

CHAPTER 5 The Evolution of Living Things

SECTION

2

How Does Evolution Happen?

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- Who was Charles Darwin?
- What ideas affected Darwin's thinking?
- What is natural selection?

National Science Education Standards
LS 2a, 2b, 2e, 3d, 5a, 5b

Who Was Charles Darwin?

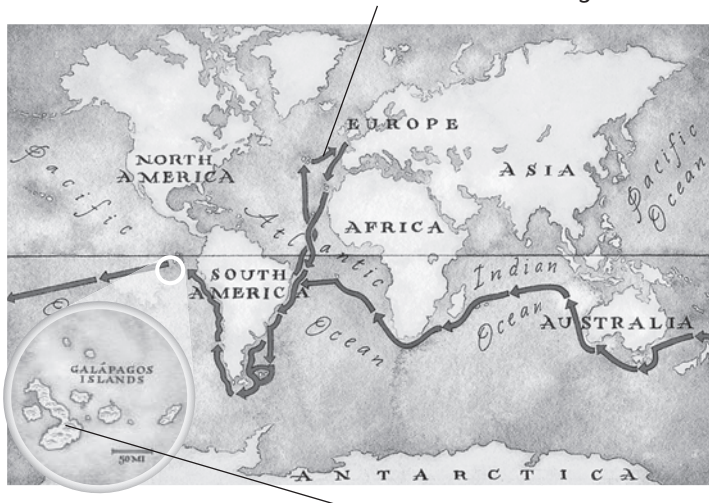
In 1831, Charles Darwin graduated from college. Although he eventually earned a degree in religion, Darwin was most interested in the study of plants and animals.

Darwin's interest in nature led him to sign on for a five-year voyage around the world. He was a naturalist on the HMS *Beagle*, a British ship. A *naturalist* is someone who studies nature. During the trip, Darwin made observations that helped him form a theory about how evolution happens. These ideas caused scientists to change the way they thought about the living world.

DARWIN'S JOURNEY

On the trip, Darwin observed plants and animals from many parts of the world. One place Darwin found interesting was the Galápagos Islands. These islands are located about 1,000 km west of Ecuador, a country in South America. Many unusual organisms live on the Galápagos Islands.

This line shows the course of the HMS *Beagle*.



Darwin studied plants and animals on the Galápagos Islands.

STUDY TIP

Summarize After you read this section, make a chart showing the four steps of natural selection. In the chart, explain what happens at each step.

Math Focus

1. Convert About how far are the Galápagos Islands from Ecuador in miles?
1 km = 0.62 mi

TAKE A LOOK

2. Describe Which continent are the Galápagos Islands closest to?

SECTION 2 How Does Evolution Happen? *continued*

DARWIN'S FINCHES

Darwin observed that the animals and plants on the Galápagos Islands were similar to those in Ecuador. However, they were not identical. For example, Darwin closely observed birds called finches. The finches on the Galápagos Islands were slightly different from the finches in Ecuador. In addition, the finches on each island in the Galápagos differed from the finches on the other islands. ✓

Darwin hypothesized that the island finches were descendents of South American finches. He thought the first finches on the islands were blown there from South America by a storm. He suggested that over many generations, the finch populations evolved adaptations that helped them survive in the different island environments. For example, the beaks of different finch species are adapted to the kind of food the species eat.

READING CHECK

3. Describe What did Darwin observe about the finches on the Galápagos Islands?



The large ground finch has a wide, strong beak. It can easily crack open large, hard seeds. Its beak works like a nutcracker.



The cactus finch has a tough beak. It uses its beak to eat cactus parts and insects. Its beak works like a pair of needle-nose pliers.



The warbler finch has a small, narrow beak. It can catch small insects with its beak. Its beak works like a pair of tweezers.

Critical Thinking

4. Infer What can you guess about the environment in which the cactus finch lives based on the information in the figure? Explain your answer.

SECTION 2 How Does Evolution Happen? *continued*

How Did Darwin Develop the Theory of Evolution by Natural Selection?

