

# 15-1 The Puzzle of Life's Diversity



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**Evolution** is the process by which modern organisms have descended from ancient organisms.

A scientific **theory** is a well-supported testable explanation of phenomena that have occurred in the natural world.

## Voyage of the *Beagle*

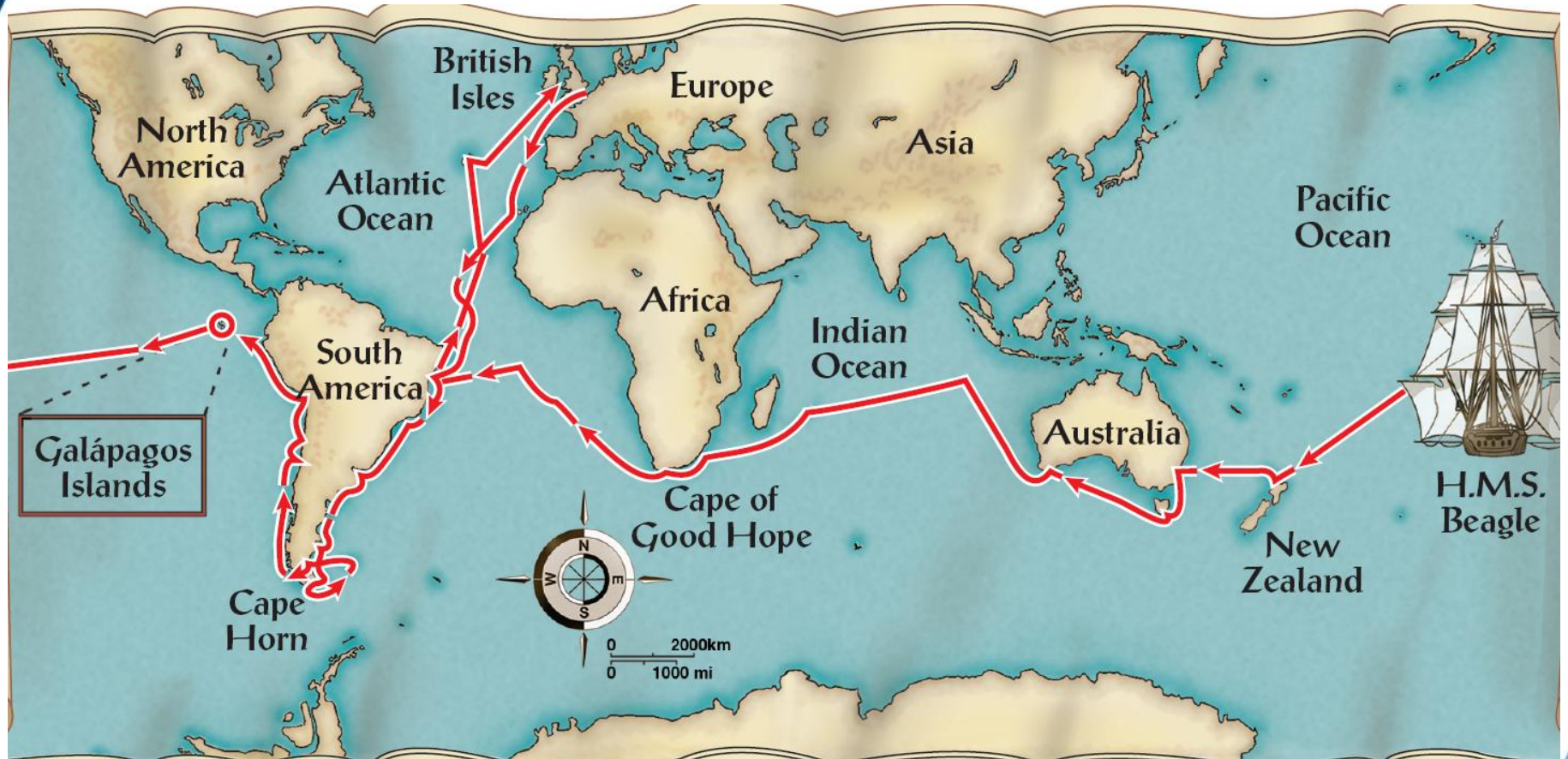
In 1831, Darwin set sail from England aboard the H.M.S. *Beagle* for a voyage around the world.

