CHAPTER 17

LESSON 1

A Voyage of Discovery

READING TOOL **Main Ideas and Details** As you read the lesson, complete the main ideas and details table. One row is completed for you.

Heading	Main Idea	Details
Darwin's Epic Journey	What did Darwin contribute to science?	Darwin developed the theory of evolution.
Observations from the Voyage		
• Species Vary Globally		
• Species Vary Locally		
• Species Vary Over Time		
• Putting the Puzzle Together		

Lesson Summary

Darwin's Epic Journey

KEY QUESTION *What did Charles Darwin contribute to science?*

Charles Darwin was born in England in 1809. In 1831, he started a five-year voyage on the ship HMS *Beagle*. The voyage of the *Beagle* took place at a time of new scientific ideas. Geologists suggested that Earth was ancient and had changed over time. Biologists suggested that life had also changed, through a process they called **evolution**. However, no scientist before Darwin had offered a scientific explanation of how evolution could occur.

Darwin developed a theory of biological evolution that offered a scientific explanation for the unity and diversity of life, by proposing how modern organisms evolved through descent from common ancestors.

As you read, circle the answers to each Key Question. Underline any words you do not understand.

BUILD Vocabulary

evolution change over time; the process by which modern organisms have descended from ancient organisms

fossil preserved remains or traces of ancient organisms

Word Origins *Evolution* comes from the Latin *volvere:* "turn, roll, revolve." With the prefix *e-*, meaning "away" or "out of," *evolution* means unfolding or unrolling. ☑ **What was Darwin's key contribution to science?**

Observations from the Voyage

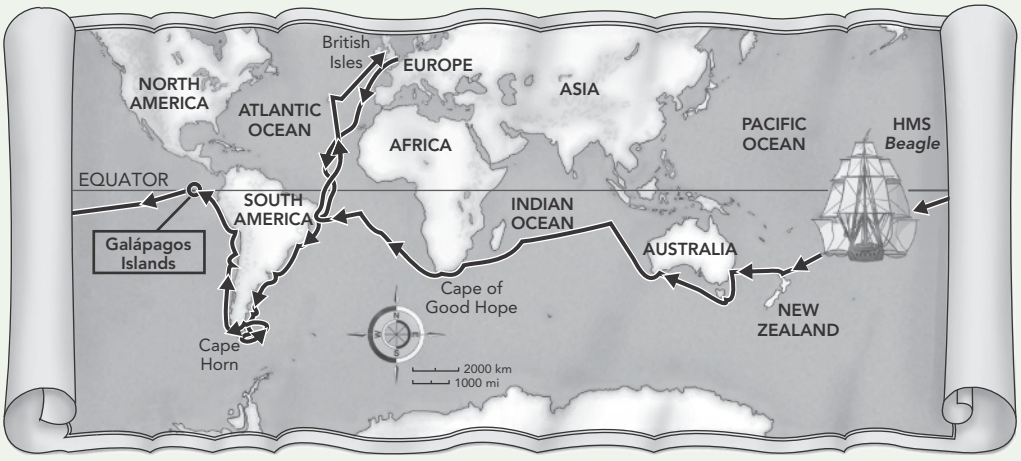
KEY QUESTION *What three patterns of biodiversity did Darwin observe?*

Darwin saw much diversity of life during the voyage. He saw how well suited plants and animals were to their environment. Darwin wanted to explain the diversity of life in a scientific way, so he kept observing, asking questions, and formulating hypothesis. Darwin focused on three patterns of diversity: (1) species vary globally, (2) species vary locally, and (3) species vary over time.

Species Vary Globally In South America, Darwin saw flightless, ground-dwelling birds called rheas. Rheas look and act a lot like ostriches. Yet rheas only live in South America, and ostriches only live in Africa. Then, in Australia, Darwin saw another large flightless bird, the emu. Darwin also noticed that rabbits and other grassland species in Europe did not live in the grasslands of South America and Australia. In Australia, Darwin saw kangaroos and other grassland species that are found nowhere else. Darwin noticed that different, yet ecologically similar, species inhabited separate, but ecologically similar, habitats around the globe.

Species Vary Locally Darwin noticed that different, yet related, species often occupied different habitats within a local area. Darwin saw two species of rheas in South America. One lived in the grasslands while a smaller species lived in a colder scrubland. Darwin also observed local variation in the Galápagos Islands off the Pacific coast of South America. The islands are relatively close to each other but are ecologically different. People who lived there could tell which island a tortoise came from just by looking at the shape of its shell.

