Name Period Date

SECTION 10.1

EARLY IDEAS ABOUT EVOLUTION

Reinforcement

KEY CONCEPT There were theories of biological and geologic change before Darwin.

Evolution is the process of biological change by which descendants come to differ from their ancestors. Charles Darwin was not the first scientist to share his ideas about evolution and how it occurs.

- Carolus Linnaeus proposed that plant varieties, or **species**—a group of organisms so similar to one another that they can reproduce and have fertile offspring—can be crossed to create new species.
- Georges Buffon proposed that species shared ancestors instead of arising separately, the common thought of the time.
- Erasmus Darwin, Charles Darwin's grandfather, noted that more-complex forms of life seemed to arise from less-complex forms.
- Jean-Baptiste Lamarck recognized that changes in physical characteristics could be passed on to offspring and were driven by environmental changes over time.

Although Lamarck had ideas that influenced Darwin's thinking, his explanation of how organisms evolve was flawed. He thought, for example, that the long necks of giraffes evolved as generations of giraffes reached for leaves higher in the trees. This idea, which was later discredited, is known as the inheritance of acquired characteristics.

The field of geology also offered insights into evolution. Geologists noted that **fossils**—traces of organisms that existed in the past—in deeper layers of rock were quite different than those found in the upper layers. There were several ideas proposed to explain how such changes occur.

- The theory of **catastrophism** states that natural disasters such as floods and volcanic eruptions have happened often during Earth's long history. These events shaped landforms and caused species to become extinct in the process.
- The principle of **gradualism** states that changes in landforms result from slow changes over a long period of time.
- The theory of **uniformitarianism** states that the geologic processes that shape Earth are uniform through time. The theory of uniformitarianism, proposed by geologist Charles Lyell, combines gradualism with the observation that changes on Earth have occurred at a constant rate and are ongoing. The concept of uniformitarianism greatly affected Darwin's thinking.

1. What are three ideas about evolution that scientists had before Darwin's ideas were published?

_____

2. Describe Charles Lyell's geologic theory, which influenced Darwin.

_____

Name Period Date

SECTION 10.2

DARWIN'S OBSERVATIONS

Reinforcement

KEY CONCEPT Darwin's voyage provided insights into evolution.

Darwin traveled aboard the ship HMS *Beagle* to map the coast of South America and the Pacific Islands in 1831. He observed **variation**—the difference in the physical traits of an individual from those of other individuals in the same population—between island species on his voyage. The differences were especially noticeable on the Galápagos Islands off of South America. Some differences seemed well-suited to the animals' environments and diets. He noticed that species have **adaptations,** or features that allow them to better survive in their environments. Adaptations can lead to genetic change in a population over time.

- Saddle-backed tortoises, which have long necks and legs, lived in areas with a lot of tall plants. Domed tortoises, with their shorter necks and legs, lived in wet areas rich in mosses and short plants.
- Finches with strong, thick beaks lived in areas with a lot of large, hard-shelled nuts. Species of finch with more delicate beaks were found where insects or fruits were widely available.

On his voyage, Darwin also saw fossil evidence of species changing over time.

- He found fossils of huge animals, such as *Glyptodon,* a giant armadillo. He recognized that these fossils looked like living species, which suggested to him that modern animals might have some relationship to fossil forms.
- He observed fossil shells of marine organisms high up in the mountains. Later, Darwin experienced an earthquake and saw firsthand the result: land that had been underwater was moved above sea level.

Darwin realized that over long periods of time, gradual geologic or biological processes can add up to great change.

1. How is a variation different from an adaptation?

_____

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_____

2. What are two examples of adaptations that Darwin observed on the Galápagos islands?

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_____

3. What did Darwin conclude from the observations he made on his voyage?

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Name Period Date

SECTION 10.3

THEORY OF NATURAL SELECTION

Reinforcement

KEY CONCEPT Darwin proposed natural selection as a mechanism for evolution.

Darwin's ideas about evolution were influenced by many different sources. One important influence was the work of farmers and breeders. **Artificial selection,** the process by which humans change a species by breeding it for certain traits, provided Darwin with some important insights. He noticed that breeders could produce a great amount of diversity through selection of certain traits. In order for artificial selection to occur, the trait must be heritable. **Heritability** is the ability of a trait to be inherited, or passed down, from one generation to the next.