Darwin went ashore and collected plant and animal specimens for his collection.

He studied the specimens, read the latest scientific books, and filled many notebooks with his observations and thoughts.



# 15-1 The Puzzle of Life's Diversity → Voyage of the *Beagle*





**What was Charles Darwin's contribution to science?**



**During his travels, Darwin made numerous observations and collected evidence that led him to propose a hypothesis about the way life changes over time.**

That hypothesis has become the theory of evolution.

## Darwin's Observations

Darwin observed that many plants and animals were well suited to the environments they inhabited.

He was impressed by the ways in which organisms survived and produced offspring.

## 15-1 The Puzzle of Life's Diversity → Darwin's Observations

Darwin was puzzled by where different species lived and did not live.

Grasslands in some regions were similar to one another but were inhabited by very different animals.



## Living Organisms and Fossils

Darwin collected the preserved remains of ancient organisms, called **fossils**.

Some of those fossils resembled organisms that were still alive.

Others looked completely unlike any creature he had ever seen.

## The Galápagos Islands

Darwin observed that the Galápagos Islands were close together but had very different climates.

# The Journey Home



**What pattern did Darwin observe among organisms of the Galápagos Islands?**



**Darwin observed that the characteristics of many animals and plants varied noticeably among the different islands of the Galápagos.**

Darwin wondered if animals living on different islands had once been members of the same species.

These separate species would have evolved from an original South American ancestor species.



# 15-1 Section QUIZ

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## 15-1 Section QUIZ

**1** Darwin's observations in the Galápagos Islands included all of the following EXCEPT

- A**
- a. characteristics of many living organisms did not vary among the different Galápagos Islands.
  - b. many plants and animals were well suited to their environments.
  - c. very different animals inhabited many similar ecosystems.
  - d. though close together, the islands had very different climates.

**2** What did Darwin learn about the tortoises of the Galápagos Islands?

- a. Tortoises with dome-shaped shells were found on all of the islands.
- b. The tortoises resembled fossil remains that were found on the islands.

**A** c. The shape of the Galápagos tortoise shells varied with their different habitats.

- d. Different shaped tortoise shells occupied the same habitats.

## 15-1 Section QUIZ

**3** According to Darwin's proposed theory of evolution, species of organisms

- A** a. change over time.
- b. are not related to fossil remains.
- c. do not vary from one location to another.
- d. remain unchanged when the environment changes.

## 15-1 Section QUIZ

**4** Darwin hypothesized that different-looking mockingbirds from different islands might be descendants of birds that

a. belonged to a single species that had originated on the islands.

**A** b. belonged to a single species from the South American mainland.

c. belonged to a different species from similar habitats in South America.

d. had been brought to the islands by earlier visitors.



## 15-1 Section QUIZ

**5** What role did the evidence gathered by Darwin play in developing his ideas?

- a. It immediately gave him the idea that organisms evolved.
- b. It confirmed evolution—an idea he had before he left England.
- c. It confirmed evolution, which he proved on his arrival in the Galápagos.

**A** d. It led to considering the possibility of evolution only after he was heading home.

## Publication of *On the Origin of Species*

Darwin filled notebooks with his ideas about species diversity and the evolution process.

Darwin was stunned and disturbed by his discoveries.

He shelved his manuscript for years and told his wife to publish it in case he died.

In 1858, Darwin received a short essay from naturalist Alfred Wallace.

The essay summarized Darwin's thoughts on evolutionary change.

Later that year, Wallace's essay was presented with some of Darwin's work.

In 1859, Darwin published his book, *On the Origin of Species*.

In his book, Darwin:

- proposed a mechanism for evolution called natural selection.
- presented evidence that evolution has been taking place for millions of years—and continues in all living things.

## Inherited Variation and Artificial Selection

Members of each species vary from one another in important ways.

In Darwin's day, variations were thought to be unimportant, minor defects.

Darwin argued that this variation mattered.



