

15-3 Darwin Presents His Case

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.

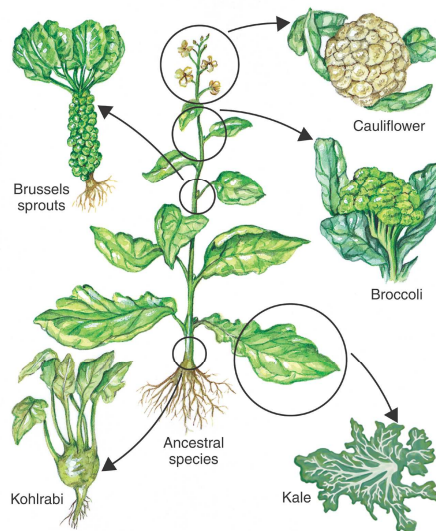
In Darwin's day, variations were thought to be unimportant, minor defects.

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**.

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



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.

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**.

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.

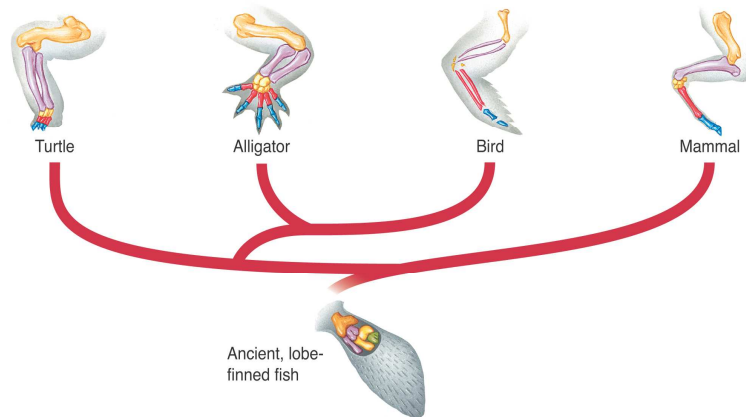
However, because some animals on each continent were living under similar ecological conditions, they were exposed to similar pressures of natural selection.

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

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.



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.

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.