After Darwin returned to England, he spent many years thinking about his experiences on the trip. In 1859, Darwin published a famous book called *On the Origin of Species by Means of Natural Selection*. In his book, Darwin proposed the theory that evolution happens by natural selection.

Natural selection happens when organisms that are well adapted to their environment survive, but less well-adapted organisms do not. When the better-adapted organisms reproduce, they pass their useful traits on to their offspring. Over time, more members of the population have these traits. Darwin combined ideas about breeding, population, and Earth’s history to come up with a theory to explain his observations. ✓

IDEAS ABOUT BREEDING

In Darwin’s time, farmers and breeders had produced many kinds of farm animals and plants. They learned that if they bred plants or animals that had a desirable trait, some of the offspring might have the trait. A **trait** is a form of an inherited characteristic. The practice in which humans select plants or animals for breeding based on desired traits is called **selective breeding**.

Selective breeding showed Darwin that the traits of organisms can change and that certain traits can spread through populations. For example, most pets, such as the dogs below, have been bred for a variety of desired traits. Over the past 12,000 years, people have selectively bred dogs to produce more than 150 breeds. ✓



People have selectively bred dogs for different traits. Today, there are over 150 dog breeds.

✓ **READING CHECK**

5. Define What is natural selection?

✓ **READING CHECK**

6. Explain How did ideas about selective breeding affect Darwin’s thinking about evolution?

SECTION 2 How Does Evolution Happen? *continued*

IDEAS ABOUT POPULATION

During Darwin’s time, a scientist named Thomas Malthus was studying human populations. He observed that there were more babies being born than there were people dying. He thought that the human population could grow more rapidly than food supplies could grow. This would result in a worldwide food shortage. Malthus also pointed out that the size of human populations is limited by problems such as starvation and disease. ✓

Darwin realized that Malthus’s ideas can apply to all species, not just humans. He knew that any species can produce many offspring. He also knew starvation, disease, competition, and predation limited the populations of all species. Only a limited number of individuals live long enough to reproduce.

Darwin reasoned that the survivors had traits that helped them survive in their environment. He also thought that the survivors would pass on some of their traits to their offspring.

IDEAS ABOUT EARTH’S HISTORY

New information about Earth’s history also affected Darwin’s ideas about evolution. During Darwin’s time, most geologists thought that Earth was very young. But important books, such as *Principles of Geology* by Charles Lyell, were changing ideas about the Earth. Lyell’s book gave evidence that Earth is much older than anyone once thought. ✓

Darwin thought that evolution happens slowly. Darwin reasoned that if Earth was very old, there would be enough time for organisms to change slowly.

READING CHECK

7. Identify According to Thomas Malthus, what are two things that can limit the size of human populations?

READING CHECK

8. Explain How did Charles Lyell’s book change how scientists thought about Earth’s history?

TAKE A LOOK

9. Describe Fill in the blank spaces in the table.

Idea	How it contributed to Darwin’s theory
Selective breeding	
	helped Darwin realize that not all of an organism’s offspring will survive to reproduce
	helped Darwin realize that slow changes can produce large differences over a long period of time

SECTION 2 How Does Evolution Happen? *continued*

HOW NATURAL SELECTION WORKS

Natural selection has four steps: *overproduction*, *inherited variation*, *struggle to survive*, and *successful reproduction*.



1 Overproduction A tarantula's egg sac can hold 500 to 1,000 eggs. Some of the eggs will survive and develop into adult spiders. Some will not.



2 Inherited Variation Every individual has its own combination of traits. Each tarantula is similar, but not identical, to its parents.



3 Struggle to Survive Some tarantulas may have traits that make it more likely that they will survive. For example, a tarantula may be better able to fight off predators, such as this wasp.



4 Successful Reproduction The tarantulas that are best adapted to their environment are likely to survive and reproduce. Their offspring may inherit the traits that help them to survive.

 **Say It**

Give Examples The figure shows one example of how the four steps of natural selection can work. In a group, talk about three or more other examples of how natural selection can affect populations.