Darwin noted that plant and animal breeders would breed only the largest hogs, the fastest horses, or the cows that produced the most milk.

Darwin termed this process **artificial selection**.



**How is natural variation used in artificial selection?**

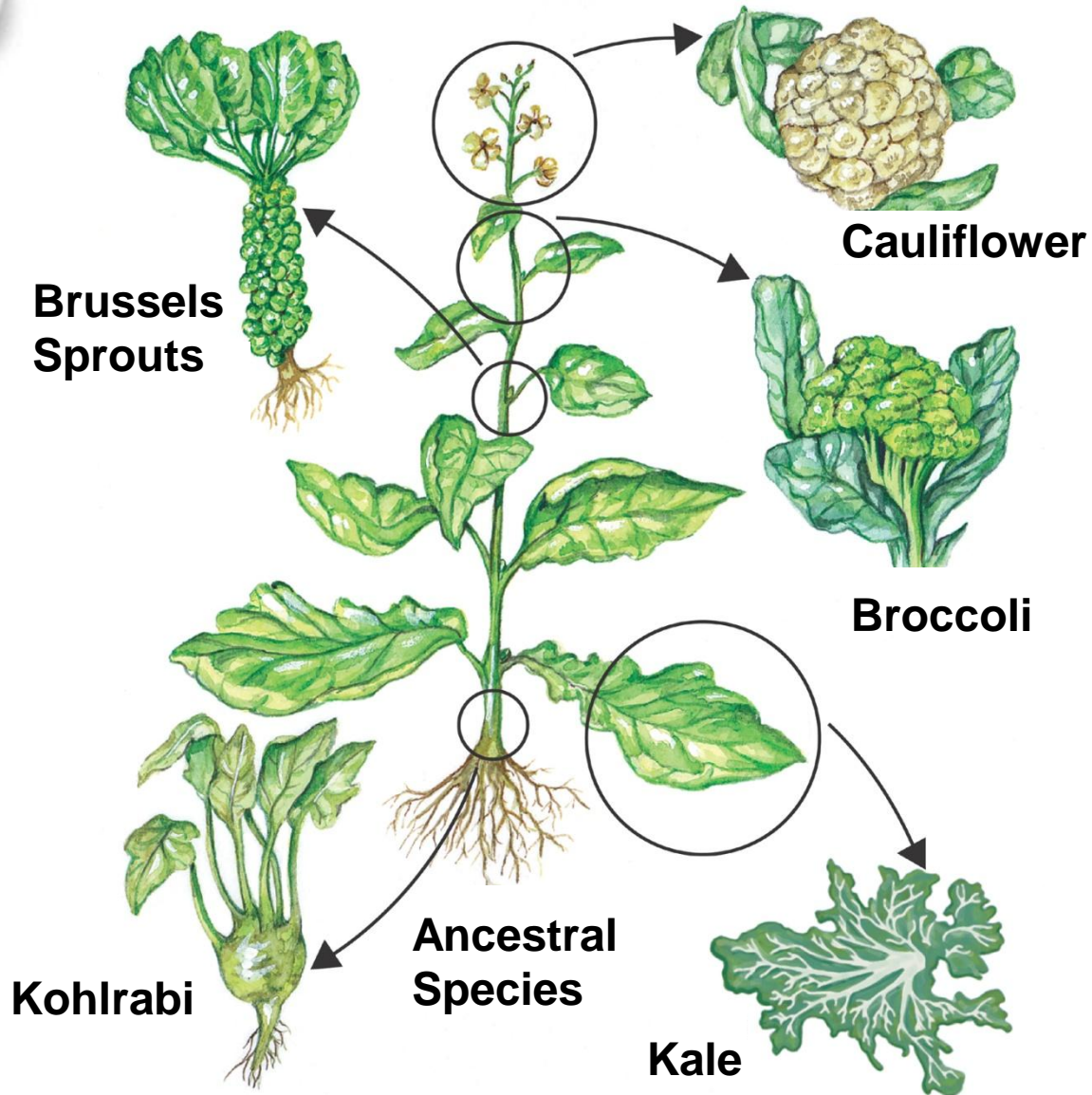


**Artificial selection is the selection by humans for breeding of useful traits from the natural variation among different organisms.**

# 15-3 Darwin Presents His Case → Inherited Variation and Artificial Selection

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# Evolution by Natural Selection

Darwin compared processes in nature to artificial selection.