Visual Reading Tool: Darwin's Journey



1. List the three species of flightless birds Darwin observed and draw a line to where he saw them.

2. List three different animals Darwin observed in the Galápagos.

READING TOOL

Make Connections Darwin observed many species of small finches in the Galápagos that had beaks of different shapes and sizes. ☑ **What do birds use their beaks for, and why would there be differences between species?**

Species Vary Over Time

In addition to collecting specimens of living species, Darwin also collected fossils. **Fossils** are preserved remains or traces of ancient organisms. In Darwin's time, scientists knew that fossils formed a record of extinct organisms, but did not know how to interpret that record. Darwin observed that the fossil record included many extinct animals that were similar to, yet different from, living species. One fossil he collected was from an extinct animal called a glyptodont. Why had glyptodonts disappeared, and why did modern armadillos resemble them? Could glyptodonts and armadillos have had a common ancestor?

Putting the Puzzle Together

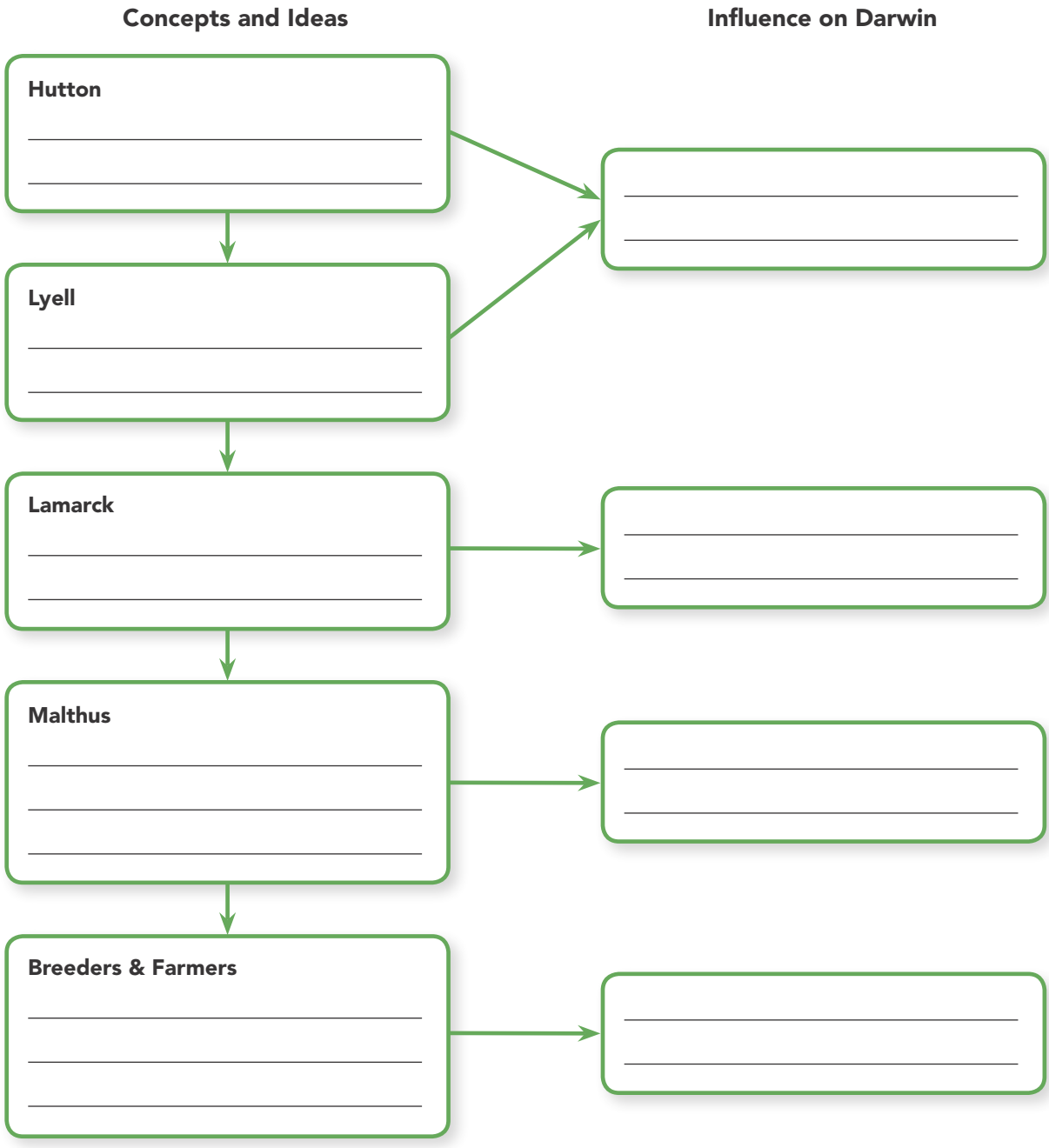
When Darwin returned home, experts identified his samples. The Galápagos mockingbirds were three separate species found nowhere else. The small brown birds were species of finches that lived nowhere else, but resembled South American species. This was true of Galápagos tortoises, iguanas, and many plants. Darwin wondered if species were really fixed and unchanging as many thought. Could organisms change over time through natural processes? Could Galápagos species have evolved from South American ancestors?

