

Pacific Ocean. He reasoned that all organisms on the Galapagos (including the finches) had to be “immigrants,” brought to the islands by wind or currents or on floating debris. On each island there was a different species of finch; the beaks of each species varied in shape and size. They, in turn, were different from the original finch species that immigrated from Ecuador. What to make of these observations?

### DARWIN'S EXPLANATION

Upon Darwin's return to England in 1836, he analyzed his vast quantity of data and specimens, read widely about populations and geology, and consulted with other scientists. For the next 20 years, he continued to define and refine his conclusions. In 1859, he published *On the Origin of Species by Means of Natural Selection*, setting forth his ideas on the evolution of organisms and changing the science of biology forever. His *theory of natural selection* includes the following premises:

- Organisms produce more offspring than can be supported by the environment.
- Among these organisms there are variations, and these variations may be inherited.
- Some variations allow some organisms to survive longer and produce more offspring.
- There is a “struggle for existence” with “survival of the fittest” among the individuals in a population. This process he called natural selection.
- Natural selection over long periods of time may lead to the accumulation of changes that differentiate one species from another and lead to new species.

Darwin's two important phrases have often been misinterpreted over the years. The “survival of the fittest” does not refer to being strong or having a long life, but to surviving and reproducing. Fitness, in biological terms, refers to the passing on of one's genes to the next generation. The most fit organism is the one that produces the most offspring. The “struggle for existence” refers not to open combat among organisms, but to the organism's ability to use its environment to survive and reproduce. For example, some birds may be more aggressive in declaring a territory and more agile in obtaining nesting materials and food supplies; these birds will survive and produce more offspring.

Darwin expanded his premises to state that all forms of life developed gradually and by chance, over long periods of time, from different and often simpler ancestors; indeed, he stated that all branches of life lead back to a common ancestor. An evolutionary tree of life is a diagram of this principle of common ancestry.

Darwin was not the first scientist to point out the demonstrable fact that living things, and the populations that they are part of, gradually change. Darwin's legacy is that he proposed a mechanism for *how* that change occurs—the theory of natural selection. It is important to note that the common usage of the term “theory” in everyday life, as a speculative idea or mental viewpoint, is not the way the word is used in science. Instead, scientists use the term theory for an important idea that is backed by considerable supporting evidence.

### A MODERN INTERPRETATION

Since Mendel's paper on the inheritance of traits was not discovered until 1900, Darwin had no knowledge of genes or genetic principles, such as why parental traits are not blended in the next generation, or why traits can disappear in one generation and reappear in the next. Research conducted in the twentieth century has offered insights into the factors that influence natural selection. As you will remember from your reading of “The Wonderful Mistake” in Learning Experience 3—The Language of Heredity, it is “errors” in DNA that drive evolution. How do DNA mutations help explain the factors that underlie Darwin's premises, premises that led him to develop the theory of natural selection and change the way we look at the natural world?

### ► ANALYSIS

Write responses to the following in your notebook.

1. Why do most organisms produce more offspring than can survive?
2. What role does the environment play in the process of natural selection?
3. Name and briefly explain at least three biological factors that can cause variation among offspring and in future generations.
4. How are the finches of the Galapagos an example of natural selection? What was the selection pressure?
5. Evolution, by definition, never ceases. How might you explain the emergence of new microbes, such as the hantavirus and the Ebola virus, according to the theory of natural selection?
6. Evolution may occur also relatively rapidly, particularly in tiny organisms that reproduce rapidly and in huge numbers. It has been said, “Try not to get sick in a hospital—it can kill you!” How might you explain bacterial resistance to antibiotics?

- Teachers should respect diverse beliefs, but contrasting science with religion, such as belief in creationism, is not the role of science.
  - Science and religion differ in significant ways that make it inappropriate to teach any of the different religious beliefs in the science classroom.
- (Excerpted from the "NABT Statement on Teaching Evolution," The American Biology Teacher, January 1996, adopted by the Board of Directors, March 15, 1995.)

## Session Two

### DISCUSSION QUESTIONS

Begin class by encouraging student questions on evolution and the theory of natural selection.

Continue by discussing responses to the Analysis that follows the homework reading "Charles Darwin's Theory—Then and Now" (modified from the Student Manual):

- ◆ Why do most organisms produce more offspring than can survive? *(Students should respond that reproduction is a natural phenomenon guided by the basic action or instinct of passing on one's genes; that a high reproduction rate is often offset by a high death rate.)*

### TEACHING STRATEGY

Be alert to student responses that are anthropomorphic, i.e., attributing human characteristics to animals. Students may say that animals "need" or "want" to pass on genes to many offspring. An instinct involves complicated innate responses, but not direct thought.

- ◆ What role does the environment play in the process of natural selection?
- ◆ Name and briefly explain at least three biological factors that can cause variation among offspring and in future generations. *(Students should respond that mutations of the DNA, segregation and independent assortment of chromosomes, and recombination in reproduction all cause variation.)*
- ◆ How are the finches of the Galapagos an example of natural selection? What was the selective pressure? *(Students should respond that those finches whose beaks were best adapted to the island on which they were located survived and reproduced. The selective pressure was the type of food [plants and seeds] on the island.)*
- ◆ How might you explain the emergence of new microbes such as the hantavirus and the Ebola virus according to the theory of natural selection? *(Students may respond that possibly a viral mutation has occurred, and the new microbe has entered hosts having no defenses. Such viruses will continue to infect until some sort of environmental barrier checks their progress.)*