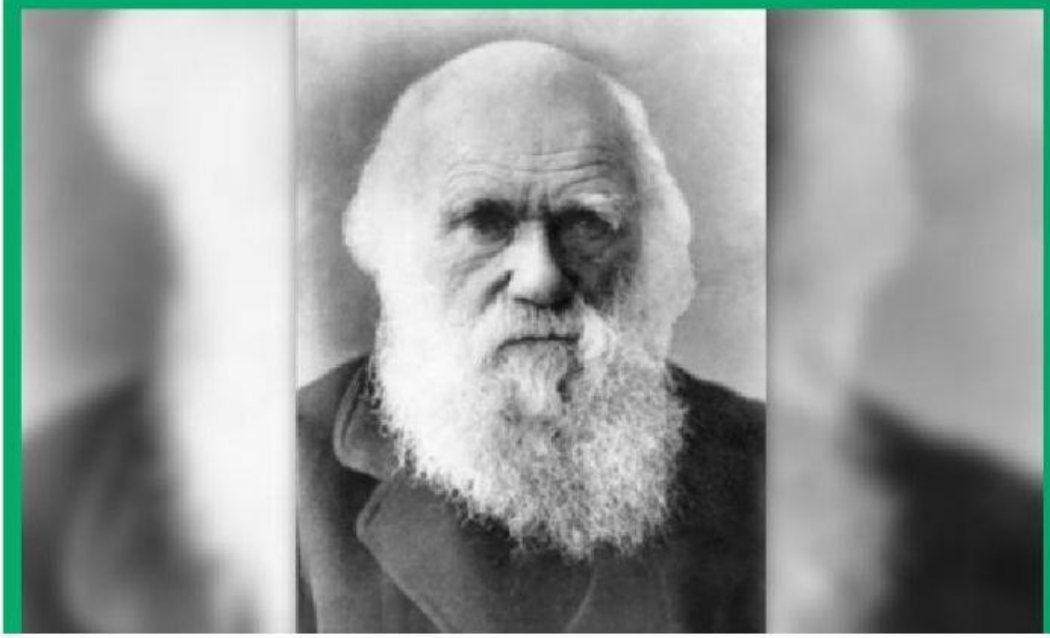
Charles Darwin's Theory of Evolution

Biological knowledge is based on the techniques of observation, comparison, and experimentation to generate theories and findings. Up until the mid-nineteenth century, the first two approaches were the ones most often utilized for scientific analysis.

Charles Darwin, English naturalist (1809–1882), carried out his work in light of these techniques. He was a very observant man, and as such, was able to compare the characteristics of living things and propose processes of adaptation, and to formulate, years later, his theory. His ideas on evolution represented a great advance of the time.

Darwin trained as a naturalist at Cambridge University and studied specimens of European biological diversity. At the age of 22, he was given the opportunity to accompany captain Robert Fitzroy as part of the crew of the ***Beagle***, a ship of the English Royal Navy, whose objective was cartography. On this expedition, Darwin was able to learn much about the biodiversity of the world.



The *Beagle* began its voyage through the Pacific Ocean, reached Tahiti and later Australia, New Zealand, South Africa, Brazil, Argentina, Chile, Patagonia, Tierra del Fuego, and islands of the Pacific, such as the Galápagos Archipelago. This allowed Darwin to compare and describe the diversity of species he observed. The *Beagle* returned to England in 1835 after a five-year voyage through the Southern Hemisphere of the planet.