By doing so, he developed a scientific hypothesis to explain how evolution occurs.

## The Struggle for Existence

Darwin realized that high birth rates and a shortage of life's basic needs would force organisms to compete for resources.

The **struggle for existence** means that members of each species compete regularly to obtain food, living space, and other necessities of life.

The struggle for existence was central to Darwin's theory of evolution.



**How is natural selection related to a species' fitness?**



## Survival of the Fittest

The ability of an individual to survive and reproduce in its specific environment is **fitness**.

Darwin proposed that fitness is the result of adaptations.

An **adaptation** is any inherited characteristic that increases an organism's chance of survival.

Successful adaptations enable organisms to become better suited to their environment and better able to survive and reproduce.

Individuals with characteristics that are not well suited to their environment either die or leave few offspring.

Individuals that are better suited to their environment survive and reproduce most successfully.

Darwin called this process **survival of the fittest**.

Because of its similarities to artificial selection, Darwin referred to the survival of the fittest as **natural selection**.

In natural selection, the traits being selected contribute to an organism's fitness in its environment.



**Over time, natural selection results in changes in the inherited characteristics of a population. These changes increase a species' fitness in its environment.**

## Descent With Modification

Natural selection produces organisms that have different structures, establish different niches, or occupy different habitats.

Each living species has descended, with changes, from other species over time.

Darwin referred to this principle as **descent with modification**.

Descent with modification implies that all living organisms are related to one another.

This is the principle known as **common descent**.



**What evidence of evolution did Darwin present?**



## Evidence of Evolution



**Darwin argued that living things have been evolving on Earth for millions of years. Evidence for this process could be found in the fossil record, the geographical distribution of living species, homologous structures of living organisms, and similarities in early development, or embryology.**

## The Fossil Record

Darwin saw fossils as a record of the history of life on Earth.

By comparing fossils from older rock layers with fossils from younger layers, scientists could document that life on Earth has changed over time.

## Geographic Distribution of Living Species







Darwin decided that all Galápagos finches could have descended with modification from a common mainland ancestor.

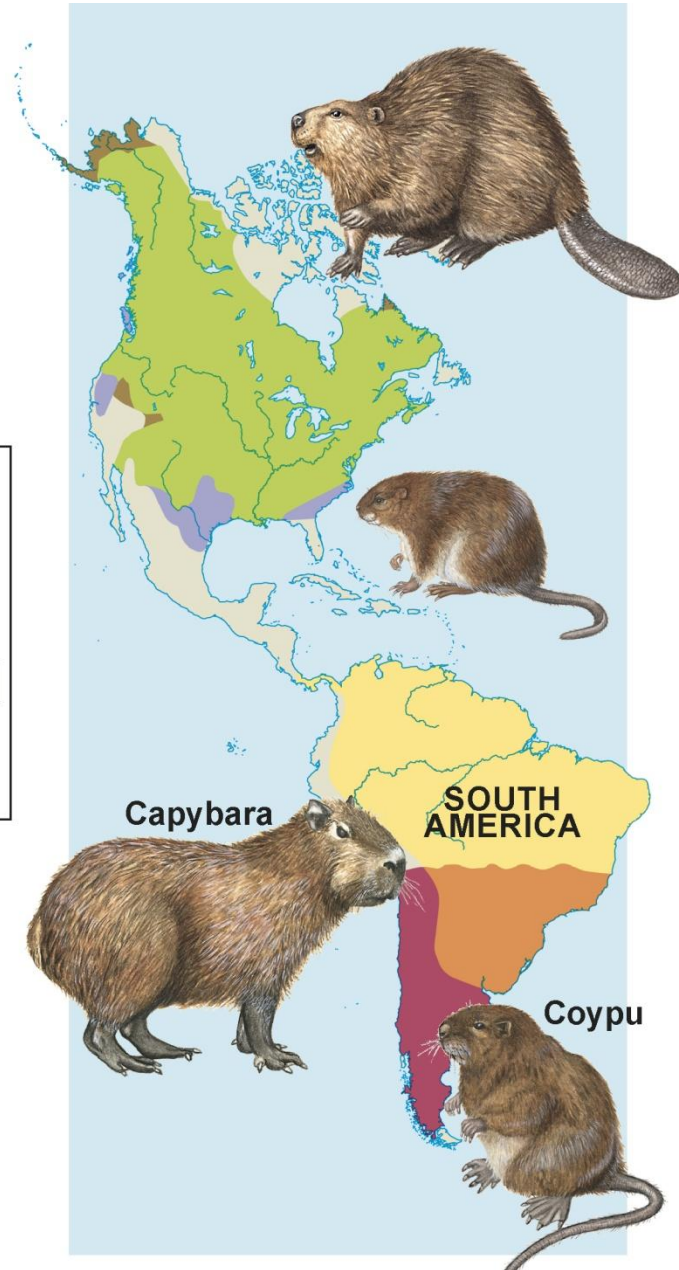
Darwin's theory was that species now living on different continents had each descended from different ancestors.

