned to Britain with 3,000 pages of notes on paleontology, geology, entomology, and zoology.

#### 6. Natural and Artificial Selection

Pre-viewing question

Q: Do you disagree with any popular opinion or belief?

A: Answers will vary.

Post-viewing question

Q: What three elements make up Darwin's theory of natural selection?

A: Darwin's theory of evolution includes the random shuffle of heredity, each individual being born slightly different from all others; the cruelty of nature, with far more individuals being born than the world can accommodate creating a struggle for survival; and genetic mutation, which allows for some inherited differences plus a random mutation giving an organism an advantage.

#### 7. Controversial *Origin of Species*

Pre-viewing question

Q: Why might Darwin's theory of evolution have been controversial?

A: Answers will vary.

Post-viewing question

Q: How did people react to Darwin's *Origin of Species* when it was first published?

A: The first printing was sold out the day of publication. From religious conservatives came the expected response that Darwin's book was atheistic nonsense. From the scientific community came high praise.





## **8. Darwinian Medicine**

Pre-viewing question

Q: Do you think natural selection plays a role in human evolution?

A: Answers will vary.

Post-viewing question

Q: What is Darwinian medicine?

A: This field of medicine works to understand how human traits evolved over hundreds of thousands of years are at work today. An example is the tendency to overeat, which often results in obesity and heart disease. This may be an evolved response to famine. According to Darwinian medicine, the selective disadvantage of eating too little may be starvation during the next famine, while overeating and putting on extra pounds would increase survival.