

KEY IDEAS

As you read this section, keep these questions in mind:

- Why is evolutionary theory associated with Charles Darwin?
- How was Darwin influenced by his personal experiences?
- How was Darwin influenced by the ideas of others?

How Did Darwin’s Experiences Influence His Ideas About Evolution?

Evolution is the process by which species change over time. Modern evolutionary theory began when Charles Darwin presented evidence that evolution happens and gave an explanation of how it happens.

THE VOYAGE OF THE BEAGLE

In the 1830s, Darwin took a global voyage on a ship called the *Beagle*. This voyage inspired many of his ideas. During the voyage, Darwin collected many natural objects, including nine species of finches in the Galápagos Islands. The birds were very similar, but their beaks differed in size and shape. He also noted that many of the islands’ plant and animal species were similar to species in South America.



Each finch has a beak that is suited to the food it eats.

Darwin proposed that the finch species descended from a single South American species. The descendants became modified, or changed, over time to survive on different foods. Darwin called such a change *descent with modification*. This idea was a key part of his theory. ✓

After he returned from his voyage, Darwin studied his data for years. He did not report his ideas about evolution right away. Instead, he took time to gather more data and to form a good explanation for how evolution happens.

READING TOOLBOX

Underline As you read, underline the descriptions of experiences and ideas that influenced Darwin.

Background

Recall that in science, a *theory* is a broad explanation that has been scientifically tested and supported repeatedly.

Talk About It

Hypothesize How do you think the foods eaten by the small-beaked finch and the large-beaked finch differ? What kinds of foods do you think the different finches eat? With a partner, discuss how the beaks of the different finch species help them eat different foods.

READING CHECK

1. Explain According to Darwin, why did the different populations of finches become modified over time?

SECTION 1 Developing a Theory *continued*

Critical Thinking

2. Infer Why is it important for breeders to select traits that are inherited?

ARTIFICIAL SELECTION

Later in his life, Darwin became interested in breeding exotic pigeons. He noted that breeders take advantage of natural variation within a species. Breeders identify traits in each generation that they prefer. For example, a dog breeder may prefer a dog with thicker fur or longer legs. If these traits can be inherited, breeders can simply select individuals that have the traits. Darwin called this process **artificial selection**.

How Did the Ideas of Others Influence Darwin?

Most people in Darwin’s time thought that species stayed the same forever. However, some scientists proposed ways that species may change over time. Darwin was influenced by ideas from the fields of natural history, economics, and geology.

LOOKING CLOSER

3. List Identify three fields of study that influenced Darwin’s ideas.

4. Identify How was the work of Hutton and Lyell important to Darwin’s theory?

Individuals and Ideas that Influenced Darwin		
Individual(s) and field	Major ideas	Importance to Darwin’s theory
Jean Baptiste Lamarck (natural history)	<ul style="list-style-type: none"> proposed that organisms change over time as they adapt to changing environments thought (incorrectly) that changes due to use or disuse of a trait would be passed on to offspring 	suggested that inheritance plays a role in evolution
Thomas Malthus (economics)	<ul style="list-style-type: none"> noted that the human population was growing faster than the food supply predicted that limited resources would cause deaths from disease, war, or famine 	Darwin proposed that all populations, not just human populations, are limited by their environments.
Georges Cuvier (geology)	argued that fossils in rock layers showed: <ul style="list-style-type: none"> differences in species over time that species from the past differed from those of the present 	showed that species change over time
James Hutton and Charles Lyell (geology)	thought that geologic processes, such as those that form rocks and fossils, work gradually and constantly	showed that Earth’s history was long enough for species to have evolved gradually

Section 1 Review

SECTION VOCABULARY

artificial selection the human practice of breeding animals or plants that have certain desired traits	evolution generally, in biology, the process of change by which new species develop from preexisting species over time; at the genetic level, the process in which inherited characteristics within populations change over time; the process defined by Darwin as “descent with modification”
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1. Describe What were Darwin’s two major contributions to modern evolutionary theory?