Darwin extended the ideas he gained from studying artificial selection to his theory of natural selection. **Natural selection** is a mechanism by which individuals that have inherited beneficial adaptations produce more offspring on average than do other individuals. Unlike artificial selection, where humans do the selecting of traits, in natural selection the environment is the selective agent.

Natural selection is based upon four principles:

- Overproduction: producing more offspring than are likely to survive
- Variation: the heritable differences that exist in every population
- Adaptation: a certain characteristic that allows an individual to survive better than other individuals it competes against for resources
- Descent with modification: the spread of an adaptation throughout new generations

Natural selection works on physical traits rather than genetic material itself. New traits are not made by natural selection. Natural selection can act only on traits that already exist in a population.

1. What is the main *similarity* between the processes of artificial selection and natural selection?

_____

2. What is the main *difference* between artificial selection and natural selection?

_____

3. Could natural selection work on a trait that is not heritable? Explain.

_____

4. Could natural selection work on a population that has no variation? Explain.

_____

Name Period Date

SECTION 10.4

EVIDENCE OF EVOLUTION

Reinforcement

KEY CONCEPT Evidence of common ancestry among species comes from many sources.

Darwin found evidence supporting evolution from a wide range of sources. The most important and convincing support came from fossils, geography, embryology, and anatomy.

- The fossil is a record of change in a species over time. Geologists found that fossil organisms on the bottom, or older, layers were more primitive than those in the upper, or newer, layers. These findings supported Darwin's concept of descent with modification.
- **Biogeography,** the study of the distribution of organisms around the world, reveals a pattern of evolution of organisms. Darwin's observations on the Galapagos islands, for instance, demonstrated that species can adapt to different environments and evolve into separate populations or species over time.
- Embryology, the study of embryo development, reveals that even organisms that are very different from each other in their adult forms can have similar patterns of development. Two species that exhibit similar traits during development are likely to have a common ancestor.
- Anatomy also provides insight into evolution. **Homologous structures** are features that are similar in structure but appear in different organisms and have different functions. **Vestigial structures** are remnants of organs or structures that had a function in an early ancestor. Both homologous structures and vestigial structures point to a shared ancestry among organisms that share them.

1. How did the study of fossils help support Darwin's ideas about evolution?

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_____

2. How did the study of organisms on islands help support Darwin's ideas?

_____

3. In all animals with backbones, including humans, early embryos have gill slits that later develop into structures of ears and throats in mammals. What does this suggest about the relationship between all vertebrates?

_____

4. What are two examples of types of body structures that provide evidence of a common ancestor among diverse organisms?

_____

Name Period Date

SECTION 10.5

EVOLUTIONARY BIOLOGY TODAY

Reinforcement

KEY CONCEPT New technology is furthering our understanding of evolution.

The study of fossils or extinct organisms, called **paleontology,** continues to provide new information and support current hypotheses about how evolution occurs. The fossil record, although incomplete, contains many transitional fossils, or "missing links," that demonstrate the evolution of traits. Transitional fossils can also indicate common ancestors between groups, such as *Basilosaurus isis*, which had a whalelike body but the limbs of a land animal.

Modern molecular techniques continue to provide new information about how evolution occurs. Examples include

- DNA sequence analysis: The more closely related two organisms are, the more similar their DNA will be.
- Pseudogenes: Pseudogenes no longer function but are still carried along with working DNA. They are not affected by natural selection, so common pseudogenes among organisms must reflect a common ancestor.
- Homeobox genes: These genes control the development of structures within the body. They are in diverse organisms, from fruit flies to humans, so they can indicate a very distant common ancestor.
- Protein comparisons: Sometimes known as molecular fingerprinting, this technique is based on the idea that different species that have cells with the same proteins most likely came from a common ancestor.

The theory of natural selection supported by genetic evidence is sometimes called the modern synthesis of evolutionary theory. The amount of data that can be collected by molecular evidence alone is overwhelming. Scientists from many fields of science are contributing to our understanding of evolution, and the field of evolutionary biology is quickly growing. Evolution is a unifying theme among all the fields of biology today.

1. Why is *Basilosauris isis* considered a transitional fossil?

_____

2. What underlying theme do the four molecular techniques share?

_____

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3. What is the modern synthesis of evolutionary theory?

_____

_____