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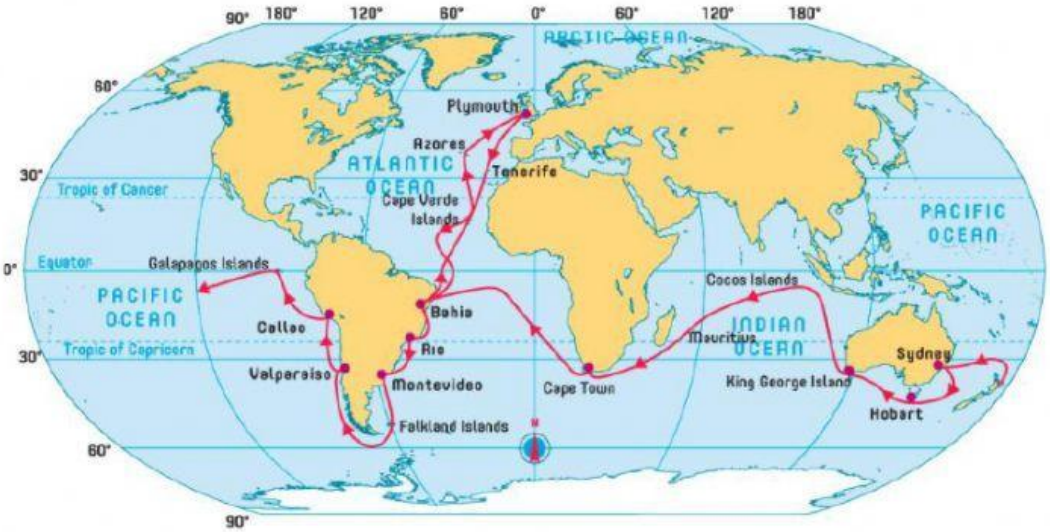
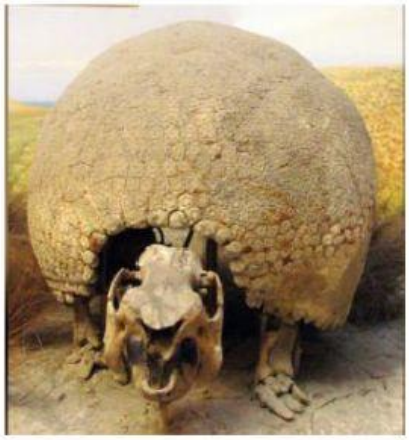


Charles Darwin's voyage on the *Beagle* (1831–1836)

Throughout his journey, Darwin recorded everything he observed while studying rocks and fossils. He also collected plants and animals for identification. The fossils proved that life on Earth had been transformed, but the mechanism for change was still unknown. In Argentina, Darwin discovered fossils of extinct mammals such as the glyptodonts.

Did you know . . . ?

The glyptodont, an herbivorous mammal with a hard shell and long tail, lived more than 10,000 years ago. It measured approximately 3 meters and weighed almost a ton and a half. It is believed the species became extinct along with the mammoth and the giant sloths following the last ice age. It is also thought that humans hunted them to use their shells as a shelter because several cleaned shells have been found.



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When Darwin traveled to South America, he found the fossil of a giant sloth, a toothless mammal with long arms and claws.

The scientist concluded that the giant sloths were from a group that had become extinct and that a smaller species in the same area had survived because it was more agile. This species was also lighter, which helped it to find food and escape from predators. Darwin concluded that since this species had survived, it was able to perpetuate itself.

Accustomed to European latitudes with less biological diversity, Charles Darwin was astonished by the species richness of the Amazon. Over the course of 11 weeks in Brazil, he collected orchids, reptiles, birds, and insects that he sent back to England. In Chile, he found marine fossils on dry land, which reinforced his idea that Earth had changed and was not static. He also visited the Galápagos Islands and was surprised by their biodiversity. In addition, he noticed that the fauna changed from one island to another, even though the climate and geology didn't vary.

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In the Galapagos, Darwin collected many birds called finches that lived on the various islands. He thought the specimens were all the same species, but years later, John Gould (1804–1881), who was dedicated to the study of birds (ornithology), noted that there were 13 species. This prompted Darwin to question the origin of this diversity.

