

What do **You** Think?

Evolution

Natural selection is a process that allows the best adapted of the species to survive and reproduce.

Evolution is based on natural selection, which is very, very slow.

Evolution explains how life originated on Earth millions of years ago.

Natural selection is a process that gives organisms what they need when they need it to survive and reproduce.



Vocabulary

adaptive value
evolution
extinction
fossil record

genetic variation
geologic time
mutation

natural selection
overproduction
theory

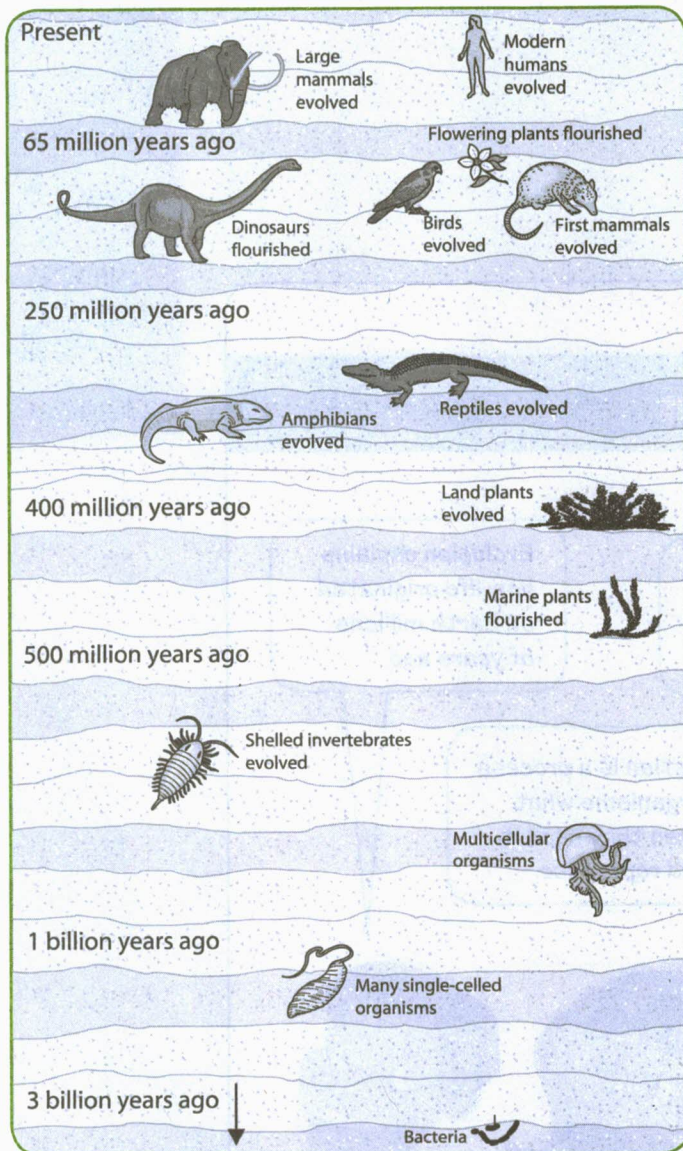


Figure 5-1. Examples from the fossil record

Topic Overview

Extensive evidence indicates that life on Earth began more than three billion years ago. Fossils found in ancient rocks have given us many clues to the kinds of life that existed long ago. The first living organisms were simple, single-celled organisms. Over time, more complex single-celled creatures developed. Then, about a billion years ago, increasingly complex, multicellular organisms began to appear. The idea that explains how this change in species has occurred over time is known as **evolution**.

The Theory of Evolution

The theory of evolution is accepted as the central theme of modern biology. It helps biologists understand how the variations among individuals can lead to changes in an entire species of organism. Since it was first suggested by Charles Darwin, the concept of evolution has been refined by massive amounts of evidence offered by thousands of scientists. So much evidence has been collected that evolution now has the stature of a **theory**, which is a concept that has been tested and confirmed in many different ways and can be used by scientists to make predictions about the natural world.

The theory of evolution helps biologists understand the similarities (such as bone structure and biochemistry) among different organisms. It also helps to explain the history of life that is revealed by the **fossil record**,

which is a collection of fossils that provides clues to the history of Earth's organisms.

The fossil record spans much of **geologic time**—the billions of years of Earth's history—revealing many changes in environments as well as species. Figure 5-1 shows examples from the fossil record through geologic time.

Evolution does NOT necessarily produce long-term progress in any set direction. Instead, evolutionary change appears to be more like the growth of a bush. Notice in Figure 5-2 that some branches survive from the beginning with little or no change. Some die out altogether. Others branch repeatedly, with each new branch representing a new species.

