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Biological Processes are Often Studied in Model Organisms

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Description

Human biology is an interdisciplinary area of academic study that examines humans through the influences and interplay of many diverse fields such as genetics, evolution, physiology, anatomy, epidemiology, anthropology, ecology, nutrition, population genetics, and sociocultural influences.

A human biology degree provides a strong foundation for several life sciences careers. Graduates holding a Bachelor of Science in Human Biology have demonstrated the ability to be precise, attentive to detail, and work through complex problems to find solutions independently or on a team. Biological evolution is the change in inherited traits over successive generations in populations of organisms. Evolutionary modification of traits occurs when variation is introduced into a population by gene mutation or genetic recombination or is removed by natural selection or genetic drift.

Model Organisms

Biological evolution is the change in inherited traits over successive generations in populations of organisms. Adaptation is a key evolutionary process in which variation in the fitness of traits and species are adjusted by natural selection to become better suited for survival in specific ecological habitats. The environment acts to promote evolution through changes in development. Therefore, determining how developmental changes are mediated is critical for understanding the mechanisms of evolution. Along path leads from the origins of primitive "life," which existed at least 3.5 billion years ago, to the profusion and diversity of life that exists today. This path is best understood as a product of evolution.

Contrary to popular opinion, neither the term nor the idea of biological evolution began with Charles Darwin and his foremost work, On the Origin of Species by Means of Natural Selection (1859). Many scholars from the ancient Greek philosophers on had inferred that similar species were descended from a common ancestor. The word "evolution" first appeared in the English language in 1647 in a nonbiological connection, and it became widely used in English for all sorts of progressions from simpler beginnings. The term Darwin most often used to refer to biological evolution was "descent with modification," which remains a good brief definition of the process today.

Darwin proposed that evolution could be explained by the differential survival of organisms following their naturally occurring variation a process he termed "natural selection." According to this view, the offspring of organisms differ from one another and from their parents in ways that are heritable that is, they can pass on the differences genetically to their own offspring. Furthermore, organisms in nature typically produce more offspring than can survive and reproduce given the constraints of food, space, and other environmental resources. If a particular offspring has traits that give it an advantage in a particular environment, that organism will be more likely to survive and pass on those traits. As differences accumulate over generations, populations of organisms diverge from their ancestors.

Biological Processes

Biological processes are often studied in model organisms. A model organism is a species that is studied extensively in the laboratory with anticipation that the results can be applied to biological phenomena in general. Cave animals can serve as excellent models to study the relationships between the environment, evolution, adaptation, and development. Troglomorphic (cave-related) traits, including elongated appendages, lowered metabolism, specialized sensory systems, and loss of eyes and pigmentation have evolved as a response to the effects of perpetual darkness. In this article, we describe the characid fish Astyanax mexicanus, as a vertebrate model system for studying the developmental basis of evolution and adaptation to the cave environment.

Biological evolution is traditionally studied in two aspects. First, paleontological records show astonishing changes in the composition of major taxonomic groups of animals and plants deposited in sedimentary rocks of various ages. Aquatic life forms give rise to the first terrestrial plants and animals, amphibians lead to reptiles including dinosaurs, ferns lead to gymnosperms, and then to flowering plants.

Extinction of most dinosaurs is followed by the spread of mammals and flying descendants of dinosaurs called birds.

Second, Darwin's theory augmented with statistical genetics demonstrated that heritable changes may accumulate in populations and result in replacement of gene variants. This process drives microevolution, which helps species to improve their functions and adjust to changing environments. But despite the importance of these two aspects of evolution, they do not capture the core of the macro evolutionary process, which is the increase of functional complexity of organisms.

Darwin's original hypothesis has undergone extensive modification and expansion, but the central concepts stand firm. Studies in genetics and molecular biology fields unknown in Darwin's time have explained the occurrence of the hereditary variations that are essential to natural selection. Genetic variations result from changes, or mutations, in the nucleotide sequence of DNA, the molecule that genes are made from. Such changes in DNA now can be detected and described with great precision.

Scientists also have gained an understanding of the processes by which new species originate. A new species is one in which the individuals cannot mate and produce viable descendants with individuals of a preexisting species. The split of one species into two often starts because a group of individuals becomes geographically separated from the rest. This is particularly apparent in distant remote islands, such as the Galápagos and the Hawaiian archipelago, whose great distance from the Americas and Asia means that arriving colonizers will have little or no opportunity to mate with individuals remaining on those continents. Mountains, rivers, lakes, and other natural barriers also account for geographic separation between populations that once belonged to the same species.

Once isolated, geographically separated groups of individuals become genetically differentiated as a consequence of mutation and other processes, including natural selection. The origin of a species is often a gradual process, so that at first the reproductive isolation between separated groups of organisms is only partial, but it eventually becomes complete. Scientists pay special attention to these intermediate situations, because they help to reconstruct the details of the process and to identify particular genes or sets of genes that account for the reproductive isolation between species.

Function can be defined as a reproducible sequence of actions of organisms that satisfies specific needs or helps to achieve vital goals (e.g., capturing a resource or reproduction). To be passed on from one generation to the next, functions must be encoded within the genome or other information carriers.