CHAPTER 17

LESSON 2

Ideas That Influenced Darwin

READING TOOL **Use Structure** As you read, use the structure of the lesson to identify the science concepts and ideas that influenced Darwin. Complete the graphic organizer by writing the concepts and ideas in the box on the left side with the scientist's name, and in the boxes on the right, fill in how those ideas influenced Darwin.



Lesson Summary

An Ancient, Changing Earth

As you read, circle the answers to each Key Question. Underline any words you do not understand.

KEY QUESTION *What did Hutton and Lyell conclude about Earth's history?*

Darwin was influenced by the work of other scientists. At the time of the *Beagle's* voyage, geologists were making new observations about forces that have shaped our planet. Naturalists were analyzing connections between organisms and their environments. These and other new ways of thinking about the natural world helped shape Darwin's thoughts. Many Europeans in Darwin's time thought that Earth was only a few thousand years old and had not changed much. Geologists James Hutton and Charles Lyell proposed hypotheses based on their own work and the work of others. Hutton and Lyell concluded that Earth is extremely old and that the processes that changed Earth in the past are the same processes that operate in the present.

READING TOOL

Academic Words Sediment is a collection of small pieces of rock that are the result of erosion. Water, wind, and ice erode, or wear down, rock into small pieces of dust, sand, and gravel. Sediment tends to end up in river valleys, along coastlines, and at the bottom of the ocean. Newer sediments are deposited on top of older sediments, forming layers. As the sediment builds up, pressure increases in the lower layers, forming sedimentary rocks.

Name three geological processes that have shaped Earth.

_____

_____

Hutton and Geological Change

Hutton recognized that certain kinds of rocks are formed from molten lava. He realized that other kinds of rock form slowly, from sediment that builds up and are squeezed into layers of rock. Hutton proposed that forces beneath Earth's surface can push layers of rock upward, tilting and twisting them in the process. These same forces can build mountain ranges. Mountains, in turn, are worn down by rain, wind, heat, and cold. These processes work very slowly. Hutton concluded that Earth must be much older than a few thousand years. Hutton introduced a concept called *deep time*—the idea that our planet's history extends back over a time so long that it is difficult for humans to imagine.

Lyell's *Principles of Geology*

Lyell argued that the laws of nature are constant over time, so scientists must explain past events in terms of processes they can observe in the present. This way of thinking is called *uniformitarianism*. It states that the geological processes we can see today, such as volcanoes and erosion, are the same processes that shaped Earth millions of years ago. Like Hutton, Lyell argues that Earth is much older than a few thousand years. Darwin read Lyell's books during the *Beagle* voyage. On the voyage he experienced volcanoes and earthquakes. The earthquake lifted a stretch of rocky shorelines more than 3 meters out of the sea. When he traveled inland, he observed fossils of marine animals thousands of feet above sea level. Darwin realized that geological events repeated over many years could form mountains from rocks that had once been underneath the sea. Darwin asked himself, "If Earth can change over time, could life change too?"

Lamarck's Evolutionary Hypothesis

KEY QUESTION *How did Lamarck propose that species evolve?*

Darwin wasn't the first to suggest that species could evolve. The fossil record provided strong evidence that life had changed over time. Jean-Baptiste Lamarck proposed two of the first hypotheses about how species could change. Lamarck suggested that individual organisms could change during their lifetimes by selectively using or not using various parts of their bodies. He also suggested that individuals could pass these acquired traits on to their offspring, enabling species to change over time.

Lamarck's Ideas Lamarck proposed that all organisms have an inborn urge to become more complex and perfect. Organisms change and acquire features that help them live more successfully in their environments. According to Lamarck, water birds could have acquired long legs by wading in deeper water looking for food. Or, if a bird stopped flying, its wings would become smaller. Lamarck called traits altered by individual organisms during their lifetime *acquired characteristics*. Lamarck also suggested that acquired traits, such as longer legs, could be passed on to offspring. This principle is called *inheritance of acquired characteristics*.

Evaluating Lamarck's Hypotheses Today we know that Lamarck's hypotheses are wrong. Organisms do not have an inborn drive to become perfect. Evolution does not mean that a species becomes "better" over time. Evolution does not progress in a predetermined direction. Traits acquired by individuals during their lifetime (such as the loss of a limb) are not inherited by their offspring. However, Lamarck was one of the first naturalists to argue that species are not fixed and unchanging. Lamarck recognized that organisms' adaptations are related to their environment and the way they live. Lamarck's hypotheses were wrong, but his ideas paved the way for Darwin's ideas.