Analyzing the distribution of the 13 species of finches, it was impossible that they had all arrived from the mainland because, for one, the species did not exist in any other location. Darwin concluded that in the past, some finches had flown from the mainland to the islands, and then **speciation** had occurred. This means new species were formed. Later, the finches scattered to other islands where they found different food, and with different beaks (for example, wider and thicker), they were able to secure food more easily.

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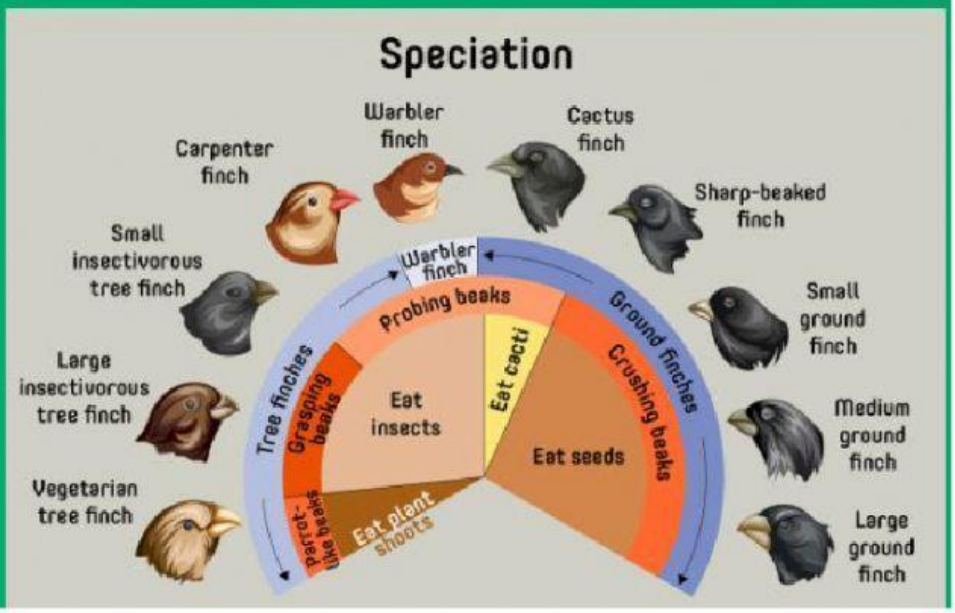
Each species of finch has a beak shape that helps it to feed itself. For example, finches with large, thick, and strong beaks eat hard seeds that they need to break open. Those with long beaks eat insects in the bark of trees, and those with medium-sized beaks eat fruits and seeds of the prickly pear cactus. (This is called a feeding adaptation.) According to the food available on the island, the individuals that could feed themselves survived and reproduced. The finches remained separated on the islands, and became differentiated. Eventually, they could not reproduce with those on the other islands and distinct species were formed.



Darwin worked for more than 30 years, organizing his collections, consulting with specialists, and analyzing his observation in order to explain the diversity that he saw during his voyage on the *Beagle*. He noted the close relationship between organisms and their physical surroundings, and he pointed out that it is the environment that causes the great variety in the plants and animals inhabiting the planet, including the human species.

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Did you know?

In the Galápagos, Darwin observed giant tortoises and noticed that a different species lived on each island. He found variations in the size of the shell. For example, on the higher and more humid islands, the tortoises were larger, with hollow shells and short necks. On the lower and drier islands, they were smaller, with long shells and long necks. Thus, he established an association between feeding habits and anatomical structure.

The different body structures of living things (morphology), not just finches, but also tortoises, iguanas, and other birds of the islands prompted Darwin to question how they had adapted to the environmental conditions.