TAKE A LOOK

10. Identify Why are some tarantulas more likely to survive than others?

GENETICS AND EVOLUTION

Darwin knew that organisms inherit traits, but not how they inherit traits. He also knew that there is great variation among organisms, but not how that variation happens. Today, scientists know that genes determine the traits of an organism. These genes are exchanged and passed on from parent to offspring.

Section 2 Review

NSES LS 2a, 2b, 2e, 3d, 5a, 5b

SECTION VOCABULARY

natural selection the process by which individuals that are better adapted to their environment survive and reproduce more successfully than less well adapted individuals do; a theory to explain the mechanism of evolution

selective breeding the human practice of breeding animals or plants that have certain desired traits

trait a genetically determined characteristic

1. Explain How did the ideas in Charles Lyell’s book affect Darwin’s thinking about evolution?

2. Identify In what way are the different finch species of the Galápagos Islands adapted to the different environments on the islands?

3. Compare How is natural selection different from selective breeding?

4. Describe How did Darwin apply Malthus’s ideas about human populations to the theory of evolution by natural selection?

5. List What are the four steps of natural selection?

- evidence in criminal cases, determining whether two people are related

Chapter 5 The Evolution of Living Things

SECTION 1 CHANGE OVER TIME

- Its bright colors warn predators that it is poisonous, so it is less likely to be eaten.
- Possible answer: hiding when predators are nearby
- the process in which populations change over time
- Some fossils are the actual remains of organisms. Others are signs that an organism existed.
- Either fossil is acceptable as an answer. The trilobite is similar to modern crustaceans. The fern is similar to modern ferns.
- Fossils from different organisms are found in rocks of different ages.
- Similar bones in each image should be the same color, with a different color for each type of bone.
- These chemicals are not preserved in fossils.
- Modern whales are mammals, not fish.
- Modern whales have no back legs, and they cannot live on land. Both have front limbs and are or were mammals.
- Fossils or bones of each species share some traits with fossils of earlier species.
- hippopotamuses
- camels and llamas

Review

- Similar bones are found in the arms of humans and the wings of bats. The similarities in forelimb bones suggest that humans and bats had a common ancestor.
- From top to bottom: orangutans, chimpanzees, humans, gorillas
- Species A is probably most closely related to species B, because their DNA is most similar.

SECTION 2 HOW DOES EVOLUTION HAPPEN?

- about 600 mi
- South America

- They were similar to, but not exactly like, the finches in Ecuador. The finches on each island were different from those on other islands.
- The cactus finch is adapted to eating cacti. Therefore, it probably lives in a dry, desert-like environment where cacti can grow.
- the process in which well-adapted organisms survive and pass on their traits, but less well-adapted organisms do not
- They helped Darwin realize that the traits of organisms can change and that traits can spread through populations.
- starvation and disease
- It gave evidence that Earth is much older than scientists had previously thought.
- Selective breeding: helped Darwin realize that traits of organisms can change with time and that traits can spread through populations; Malthus's ideas on population growth: helped Darwin realize that not all of an organism's offspring will survive to reproduce; Earth is very old: helped Darwin realize that slow changes can produce large differences over a long period of time
- They have traits that help them avoid dying.

Review

- Lyell's book gave evidence that Earth is very old. Because Earth is very old, there has been enough time for organisms to change slowly over time.
- The finches have differently shaped beaks based on the type of food they primarily eat.
- During natural selection, certain individuals survive because they have traits that give them a survival advantage over other individuals. During selective breeding, people breed individuals for traits that people find appealing or useful, even if the traits have no particular survival advantage.
- Darwin realized that Malthus's ideas apply to all species. Most individuals produce more offspring than can survive. The size of a population is limited by the availability of resources, starvation, disease, and predation.
- overproduction, inherited variation, struggle to survive, successful reproduction

SECTION 3 NATURAL SELECTION IN ACTION

- People hunt tusked elephants.
- something that kills insects
- They would all die.