READING TOOL

Apply Prior Knowledge

Lamarck did not know what we know today about how parents pass traits or characteristics on to their offspring. Now we know that characteristics are passed on by DNA in the germ cells: sperm in the male, and eggs in the female.

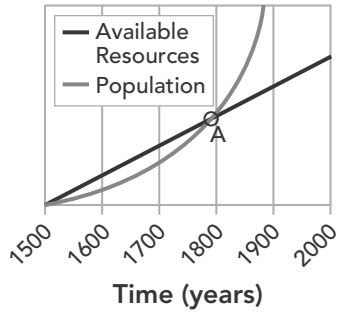
☑ **If you exercise a lot and build up big muscles, will your children be born with bigger muscles? Why or why not?**

READING TOOL

Connect to Visuals

Thomas Malthus recognized that our planet can only support a certain amount of people before it gets overcrowded, and there are not enough resources for everyone. The graph below represents the population of Earth and the available resources over time.

Malthus's Basic Theory



☑ **What happens after point A in regard to the population and resources available at that point in time?**

_____

_____

_____

BUILD Vocabulary

artificial selection selective breeding of plants and animals to promote the occurrence of desirable traits in offspring

Root Word *Artificial* has the root *artifice*, from *art*, meaning "skillful, creative," and *facere*, meaning "doing, making." *Artificial* means "made or done by humans."

☑ **Why is animal and plant breeding by farmers artificial?**

_____

_____

_____

Population Growth

KEY QUESTION *How did Malthus explain population growth?*

Before Darwin's time, the economist Thomas Malthus recognized that people were being born faster than people were dying, causing overcrowding. Malthus reasoned that if the human population grew unchecked, there wouldn't be enough living space and food for everyone. The forces that work against population growth, he suggested, include war, famine, and disease. Darwin realized that if Malthus's reasoning applied to people, it applied even more to other organisms. Many organisms can produce many more offspring than humans. Darwin realized that if all descendants of just one pair of oysters, which produce millions of eggs, were to survive, oysters would overrun Earth. However, many die and only a few survive to reproduce. This is known as differential reproductive success. This idea was important to Darwin in determining the mechanism, or natural process, that could produce evolutionary change. Darwin wanted to know which individuals survive, and why.

Artificial Selection

KEY QUESTION *How is inherited variation used in artificial selection?*

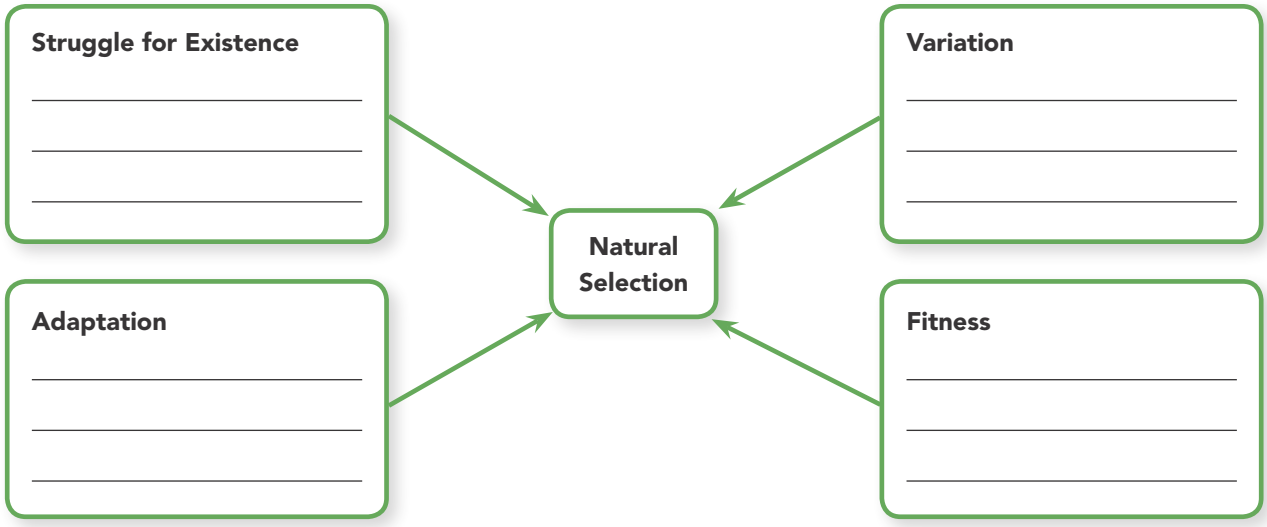
Some plants have larger or smaller fruit than average for their species. Some cows produce more or less milk than others in their herd. Farmers told Darwin that some of these differences were inherited variation—meaning they were traits that were passed from parents to offspring. Farmers would select for breeding only the plants that produced the largest fruit or cows that produced the most milk. Darwin called this selective breeding **artificial selection**. In artificial selection, nature provides the inherited variations, and humans select those variants they find useful. Darwin did not know how heredity worked, but he knew that inherited variation occurred in wild species as well as in domesticated plants and animals. Unlike earlier scientists, Darwin recognized that inherited variation was important, because it could provide the material for a natural process that could drive evolution.

