

# Evolution and scientists

[Science](#), [Biology](#)



Unit 2 — Evolution Steps Leading Up to Charles Darwin's Theory

¼ Around the world, there is an enormous diversity of life Each species has its own set of characteristics Arctic animals — have characteristics that help them survive in the cold, harsh environment Desert animals — have characteristics that help them survive in the extreme heat

¼ Theory is a set of statements that explains a group of facts or phenomena Tested repeatedly and supported by evidence Can be used to make predictions about natural phenomena

¼ In the 19th Century, Charles Darwin developed a theory Designed to explain: Diversity of life on earth How all organisms are related to one another and to the environment in which they live Sought to explain evolution It is the idea that all species are descendants of ancient species that were different from modern-day species Biological history of life on Earth, from the earliest micro-organisms to the diversity of modern-day organisms Two ideas before Darwin's time Species are fixed/permanent — do not change over time Earth is less than 10 000 years old and also relatively unchanging

Changing Ideas About the Natural World

¼ James Hutton Scottish geologist Proposed that rock formations are being continually formed Molten material is forced up to Earth's surface to form rock Studied the rates of present-day erosion and sedimentation and the thickness of bands of sedimentary rock Concluded that it must have taken millions of years, not thousands, to form the current landscape Supported the theory of uniformitarianism States that Earth was formed by slow-moving processes, such as erosions and sedimentation, and still continues to shape our landscapes

¼ Charles Lyell English geologist Popularized and expended on Hutton's ideas of uniformitarianism in his book Principles of Geology

Found more evidences to support the idea that rock formations were formed by incredibly slow processes that are still at work today

• Georges Cuvier  
French naturalist Compared the bones of modern-day elephants and fossilized mammoths Concluded that the mammoth's skeleton was different enough from an elephants' that mammoths had to be considered a different species and that the mammoth had become extinct

Another example — T. rex

• Jean-Baptiste Lamarck  
French naturalist Recognized that species are not permanent Proposed that species evolve, or change, over time Explained that evolution as a process of adaptation Adaptation is an inherited characteristic that improves an organism's ability to survive and reproduce in a particular environment Also proposed a hypothesis to explain how changes in species happen Realized that organisms were adapted to their environment Had 3 ideas: By using, or not using, certain body parts, an organism develops certain characteristics Ex) giraffes need to reach vegetation high up in the trees • developed long necks These enhanced characteristics would be passed onto the offspring Called this idea "inheritance of acquired characteristics" All organisms have a "tendency towards perfection" Organisms continuously change and acquire features in order to be more successful in their environments

ALTHOUGH IT SEEMED LOGICAL AT THE TIME, OUR KNOWLEDGE OF DNA AND ITS ROLE IN THE INHERITANCE OF TRAITS DOES NOT SUPPORT LAMARCK'S HYPOTHESIS An acquired characteristic would have to somehow change the DNA of particular genes in order to be inherited Nonetheless, he was important in analyzing the role of the environment and explaining evolution as a process of adaptation to the environment

Darwin's Observation

• In 1831, the HMs

Beagle set sail on a voyage around the world As a naturalist, Darwin collected many fossil records and samples around the world His main interest was to study the geology, plants, and animals encountered on the voyage

Patterns in Diversity Species Vary Globally Distantly related species living in similar habitats in different parts of the world looked similar and acted in similar ways Ex) Rheas (S. America) + Emus (Australia) + Ostrich (S. Africa) are all flightless birds living in grasslands Some areas had unique organisms not found anywhere else in the world Ex) Kangaroos and other marsupials are found only in Australia

Species Vary Locally Related animal species that occupied different habitats within a local environment had different features Noticed this on his trip to the Galapagos Islands Ex) tortoises in the Isabela Island had greater rainfall, which allowed them to metabolize on vegetation close to the ground

Espanola Island is hot and dry, tortoises have different adaptations to allow them to reach the high, sparse vegetation He thought different finch species Initially, he thought these birds were from different bird families because they looked so different from one another Further examinations showed that they are from same bird families They were just differently adapted to fit the need of their particular food sources

Species Vary Over Time Emerged from his study of the South American fossils he found on his journey Some were gigantic versions of modern-day animals Species living in South America today were descended from ancestral species on that continent Also discovered new species that were extinct millions of years ago

Darwin develops his theory by reading an essay written by Thomas Malthus He said much of human suffering was due to the human population's potential to grow Human populations grow

faster than the resources – runs out and struggles for existence, and something must correct it. So, the human population goes over the carrying capacity, but it does not affect the well-being of the human population for a long time but the nature will most likely correct it by pandemic and etc.

DARWIN REALIZED THAT HE CAN APPLY THIS TO THE MECHANISMS OF EVOLUTIONARY CHANGE

Darwin's Theory – ¼ When we look at our anatomy, we resemble other animals. Some have similar functions in common with other species. Ex) cat's front leg = human arms – ¼ Some features are common with other species but has no function for us. Ex) Goosebumps: Birds – skins contract to raise hair on skin – keeps them warm. Humans – same process, but no function. IT DOESN'T KEEP UP WARM – ¼ In his book *The Origins of Species*, he has 2 main points: All species of organism living on Earth today are descended from ancestral species – species evolve over time. The mechanism that cause species to change over time is natural selection. Descent with Modification – ¼ The descendants of the earliest organisms spread into various habitats over millions of years. They accumulated different modifications/adaptations to diverse ways of life. Called descent with modification. Original name of evolution – Darwin never actually used the term. Proved as an explanation of diversity of life. Hares – spread into different environment, they have benefited by having various adaptations that allowed them to thrive in such conditions. Ex) Jackrabbit benefits from fur that blends well in the desert and ears that help cool its body. Ex2) Snowshoe hare benefits from fur that blends well in the snow. They are all from common hare ancestors.