However, because some animals on each continent were living under similar ecological conditions, they were exposed to similar pressures of natural selection.

Because of these similar selection pressures, different animals ended up evolving certain features in common.

# Similar, But Unrelated Species

	<b>Beaver</b>		<b>Coypu</b>
	<b>Muskrat</b>		<b>Capybara</b>
	<b>Beaver and Muskrat</b>		<b>Coypu and Capybara</b>

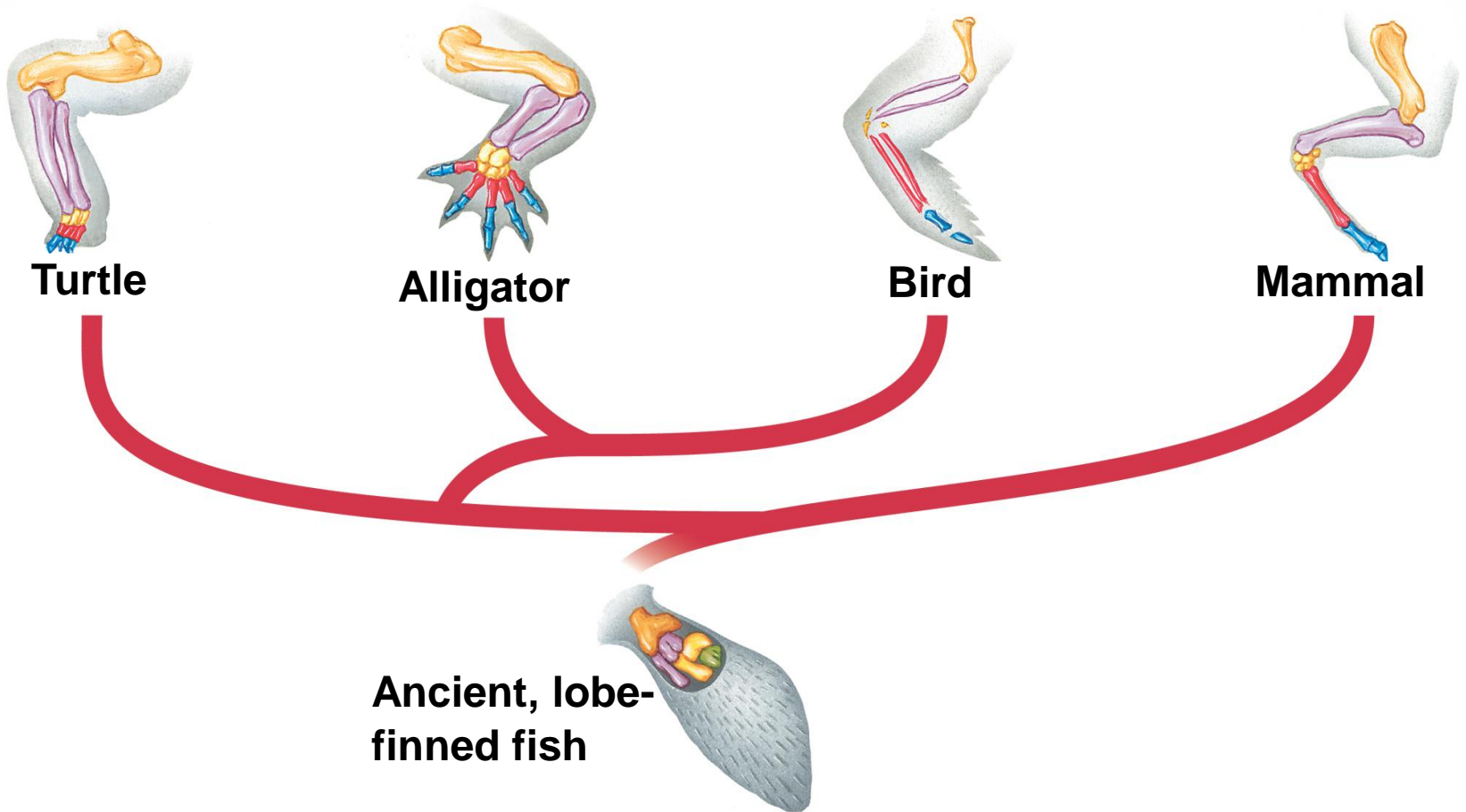


## Homologous Body Structures

Structures that have different mature forms but develop from the same embryonic tissues are called **homologous structures**.

Similarities and differences in homologous structures help biologists group animals according to how recently they last shared a common ancestor.

# Homologous Structures



Not all homologous structures serve important functions.

The organs of many animals are so reduced in size that they are just vestiges, or traces, of homologous organs in other species.

These organs are called **vestigial organs**.



## Similarities in Embryology

The early stages, or embryos, of many animals with backbones are very similar.

The same groups of embryonic cells develop in the same order and in similar patterns to produce the tissues and organs of all vertebrates.

## Summary of Darwin's Theory

Individual organisms differ, and some of this variation is heritable.

Organisms produce more offspring than can survive, and many that do survive do not reproduce.

Because more organisms are produced than can survive, they compete for limited resources.

Individuals best suited to their environment survive and reproduce most successfully.

These organisms pass their heritable traits to their offspring. Other individuals die or leave fewer offspring.

This process of natural selection causes species to change over time.