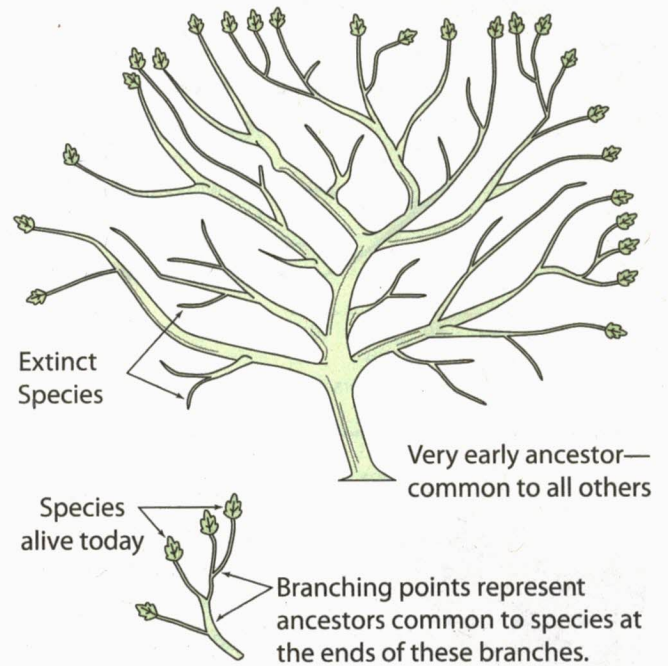
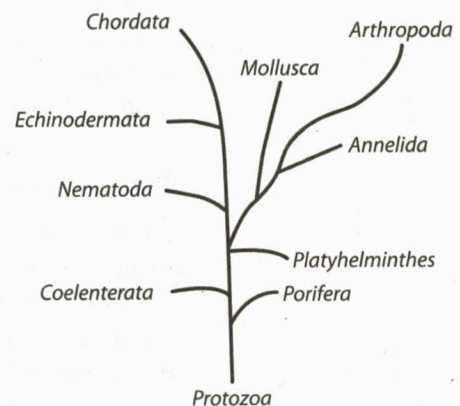


Figure 5-2. Evolution modeled as the growth of a bush: Evolutionary changes in species are like the growth of a bush in which some twigs grow and branch, while others die. The tips of the living twigs represent species that are alive now.

Review Questions

- Evolution is the process of
 - development of one-celled organisms from mammals
 - change in species over long periods of time
 - embryonic development of modern humans
 - changing energy flow in food webs
- Which phrase best defines evolution?
 - an adaptation of an organism to its environment
 - a sudden replacement of one community by another
 - the isolation of organisms from each other for many years
 - a process of change in species over a period of time
- The study of fossils has allowed scientists to
 - describe past environments and the history of life
 - study present ocean temperatures at different depths
 - analyze the chemical composition of sedimentary rocks and minerals
 - describe the details of the process by which life first began on Earth

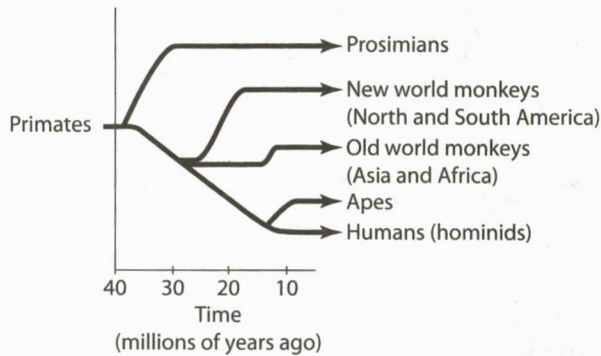
- The evolution of species is often represented as a branching tree similar to the one shown in the diagram below. The names shown represent different groups of organisms alive today; the lines represent their evolutionary histories.



The statement that is best supported by the diagram is that

- Annelida and Arthropoda have an ancestor in common
- Echinodermata are more closely related to Mollusca than they are to Chordata
- Mollusca and Arthropoda evolved before Porifera
- Annelida and Arthropoda evolved from Echinodermata

5. The diagram below represents possible lines of the evolution of primates.



Which inference can best be made based on the diagram?

- (1) Adaptations for living in trees are inherited by all primates.
- (2) Humans and apes have a common ancestor.
- (3) The embryos of monkeys and apes are identical.
- (4) The period of development is similar in most primates.

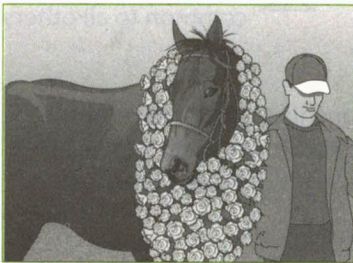


Figure 5-3. Racehorses are bred for speed and stamina: When humans breed plants or animals, they select specific traits, such as speed, flower color, or resistance to insects. In a similar way, “nature” selects any trait that increases an organism’s ability to survive and reproduce.

The Mechanics of Evolution

Darwin did not only suggest that species evolved. He also suggested how that evolution might have occurred. Darwin thought that the mechanism of evolution was like the process of artificial selection practiced by breeders of plants and animals. (See Figure 5-3.) He used the term **natural selection** to indicate that the process of evolution was controlled by “nature” rather than by people. In the process of natural selection, individuals that survive are able to breed and pass their genetic information to the next generation. Those that are not as successful in the environment often die without leaving any offspring.

Overview of Evolution

Darwin’s ideas are easy to understand: In any environment, an individual may be born with a characteristic that makes it stronger, faster—any sort of advantage that will help it survive and reproduce. The individuals that prove to be the best adapted to their environment will be more likely to survive. If they do survive, their favorable characteristics will be passed on to many of their offspring. As a result, these useful adaptations, which first appeared randomly, are likely to become more and more common with each generation. Similarly, characteristics that reduce an individual’s chance of surviving and reproducing will tend to decrease over time.

The long-term result of natural selection is a change in the frequency of certain traits in a population. Beneficial traits tend to become more common; harmful traits tend to become less common. As the frequency of a trait in a population increases or decreases over time, it can be said that the species is evolving. Note that the population—not the individual—changes as a result of evolution. An individual does not evolve; each is born with genetic information that may or may not help it survive and reproduce. As natural selection leads to changes in the composition of a population, that population may have more individuals with a certain favorable characteristic than it did earlier.

Interactions and Evolution

The driving force behind evolution is the interaction between individual organisms and their environment. Conditions that are vital to the process of evolution include