The differences between wild and domesticated animals also caught the attention of the scientist. He observed that by choosing certain characteristics, a species changed

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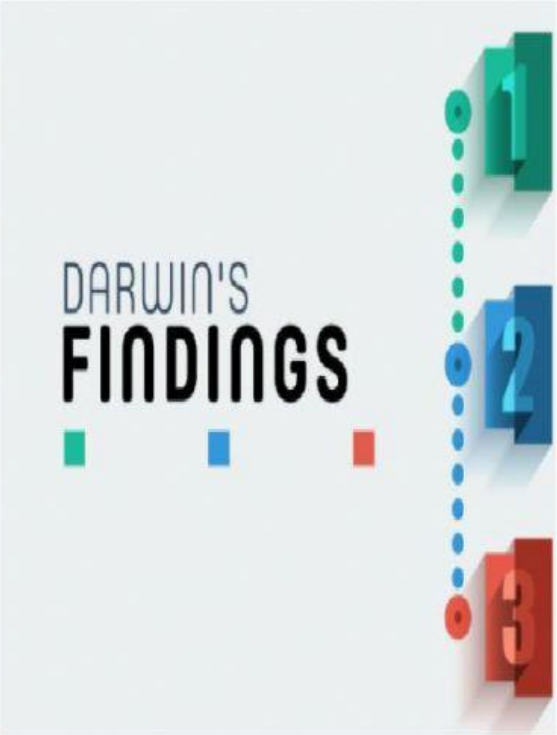
in just a few generations. This process of choice later became known as **artificial selection**.



As conditions vary, such as the amount of food, unlimited reproduction in captivity, or changes in climate, diversification occurs. In this way, a primitive species will vary over generations.

The changes create variations between wild species and domesticated species, such as the thickness of the skin or fur, according to the climate, the size, or the amount of food.

The effects of the behavior and activities of organisms also create variations. This is called variability.

For a long time, it was thought that evolution required millions of years. However, there are examples of short-term evolutionary processes, such as moths in England. Did you know . . . ?

The English moth, *Biston betularia*, lives in birch trees. There are white and dark specimens. Before the Industrial Revolution, the white moth was camouflaged since the bark of the birch tree is white. But with industrialization, soot from factories was deposited on the bark of the trees, making them darker. As a result, the white moths became more visible to predators, which caused a decline in this population.

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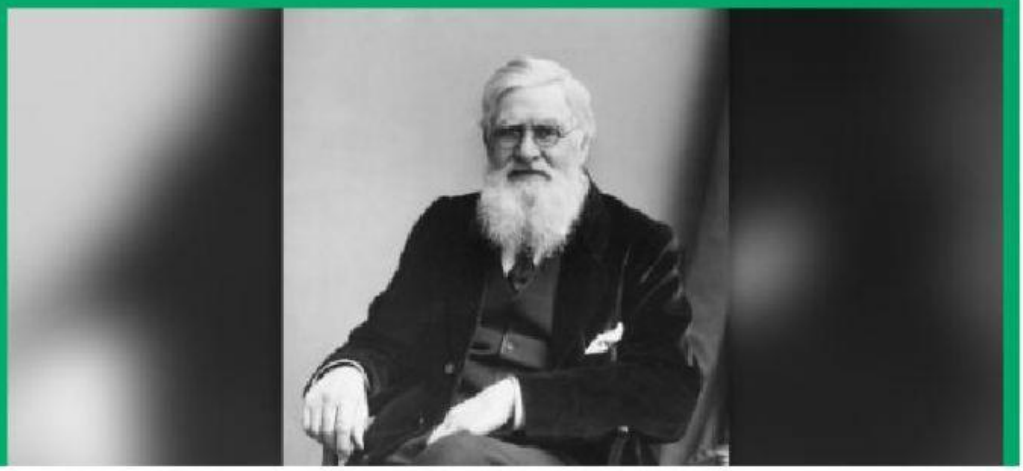
As a result of his observations and analysis, Darwin established that organisms evolved. However, even though he had collected the evidence to prove it, he did not publish his ideas for fear of the negative response.

In 1858, Darwin received a letter from Alfred Russell Wallace, a young Welshman, accompanied by the essay "On the Tendency of Varieties to Depart Indefinitely from the Original Type." In this document, Wallace spoke about how "the life of animals is a fight for survival." In essence, these were the same ideas as Darwin. For this reason, Wallace is said to be the co-creator of the theory of evolution.



