

CHAPTER 14

Evolution: A History and a Process

Summary of Key Concepts

Concept 14.1 Darwin developed a theory of evolution. (pp. 292–298)

Evolution is all of the changes that have transformed life over an immense time. An *adaptation* is an inherited characteristic that improves an organism’s ability to survive and reproduce in a particular environment.

In the 1830s, Charles Darwin sailed around the world on the *Beagle*. His observations of variation in birds and other organisms led him to suggest that species change as they adapt to their changing environments. Evidence from geology convinced him that slow and gradual processes could cause enormous change. Darwin’s theory of evolution contained two main points. First, species living on Earth today descended from earlier species. Darwin called this process *descent with modification*. Second, the mechanism for evolution is natural selection. *Natural selection* is the process by which individuals with inherited characteristics well-suited to the environment leave more offspring on average than do other individuals.

1. Define evolution. _____

2. What is natural selection? _____

Concept 14.2 Evolution has left much evidence. (pp. 299–304)

Evidence for evolution includes fossils and the geographic distribution of modern species. The structures, embryos, and DNA of modern species also provide evidence for evolution. *Fossils* are preserved remains or markings left by organisms that lived in the past. Most fossils are found in sedimentary rock layers. The *fossil record* is the collection of fossils recorded in rock layers over time. Fossils of *extinct* species, or species that no longer exist, help scientists reconstruct the past. Where organisms are distributed throughout the world gives clues to how modern species may have evolved. For example, many unique species evolved on the isolated island of Australia. Similar structures among related species, called *homologous structures*, also provide clues about evolution. *Vestigial structures* are homologous structures that have a major function in one species but not in a related species. Other clues about evolution come from comparing embryos, which are similar in closely related species. DNA sequences of different species also can be compared. The more similar the sequences, the more recently the species shared a common ancestor.

3. What is the fossil record? _____

4. What are some clues scientists use as evidence for evolution? _____

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Concept 14.3 Darwin proposed natural selection as the mechanism of evolution. (pp. 305–309)

Darwin based his theory of natural selection on two sets of observations. First, species tend to produce more individuals than the environment can support. This leads to a struggle to survive among members of a *population*, a group of individuals of the same species living in the same area at the same time. Second, there is much *variation*, or differences among members of the same species. Much of the variation passes from generation to generation.

According to Darwin’s theory of natural selection, individuals that function best in their environment tend to leave the most offspring. When this process repeats over time, each new generation has a higher proportion of individuals with traits that give them an advantage. Darwin thought that natural selection could eventually cause isolated populations of the same species to become separate species as they adapted to their different environments. Darwin found support for his ideas in the results of *artificial selection*, which is the selective breeding of plants and animals to produce offspring with traits that humans value.

5. Identify two sets of observations on which Darwin based his theory of natural selection. _____

6. How did Darwin think new species evolved? _____

Concept 14.4 Microevolution is a change in a population’s gene pool. (pp. 310–316)

The *gene pool* consists of all the alleles, or different forms of genes, in all the individuals in a population. The frequency of an allele refers to how often it occurs in the gene pool. *Microevolution* is a generation-to-generation change in the frequencies of alleles within a population. Populations that do not undergo change to their gene pools are not presently evolving. These populations are said to be in *Hardy-Weinberg equilibrium*.

Three factors can change a gene pool without leading to adaptation. *Genetic drift* is a change in a gene pool due to chance. *Gene flow* is the exchange of genes with another population. Mutation is a change in an organism’s DNA. Of all causes of microevolution, only natural selection usually leads to adaptation. Natural selection occurs because of differences in biological fitness. *Fitness* is the contribution that an individual makes to the gene pool of the next generation compared to the contribution of other individuals.

7. List three factors that can change a gene pool without leading to adaptation. _____

8. What is fitness? _____

Concept 14.5 Evolutionary biology is important in health science. (pp. 317–319)

The theory of evolution can help scientists better understand certain inherited and infectious diseases. For example, natural selection explains why many

African populations have a high frequency of the allele that causes sickle cell disease. Individuals with just one copy of the allele are resistant to the disease malaria, which is common in Africa. Natural selection also explains how bacteria have evolved resistance to *antibiotics*, which are drugs that kill or slow the growth of bacteria. While the drugs kill most of the bacteria, the resistant bacteria multiply. They quickly become widespread in the population.

9. Explain how having one copy of the allele that causes sickle cell disease can be advantageous. _____

10. Describe how bacteria that are resistant to antibiotics evolve. _____

Reading Skills Practice

Extracting information from a figure In Figure 14-21 on page 308, describe what happens to the gene for pesticide resistance from part 1 to part 3 of the figure. Then, explain why this change occurs.

Vocabulary Review and Reinforcement

In 1–4, write true if the statement is true. If the statement is false, replace the underlined term with a term that makes the statement true.

- _____ 1. The fossil record is the collection of fossils recorded in rock layers over time.
- _____ 2. A generation-to-generation change in the frequencies of alleles within a population is called Hardy-Weinberg equilibrium.
- _____ 3. A change in the gene pool of a population due to chance is called gene flow.
- _____ 4. Fitness is the contribution that an individual makes to the gene pool of the next generation compared to the contributions of other individuals.

In 5–8, write the letter of the correct definition on the line next to each term.

- | | |
|---|---|
| <ul style="list-style-type: none"> _____ 5. descent with modification _____ 6. gene pool _____ 7. Hardy-Weinberg equilibrium _____ 8. gene flow | <ul style="list-style-type: none"> a. the exchange of genes with another population b. all the alleles in all the individuals that make up a population c. Darwin's name for the process in which descendants of the earliest organisms accumulated different adaptations as they spread into various habitats over millions of years d. condition in which populations do not undergo change to their gene pools |
|---|---|

WordWise

Use the clues to fill in the blanks with Key Terms. Then put the circled letters in order to spell out the answer to the riddle.

Clues

1. This type of structure is similar in related species.
2. This type of evidence for evolution is found in rocks.
3. This type of species no longer exists.
4. This type of selection causes evolution.
5. This group of individuals of the same species lives in the same area at the same time.
6. This type of structure has no clear function in some modern species.
7. This term refers to differences among members of the same species.
8. This term refers to the biological history of life on Earth.
9. This type of drug kills or slows the growth of bacteria.
10. This type of selection means selective breeding of plants and animals.
11. This type of trait improves an organism's ability to survive and reproduce in a particular environment.

Key Terms

1. _ _ _ _ _ _ _ _
2. _ _ _ _ _
3. _ _ _ _ _ _
4. _ _ _ _ _ _
5. _ _ _ _ _ _ _ _
6. _ _ _ _ _ _ _
7. _ _ _ _ _ _
8. _ _ _ _ _ _ _
9. _ _ _ _ _ _ _
10. _ _ _ _ _ _ _ _
11. _ _ _ _ _ _ _

Riddle: What is evolution on the smallest scale?

Answer: _ _ _ _ _