2. Identify How did Darwin explain the similarities among finches in the Galápagos Islands and in South America?

3. Define What is *descent with modification*?

4. Infer How does artificial selection provide evidence that species can change over time?

5. Identify What idea did Lamarck and Darwin share?

6. Describe What evidence from fossils and rock layers influenced Darwin’s ideas?

7. Identify What idea of Malthus did Darwin extend to all populations?

KEY IDEAS

As you read this section, keep these questions in mind:

- What does Darwin's theory predict?
- Why are Darwin's ideas now widely accepted?
- What were the strengths and weaknesses of Darwin's ideas?

READING TOOLBOX

Underline As you read this section, underline the answers to the Key Ideas questions.

READING CHECK

1. Define What is an adaptation?

READING CHECK

2. Identify What mechanism for evolution did Darwin propose?

LOOKING CLOSER

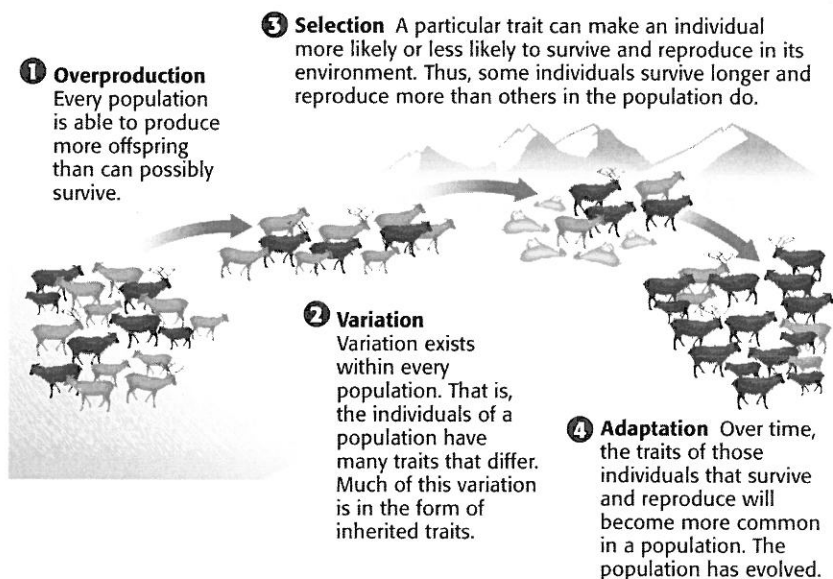
3. Explain What happens to traits that help individuals survive and reproduce in their environment?

What Is Natural Selection?

Darwin noted that individuals with particular traits are more likely to survive in their environments. He also noted that individuals with these traits tend to produce more offspring than those without the traits do. A trait that helps individuals survive and reproduce in a given environment is called an **adaptation**. Differences in ability to survive and reproduce are part of the process of **natural selection**. ✓

Darwin proposed that natural selection is a cause of evolution. Evolution is a change in inherited characteristics in a population from one generation to the next. Darwin's explanation is commonly called *the theory of evolution by natural selection*. His theory predicts that, over time, the number of individuals with beneficial traits will increase in a population. ✓

The Theory of Evolution by Natural Selection



SECTION 2 Applying Darwin's Ideas *continued*

What Does Darwin's Theory Explain?

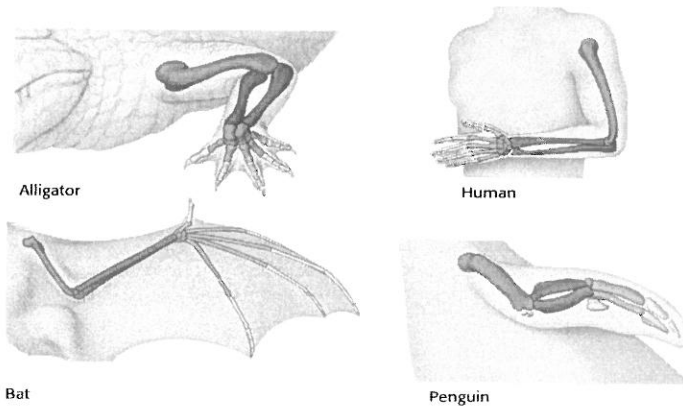
In his book *On the Origin of Species by Means of Natural Selection*, Darwin presented evidence that evolution happens. He also presented a logical explanation for how evolution happens. Darwin's ideas are widely accepted today because large amounts of evidence continue to support them. ✓