Darwin took more than 20 years to finish his book ***The Origin of Species***, which was published in 1859. Such was the impact of the first edition, some 1,250 copies, that it sold out on the very first day. To formulate and scientifically support his evolutionary theory, Darwin based his observations on the variation of species resulting from the breeding of animals and the cultivation of plants. He proposed that the species that survived over time were those that, due to their characteristics, were better adapted to their environment. Those that could not adapt, died. So emerged his theory of **natural selection**. This is the process through which better-adapted organisms have an advantage over those that are more poorly adapted. In this way, there is a gradual accumulation of favorable genetic changes in the population over generations. And when natural selection works over many generations, it can lead to the formation of an entirely new species.

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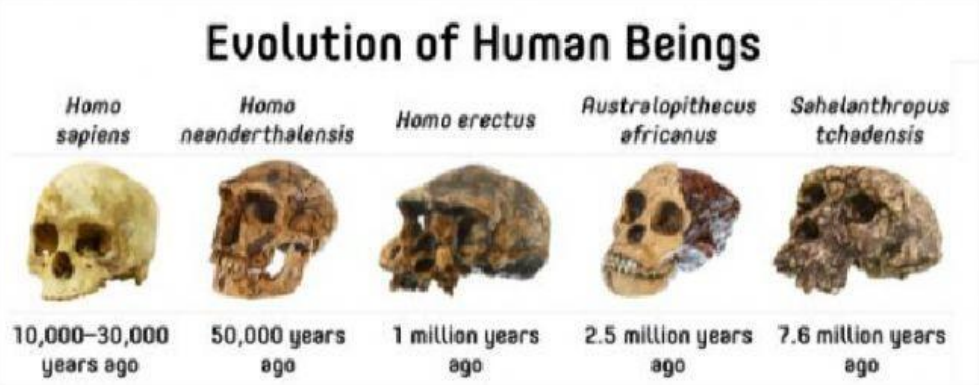
— Know more

Darwin's book transformed thinking because it showed that current species are the result of a long line of historically linked forms, placing ancestral species and their descendants in a **genealogy**. Ancient species give rise to those today.

For humans, genealogy shows that the species *Homo habilis* was the ancestor of the species *Homo erectus*, which was, in turn, the ancestor of both *Homo sapiens* and Homo *neanderthalensis*. The last two are considered sister species.



The first chapter of The Origin of Species deals with variation in domesticated species. With a collection of examples, it describes the characteristics of domesticated animals and plants whose adaptations don't benefit the animal or plant itself, but rather the consumer or buyer. Domestication, also called artificial selection, is the activity closest to the experiments that Darwin developed in order to understand how species change.

Variation in Dogs

The small size and slender build of some varieties of dogs would not serve them if they had to hunt for their food like wolves. However, dogs are animals that live with humans, and so there are smaller breeds that can be carried or easily transported.

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Variation in Ducks

Darwin said that the bones of the wild duck are heavy and strong because it needs to fly to find food and escape its predators. In contrast, the domestic duck does not behave this way and has weaker bones and muscles.

Thanks to this research, it is now understood that the better adapted living things are those that will survive. When they reproduce, they will pass down their characteristics to new generations. In addition, fossils of different living things have shown a series of changes over time. This confirms the theory of biological evolution (the process through which species gradually change and give rise to new species). In general, The Origin of Species presents four postulates.

Postulates of *The Origin of Species*			
1. Forms of life are not static, rather they evolve, and species continually change (there is a variation); while some emerge, others disappear.	2. The process of evolution is gradual, slow, and continual, without jumps or sudden changes; this is called **gradualism**.	3. The organisms that have appeared are related to and descended from a common ancestor. All organisms have a unique origin.	4. In a changing environment, the fittest individuals are selected; variation and the capacity to reproduce come together so that the best adapted survive.

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