Species alive today are descended with modification from ancestral species that lived in the distant past.

This process, by which diverse species evolved from common ancestors, unites all organisms on Earth into a single tree of life.

# Strengths and Weaknesses of Evolutionary Theory

Scientific advances in many fields of biology, geology, and physics have confirmed and expanded most of Darwin's hypotheses.

Evolutionary theory continues to change as new data are gathered and new ways of thinking arise.

## 15-3 Section QUIZ

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## 15-3 Section QUIZ

**1** The scientist who motivated Darwin to publish *On the Origin of Species* was

- A**
- a. Alfred Russel Wallace.
  - b. Charles Lyell.
  - c. Jean-Baptiste Lamarck.
  - d. Thomas Malthus.

## 15-3 Section QUIZ

**2** Differences among individuals of a single species are referred to as

a. artificial selection.

**A** b. genetic variation.

c. survival of the fittest.

d. environmental adaptation.



## 15-3 Section QUIZ

- 3** Changes that increase a species' fitness in its environment over time are due to
- a. the principle of common descent.
  - b. the geographic distribution of that species.
  - A** c. natural selection.
  - d. habitat selection.

## 15-3 Section QUIZ

**4** An inherited characteristic that increases an organism's chance of survival is called a(an)

- a. homologous structure.
- b. vestigial organ.

**A** c. adaptation.

- d. analogous structure.

## 15-3 Section QUIZ

**5** Evidence used by Darwin to support the idea of evolution included all the following EXCEPT

a. fossils that demonstrate change over time.

**A** b. the genetic mechanism by which useful traits are inherited.

c. the geographic distribution of living things.

d. the presence of many homologous structures in plants and animals.

**END OF SECTION**