THE FOSSIL RECORD

Fossils are traces of organisms that have lived in the past. The *fossil record* is made up of all the fossils known to science. Darwin noticed patterns in the fossil record that suggested that species change over time. However, he also knew that the pattern had gaps. The conditions that create fossils are rare. Thus, we will never find fossils of every species that ever lived. The fossil record will grow but will never be complete. ✓

ANATOMY

Scientists can compare the internal structures, or *anatomy*, of different species to see the results of evolution. Evolution explains the similarities in internal structures. Similar internal structures are evidence of how species are related. Structures that are similar in two or more species and were inherited from a common ancestor are called **homologous** structures.



Although they look very different from one another on the outside, the forelimbs of these four vertebrates have very similar groups of bones. This suggests that all vertebrates descended from a common ancestor.

✓ **READING CHECK**

4. Explain Why are Darwin's ideas widely accepted today?

✓ **READING CHECK**

5. Identify For Darwin, what evidence for evolution does the fossil record provide?

LOOKING CLOSER

6. Identify What do the similarities in the forelimb structures of these vertebrates suggest?

SECTION 2 Applying Darwin's Ideas *continued*

Critical Thinking

7. Apply Concepts Why is Darwin's explanation of evolution a *theory* and not a *hypothesis*?

BIOGEOGRAPHY

Biogeography is the study of the locations of organisms around the world. Darwin noticed similarities in three species of large birds: the rhea in South America, the ostrich in Africa, and the emu in Australia. These species are similar in size, shape, eating habits, and habitats. Darwin's observation was evidence that similar environments shape the evolution of organisms in similar ways.

Sometimes geography separates populations. For example, a population may split into two groups that live on two different islands. Over time, the two groups may evolve in different ways.

DEVELOPMENTAL BIOLOGY

Scientists may compare the development of embryos of different species to look for similar patterns and structures. For example, scientists have found that all vertebrate embryos have tails at some time in their development. This similarity most likely comes from an ancestor that vertebrate species share.

BIOCHEMISTRY

A comparison of DNA or amino-acid sequences shows that some species are more genetically similar than others. Organisms with similar sequences are more closely related than are organisms with more differences in their sequences.

Critical Thinking

8. Apply Concepts Horses share a larger percentage of their genes with dogs than with earthworms. What does this suggest?

What Are the Strengths of Darwin's Theory?

Darwin's ideas are widely accepted because of their strengths:

- His work is supported by, and helps explain, a large amount of data.
- He developed a logical and testable mechanism—natural selection—to explain the process of evolution.
- He showed that variation could serve as a starting point for evolution.

There was only one major weakness in Darwin's theory. Inherited variation was important to the theory of natural selection. However, because he knew little about genetics, Darwin could not propose a clear mechanism for inheritance.

Section 2 Review

SECTION VOCABULARY

<p>adaptation the process of becoming adapted to an environment; an anatomical, physiological, or behavioral change that improves a population's ability to survive</p> <p>fossil the trace or remains of an organism that lived long ago, most commonly preserved in sedimentary rock</p>	<p>homologous describes a character that is shared by a group of species because it is inherited from a common ancestor</p> <p>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</p>
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1. **Identify** What does Darwin's theory of evolution by natural selection predict?

2. **List** What are the four steps of Darwin's theory of evolution?

3. **Summarize** Complete the table below to summarize how evidence supports Darwin's theory of evolution.

Source of evidence	What the evidence indicates
Fossil record	
Anatomy	
Biogeography	
Developmental biology	Species with embryos that show similar patterns of development probably share a common ancestor.
Biochemistry	

4. **Identify** What are three major strengths of Darwin's theory of evolution by natural selection?