CHAPTER 17

LESSON 3

Darwin's Theory: Natural Selection

READING TOOL **Make Connections** As you read your textbook, complete the natural selection concept map by entering an explanation for each term or concept.



Lesson Summary

Evolution by Natural Selection

KEY QUESTION *Under what conditions does natural selection occur?*

As you read, circle the answers to each Key Question. Underline any words you do not understand.

Darwin worked out his theory of evolution by natural selection soon after reading Malthus, but did not publish his ideas for another 20 years. Darwin knew that many scientists ridiculed Lamarck's ideas, and Darwin's theory was even more radical. Darwin wanted to gather as much evidence as he could before making his ideas public.

In 1858, Alfred Russel Wallace published his ideas about evolution, which were almost identical to Darwin's. Darwin's ideas and Wallace's essay were presented together at a scientific meeting in 1858. Darwin then moved forward with his own work. He published his ideas in *On the Origin of Species* in 1859. Although both had the right idea, Darwin had more data to support his hypotheses than Wallace. Darwin's contribution was to describe a natural process that could operate like artificial selection.

The Struggle for Existence Malthus's work convinced Darwin that members of a population compete for a finite supply of resources. Darwin described this as *the struggle for existence*. Which individuals would succeed in surviving and reproducing?

BUILD Vocabulary

adaptation heritable characteristic that increases an organism's ability to survive and reproduce in an environment

fitness how well an organism can survive and reproduce in its environment

natural selection process by which organisms that are most suited to their environment survive and reproduce most successfully; also called survival of the fittest

Using Prior Knowledge You may have described someone as "fit," or you may have taken "fitness classes." *Fit* in these cases refers to the physical condition and health of a person.

☑ **Why is survival not enough to describe biological fitness?**

_____

_____

Variation and Adaptation Darwin hypothesized that some individuals inherited traits that made them better suited, or better adapted, than other individuals to life in their environment. Any heritable characteristic that increases an organism's ability to survive and reproduce in its environment is called an **adaptation**. Adaptations can involve body parts or structures, physiology, or behaviors.

Survival of the Fittest Darwin, like Lamarck, recognized that there is a connection between the way an organism "makes a living" and its environment. According to Darwin, differences in adaptations affect an individual's fitness. **Fitness** describes how well an organism can survive and reproduce in its environment. Individuals with adaptations that are well suited to their environment so that they can survive and reproduce are said to have high fitness. Individuals with characteristics that are not well suited to their environment either die without reproducing, or leave few offspring, and are said to have low fitness. This differential reproductive success is called by some *survival of the fittest*. Survival means not only staying alive. In evolution, *survival* means surviving, reproducing, and passing adaptations on to the next generation.

Natural Selection Darwin named his mechanism for evolution *natural selection*. **Natural selection** is the process by which organisms in nature with variations most suited to their environment survive and leave more offspring. The different conditions of the environment influence fitness. Natural selection occurs in any situation in which:

- more individuals are born than can survive (the struggle for existence),
- natural heritable variation affects the ability to survive and reproduce (variation and adaptation), and
- fitness varies among individuals (differential reproductive success).

Well-adapted individuals survive and reproduce. Populations continue to change from generation to generation as they become better adapted or as their environment changes.

Natural selection only acts on inherited traits, because those are the only characteristics that parents can pass on to offspring. Natural selection does not make organisms "better." Adaptations only have to be good enough to enable an organism to pass on its genes. Natural selection does not move in one fixed direction. If the environment changes, this may change which traits are adaptive. This leads to a great diversity of adaptations in different environments. A species may become extinct if it cannot adapt to a changing environment fast enough. Natural selection is not the only mechanism that leads to evolutionary change.