Natural Selection: The Mechanism of Evolution – ¼ Struggle for Existence. All species tend to produce excessive

number of offspring But in nature, resources are limited # of offspring > resource ã leads to struggle of the general population of the species In most cases, small % of offspring will survive in each generation Rests are starved, eaten, frozen, diseased, unmated, or unable to reproduce for various reasons... (Yeah... let's not go into that...L) ã¼ Variation Refers to differences among members of the same species Ex) @ the classroom, look how many different hair colors, facial colors, etc among the students Most of the variation is heritable, meaning it passes from one generation to the next Ex) siblings are more related to each other and to its parents than to other general public (I'm not related to Adolf Hitler... Am I?) Sometimes a certain variation was best suited to the local environment, and individuals with this heritable variation were more likely to leave the most offspring ã¼ The Role of the Environment Like Lamarck, Darwin observed that a key factor in the survival of the organism was how well it was suited to the environment. Lamarck though that the environment makes individual organisms acquire characteristic throughout their lives that help them survive in their environment Darwin explained that there were variations among the member of species Environment selected those individuals with variations that were best suited for that environment Ex) Giraffes — some were born with short necks, some were born with long necks ã Long necks survived because the environment favored them ã reproduced and passed along the good genes Genetics supports Darwin's views, not Lamarck's idea that giraffes grow longer necks during their lifetimes because they need to, and they passed the characteristic to the next offspring Synthesis of Observations Natural selection/Survival of the Fittest — the process by which

individuals with inherited characteristics well suited to their environment leave more offspring on average than do individuals with adaptations less suitable to the environment. The individuals that function best in the local environment tend to leave the most offspring. This process causes a population to change over time. An organism's natural surroundings (its ecological niche) determine whether or not it will survive and reproduce. Darwin's theory of evolution = natural selection as the mechanism of evolution. The result of natural selection is adaptation. Evidence for Evolution Fossil Record

- ¼ The younger rock layers are deposited on top of older ones. Positions of fossils in the rock strata can reveal their relative age. Deeper the layer in which the fossil is found, the older the age of the fossil.
- ¼ The fossil record is this chronological collection of life's remains in the rock layers, recorded during the passage of time.
- ¼ Paleontologists discovered fossils of many ancestral life forms that link the past with the present. Supports the hypothesis that whales, which have no hind limbs, evolved from land-dwelling ancestors that had 4 limbs.
- ¼ Can also provide evidence of the extinction of some species. Shows the sudden disappearance of dinosaurs.
- ¼ Limits — species that do not possess hard tissues such as bones and shells rarely become fossilized.

Geographic Distribution

- ¼ Closely related but different. Ex) finches. They were all descendants of a single ancestral species from the South American mainland. Became geographically isolated.
- ¼ Distantly (Geographical-wise) related but similar. Ex) sometimes similar habitats select for similar adaptations. Beaver, muskrat, capybara, and coypu all live in different habitats, but they are closely related to each other.

Comparative Anatomy

- ¼ Homologous

Structures Similar structures in species that share a common ancestor

Structures that originally functioned one way in ancestral species become modified as they take on new functions

¼ Vestigial Structures Remnants of structures that may have had an important function in an ancestral species but have no clear function in some modern descendants Ex) appendix — reduced in size due to a change in the human diet

¼ we're not vegetarian, we're omnivores May have been a secondary use in the immune system It had lost its original function

¼ Analogous Structures Distantly related species develop structures that are anatomically different but the structures' functions are the same Ex) Butterfly's wing & Bird's wing

Comparative Embryonic Development

¼ Embryo of closely related organisms often have similar stages in development Vertebrates all have an embryonic stage where pharyngeal pouches appear on the side of their throat, As development progresses, these vertebrates take on more distinctive features

Fishes — pharyngeal pouches turn into gills

Molecular Biology

¼ The ordered sequences of the components that make up DNA molecules are passed from parents to offspring Provide a record of an organism's ancestry

¼ Ex) you can compare the number of amino acids that differ from human hemoglobin chain (total length = 146 amino acids)

¼ Ex) Cytochrome C is another protein found in all organisms that need oxygen to survive — helps them with cellular respiration. Humans and chimpanzees have identical amino acid sequences and that means they are more likely to be related to each other and diverged from a common ancestor

Evidence for Natural Selection

Artificial Selection

¼ Selective breeding of domesticated plants and animals to produce offspring with genetic traits that humans value Ex)



when buying a pet or an animal, one might look for growth rate and temperament Breeders do what the environment does in natural selection

Ex) dogs — humans have been modifying dog for thousands of years

Changes in Beak Shape

- ¼ The Grants showed that the beak shape and sizes change as El Nino come and go
- ¼ During the wet years, seeds are soft and on the ground, they don't need a big beak to eat it — so smaller beak
- ¼ During the dry years, seeds are hard and they need big beak to break open the seed shell — bigger beak

Antibiotic Resistance in Bacteria

- ¼ Tuberculosis The drug Streptomycin was discovered in the 1950s to treat tuberculosis By the 1970s they are all wiped out In 2007 the TB went on a rampage They have many variations, some can be destroyed by antibiotics, and some are more resilient. That means through natural selection and survival of the fittest, they are able to reproduce and their population increases