

## Critical Analysis of Evolution – Grade 10

### Ohio Standards Connection:

#### Life Sciences

#### Benchmark H

Describe a foundation of biological evolution as the change in gene frequency of a population over time. Explain the historical and current scientific developments, mechanisms and processes of biological evolution. Describe how scientists continue to investigate and critically analyze aspects of evolutionary theory. (The intent of this benchmark does not mandate the teaching or testing of intelligent design.)

#### Indicator 23

Describe how scientists continue to investigate and critically analyze aspects of evolutionary theory. (The intent of this indicator does not mandate the teaching or testing of intelligent design.)

#### Scientific Ways of Knowing

#### Benchmark A

Explain that scientific knowledge must be based on evidence, be predictive, logical, subject to modification and limited to the natural world.

#### Indicator 2

Describe that scientists may disagree about explanations of phenomena, about interpretation of data or about the value of rival theories, but they do agree that questioning.

### Lesson Summary:

*This lesson allows students to critically analyze five different aspects of evolutionary theory. As new scientific data emerge, scientists' understandings of the natural world may become enhanced, modified or even changed all together. Using library and Internet sources, groups of students will conduct background research for one of the aspects of evolution in preparation for a critical analysis discussion. Students also will listen to, and take notes on, their classmates' critical analyses of evolution theory.*

*Estimated Duration:* Four to six hours

### Commentary:

This lesson should be used midway or toward the end of a unit on evolution. This will allow students to “carry over” their knowledge of basic evolutionary concepts into this lesson. The strength of this lesson lies in having students research topics that interest them about evolutionary biology. Students are encouraged to consider the research and discuss their findings with fellow students.

### Pre-Assessment:

- The following items can be used to stimulate dialogue with the students.
- Instruct students to copy the following items from the chalkboard in their science lab notebook.
  1. Describe what constitutes an anomaly.
  2. Why do anomalies exist in science?
  3. Are there any benefits to exploring scientific anomalies?
  4. How do scientists critically analyze conflicting data?
  5. Define the following terms in your own words:
    - Theory
    - Critical analysis
    - Natural selection
    - Biological evolution
    - Macroevolution
    - Microevolution
- Direct students to respond to the questions in their science notebook in as much detail as possible leaving space to record information from the ensuing dialogue to add to their notes.

## Critical Analysis of Evolution – Grade 10

response to criticism and open communication are integral to the process of science.

### Indicator 3

Recognize that science is a systematic method of continuing investigation, based on observation, hypothesis testing, measurement, experimentation, and theory building, which leads to more adequate explanations of natural phenomena.

### Scoring Guidelines:

Collect pre-assessments and evaluate for indication of prior knowledge and/or misconception. Sample definitions for question five in the pre-assessment include, but are not limited to, the following:

- **Theory**  
A supposition or a system of ideas intended to explain something, especially one based on general principles independent of the thing to be explained.
- **Critical analysis**  
The separation of an intellectual idea into its constituent parts for the purpose of a careful, exact evaluation and judgment about those parts and their interrelationships in making up a whole. (This definition combines the definition for critical and analysis.)
- **Natural selection**  
The principle that in a given environment, individuals having characteristics that aid survival will produce more offspring, and the proportion of individuals having such characteristics will increase with each succeeding generation.
- **Biological evolution**  
Changes in the genetic composition of a population through successive generations.
- **Macroevolution**  
Large-scale evolution occurring over geologic time that results in the formation of new taxonomic groups.
- **Microevolution**  
Evolution resulting from a succession of relatively small genetic variations that often cause the formation of new subspecies.

### Post-Assessment:

- Describe why scientific critical analysis of evolution is important.
- Describe three major pieces of evidence used to support evolution and explain why these pieces are important.

## Critical Analysis of Evolution – Grade 10

- Describe three major pieces of evidence used to challenge evolution and explain why these pieces are important.
- Compare and contrast the supporting and challenging information regarding the aspect of evolution you studied.
- Evaluate the scientific data supporting and challenging areas of evolution in light of the scientific method. In other words, is the data that is used to support or challenge evolution consistent or inconsistent with the scientific method? Are there any limitations? (NOTE: steps of scientific method: Observation, hypothesis, test, retest and conclusion)

### **Instructional Procedures:**

#### **Instructional Tip:**

Scientists make a distinction between two areas of evolutionary theory. First, scientists consider mutation, natural selection, genetic drift and gene flow (immigration and emigration) as the processes that generate evolutionary changes in organisms and populations. Second, the theory of universal common descent describes the historical pattern of biological change. This theory maintains that all living forms have descended from earlier living forms and ultimately from a single common ancestor. Darwin envisioned the theory of universal common descent as a necessary result of evolutionary changes in organisms and populations, and represented it in his branching tree of life. Students will investigate and analyze these two areas of evolutionary theory in this lesson.

In addition to the distinctions between different areas of evolutionary theory, scientists also find it helpful to distinguish amounts of biological change or evolution. Microevolution refers to evolution resulting from a succession of relatively small genetic variations that often cause the formation of new subspecies. Macroevolution refers to large-scale evolution occurring over geologic time that results in the formation of new taxonomic groups. These terms are helpful distinctions in the course of analyzing evolutionary theory. These terms have appeared in OhioLink research databases, numerous Internet sites, and biology and evolution textbooks. Though “micro” and “macro” are prefixes, it is quite clear that the scientific community recognizes and acknowledges the distinction between the words. There is more research on microevolution than there is on macroevolution. To help ensure academic

## Critical Analysis of Evolution – Grade 10

clarity, this lesson distinguishes between microevolution and macroevolution. Teachers may need to provide support to students to help them understand this distinction throughout the lesson.

### Student Engagement

1. Write the following statement on the chalkboard or overhead:  
Anomalies are ideas in science that depart from the general consensus of the time. Many anomalies occur in science. In an effort to determine the cause of this deviation, scientists conduct research to collect data that will explain the phenomena. As the evidence mounts by careful analysis of the data, original ideas may change from one scientific understanding to another.
2. Ask students to think through the following science topics and discuss where anomalies led to the collection of data that further explained the phenomena and contributed to changing scientific understandings.
  - Spontaneous generation versus biogenesis  
Several pieces of data could be used. One example is Francesco Redi's observation that flies must contact meat in order for maggots to appear on the meat.
  - Geocentric versus Heliocentric  
Several pieces of data could be used. One example is the observed phases of Venus.
  - Global warming versus non global warming  
Several pieces of data could be used. One example is the observed increasing size of the hole in the ozone layer.
3. Ask students to cite additional areas where critical analysis is needed by the scientific community.

### Teacher Presentation

4. Present supporting and challenging information for five aspects of evolution found in Attachment A. This will give students background information concerning both supporting and challenging evidence. Students can use this information to focus their research.

### Instructional Tip:

Alternative strategies for beginning this lesson could be to engage students in a Socratic discussion or a mini-lecture. See