Common Ancestry

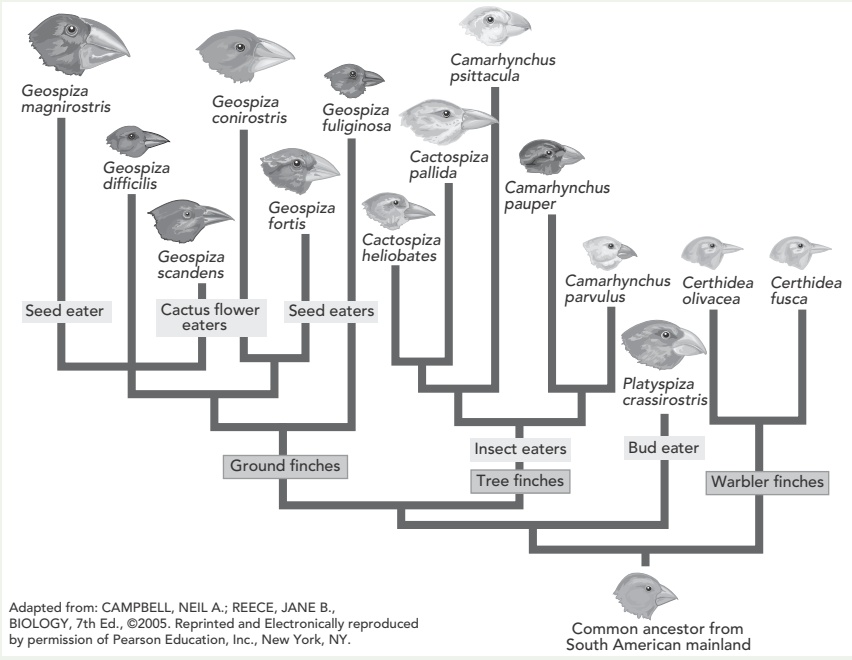
KEY QUESTION *What does evolutionary theory suggest about the unity and diversity of life?*

Every organism is descended from parents who survived and reproduced. Those parents also descended from their parents, and so forth back through time. Just as well-adapted individuals survive, well-adapted species survive over time. Darwin proposed that living species descended with changes over time from common ancestors, an idea called *descent with modification*. Over many generations, changing environmental conditions lead to adaptations that cause a single species to split into two or more new species. Darwin supported this theory using the fossil record and Hutton and Lyell's work on deep time.

The idea that natural selection and adaptation can produce new species explains both the unity and the diversity of life. Darwin used a sketch of a branching tree to show descent from common ancestors. Look back in time and you can find common ancestors for similar species of mammals. Farther back is the common ancestor of all mammals. Farther back is the common ancestor of all animals and, farther back, of all living things. According to the principle of common descent, all species—living and extinct—are united by descent from ancient common ancestors, and they exhibit diversity due to natural selection and adaptation.

Visual Reading Tool:

The diagram below shows a tree diagram like the one Darwin used to show relationships between different species of finches on the Galápagos Islands.



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1. On the diagram, circle all the species that eat seeds.

2. All of these birds descended from a common ancestor. Is the common ancestor shown at the bottom or the top of the tree diagram?

_____

3. What caused the different species to evolve separately of each other if they lived on the same islands?

_____

_____

CHAPTER 17

LESSON 4

Evidence of Evolution

READING TOOL **Active Reading** As you read, complete the chart to describe the evidence of evolution.

Concept	How Concept Supports Evolution
Biogeography	
Closely Related but Different	
Distantly Related but Similar	
The Age of Earth and Fossils	
The Age of Earth	
Recent Fossil Finds	
Comparing Anatomy and Development	
Homologous Structures	
Analogous Structures	
Development	
Genetics and Molecular Biology	
Life's Common Genetic Code	
Molecular Homology	
Testing Natural Selection	
The Grants' observations of finches on the Galápagos Islands	

Lesson Summary

Scientists in Darwin's time did not have the knowledge or technology to test his ideas. However, every scientific test since then has supported Darwin's basic ideas about evolution.

Biogeography

KEY QUESTION *How does geographic distribution of species today relate to their evolutionary history?*

As you read, circle the answers to each Key Question. Underline any words you do not understand.

Darwin recognized the importance of patterns in where organisms live. The study of where organisms live now and where they and their ancestors lived in the past is called **biogeography**. Patterns in the distribution of fossils and living species tell us how modern organisms evolved from their ancestors. Darwin made two observations involving biogeography. First, closely related species can evolve diverse adaptations in different environments. Second, distantly related species can evolve similar adaptations if they live in similar environments.

Closely Related but Different The biogeography of Galápagos bird species suggested to Darwin that different island species evolved from a mainland species. Natural selection on different islands selected individuals with different inherited variations. The populations on different islands evolved into different, but closely related, species.

Distantly Related but Similar Darwin noted that ground-dwelling birds in ecologically similar grasslands in South America, Australia, and Africa resembled one another, although they were not closely related. Natural selection in similar habitats led to similar adaptations, such as legs and feet adapted for running.

BUILD Vocabulary

biogeography study of past and present distribution of organisms

Prefixes The prefix *bio-* means "life," and the prefix *geo-* means "Earth." The study of biogeography combines Earth science and life science. **What caused the island finch species to diversify over time?**

The Age of Earth and Fossils

KEY QUESTION *How do fossils help document descent of modern species?*

The Age of Earth Darwin, along with Hutton and Lyell, knew that the Earth must be very old. The discovery of radioactivity and radioactive dating enabled geologists to determine the age of certain rocks and fossils. This data indicates that Earth is about 4.5 billion years old, old enough for evolution by natural selection to have taken place.

Recent Fossil Finds Scientists in Darwin's time had not found enough fossils to show the evolution of modern species from their ancestors. More recently discovered fossils now show clearly how modern species evolved from extinct ancestors. All records are incomplete, but many intermediate forms have been found. The fossil evidence tells an unmistakable story of evolutionary change.

READING TOOL

Connect to Visuals Examine Figure 17-14 in your textbook. This shows the evolution of whales from animals that walked on land, and highlights some of the changes that occurred in the front limbs (forelimbs) and rear limbs (hind limbs) as these animals evolved.

☑ ***Artiodactyl* has legs for walking on land. *Dorudon* has flippers for swimming. The flippers of *Dorudon* and the legs of *Artiodactyl* are what kinds of structures?**

_____

BUILD Vocabulary

homologous structure structure that is similar in different species of common ancestry

vestigial structure structure that is inherited from ancestors but has lost much or all of its original function

analogous structure body part that shares a common function, but not a common structure

Word Roots *Homologous* and *analogous* share the Greek root *logos*, meaning "speech" or "reason." With the prefix *homo-*, *homologous* means "the same," and with the prefix *ana-*, *analogous* means "said to be similar."

☑ **How are homologous and analagous structures different?**

_____

_____

_____

_____

Comparing Anatomy and Development

KEY QUESTION *What do homologous structures and similarities in development suggest about the process of evolutionary change?*

By Darwin's time, scientists knew that the bones in all vertebrate limbs resembled each other. The same basic bone structure is used for climbing, running, and flying.

Homologous Structures

Similar structures, like the bones of vertebrate limbs, that are shared by species and inherited from a common ancestor are called **homologous structures**. Evolutionary theory explains the existence of homologous structures adapted to different purposes as the result of descent with modification from a common ancestor. Biologists determine that structures are homologous by studying anatomical details, the way the structures develop in embryos, and their appearance over evolutionary history.

The degree of similarity in homologous structures is related to how recently species shared a common ancestor. Many bones of reptiles and birds are more similar to one another in structure and development than they are to homologous bones in mammals. This is evidence that reptiles and birds had a common ancestor that lived more recently than the common ancestor of mammals, reptiles, and birds. The key to identifying homology is common structure and origin during development, not function. Homology occurs in plants, too. Groups of plants share homologous stems, roots, leaves, and flowers.

Some homologous structures don't serve important functions. **Vestigial structures** are inherited from ancestors but have lost much of their original size and function. An example is the hipbone of a dolphin, or remnants of limbs in legless lizards. These structures may persist because they don't affect an organism's fitness. Therefore, natural selection does not fully eliminate them.

Analogous Structures

Body parts that serve similar functions, but do not share a similar structure and development, are called **analogous structures**. The wing of a bee and the wing of a bird are examples of analogous structures. Both are used for flight, but they develop from different embryonic tissues.

Development

Scientists noticed long ago that early developmental stages of many vertebrates look similar. Recent studies show that the same groups of embryonic cells develop in the same order in vertebrates to produce many homologous tissues and organs. Darwin realized that similar patterns of embryological development provide evidence that organisms have descended from a common ancestor.

Genetics and Molecular Biology

KEY QUESTION *How can molecular biology be used to trace the process of evolution?*

Genetics provides strong evidence supporting evolutionary theory. At the molecular level, similarities in the genetic code of all organisms, along with homologous genes and molecules, provide evidence of common descent. Mutation and gene shuffling during sexual reproduction produce the heritable variation on which natural selection works.

Life's Common Genetic Code All living organisms use information coded in DNA and RNA to carry information from one generation to the next. This genetic code is nearly identical in all organisms, including bacteria, fungi, plants, and animals. This is evidence that all organisms evolved from common ancestors that had the same code.

Molecular Homology Homology resulting from common ancestors is seen at the molecular level too. One example of homologous genes is the set of Hox genes that determine the development of body parts. Hox genes determine which parts of an embryo become the head and which become the tail. In vertebrates, Hox genes direct the growth of the front and hind limbs. Small changes or mutations in the Hox genes can produce major changes in an organism's structure. Some homologous Hox genes are found in almost all multicellular animals, from fruit flies to humans. The Hox genes must have been inherited from ancient common ancestors.

Testing Natural Selection

KEY QUESTION *What does recent research of the Galápagos finches show about natural selection?*

Darwin did not think it was possible to observe natural selection in nature because evolutionary change happens very slowly. Recently biologists have designed experiments to study natural selection in the wild.

Back to Galápagos The longest-running study of evolution in a natural environment is the ongoing work on Darwin's finches by Peter and Rosemary Grant. The Grants have been studying the finches on the island Daphne Major in the Galápagos. For over 40 years the Grants have been capturing, identifying, and measuring every finch on the island. When new birds hatch, the Grants note the parents and tag the birds. The Grants and their assistants also count and measure all the different kinds of seeds the birds use for food. They created a device to measure the hardness of the seeds.

READING TOOL

Apply Prior Knowledge Most of the enzymes and other proteins you have studied can be found in many different organisms. For example, when you studied DNA replication, you learned about the enzyme DNA polymerase. When you studied photosynthesis and cellular respiration, you learned about the enzyme ATP synthase. These two enzymes are found in nearly all living organisms. When you studied the cytoskeleton, you learned about the proteins actin and tubulin. Actin and tubulin are found in all eukaryotes.

☑ **An actin gene in humans is 92% identical to the homologous actin gene in mice. An actin gene in humans is 80% identical to the homologous gene in yeast. What does this say about how long ago these organisms had a common ancestor?**

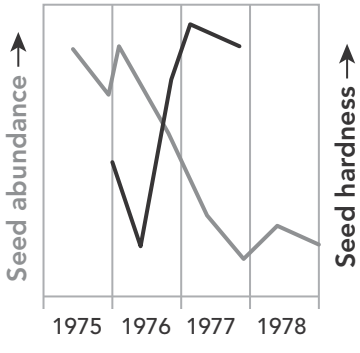
A Testable Hypothesis Darwin had observed that different Galápagos finch species have beaks of different sizes and shapes. He hypothesized that natural selection shaped the beaks of different populations as they adapted to eat different foods. The Grants realized this hypothesis rested on two testable assumptions. First, in order for beak size and shape to evolve, there must be heritable variation in those traits. Second, if the beak differences were involved in natural selection, birds with different beak sizes and shapes should show differential survival and reproduction.

Natural Selection The Grants found a lot of heritable variation in beak size and shape in finch populations. During their study, a severe drought occurred. Plants produced fewer seeds. As the drought continued, birds ate the smaller and softer seeds first. Over time, only the largest and hardest seeds remained. Many birds starved and the finch population decreased. The Grants showed that birds with the largest beaks were more likely to survive, which gave them higher evolutionary fitness. The drought caused the average beak size in this finch population to change greatly in a few years. If the finch population did not have enough variation for natural selection to operate, they would not have been able to adapt and change.

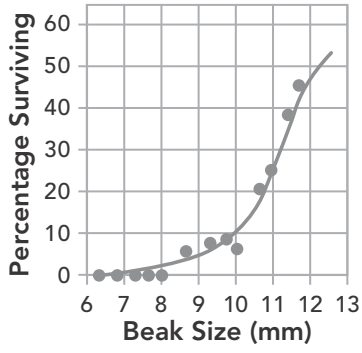
Evolutionary Theory Evolves Many scientific discoveries have confirmed and expanded Darwin's hypotheses. Like any scientific theory, evolutionary theory is reviewed as new data are collected. Any questions that remain are about *how* evolution works, not *whether* evolution occurs.

Visual Reading Tool: Data from the Galápagos

Seed Abundance and Hardness



Bird Survival Based on Beak Size



1. What caused seed abundance to decrease from 1975 to 1978? _____
2. What do you think the effect of the decrease in seed abundance was? _____
3. What is the connection between the change in seed hardness and the characteristic in the second graph? _____

17 Chapter Review

Review Vocabulary

Choose the letter of the best answer.

1. An inherited structure that has lost much of its original function is called a/an

- ☐ A. fossil.
- ☐ B. adaptation.
- ☐ C. vestigial structure.
- ☐ D. analogous structure.

2. The study of past and present distribution of organisms is called

- ☐ A. evolution.
- ☐ B. adaptation.
- ☐ C. fossils.
- ☐ D. biogeography.

Match the vocabulary term to its definition.

3. _____	process by which organisms survive and reproduce	a. analogous structures
4. _____	body parts similar in structure in different species	b. homologous structures
5. _____	body parts similar in function but not in structure	c. adaptation
6. _____	heritable characteristic that increases fitness	d. natural selection

Review Key Questions

Provide evidence and details to support your answers.

7. What three patterns of biodiversity did Darwin observe?

8. What are two ways that Lamarck's ideas paved the way for later biologists such as Darwin?

9. Why is heritable variation important for both artificial and natural selection?

10. List three forms of evidence for descent from a common ancestor.

11. How does the work of Peter and Rosemary Grant illustrate natural selection?