Competitive Exams: Evolution: Fact and Theory

Evolution Theory Explains How Organisms Have Changed over Time

Scientific understanding requires both facts and theories that can explain those facts in a coherent manner. Evolution, in this context, is both a fact and a theory. It is an incontrovertible fact that organisms have changed, or evolved, during the history of life on Earth. And biologists have identified and investigated mechanisms that can explain the major patterns of change.

There are four major patterns of change.

1. Patterns in Nature: The field of evolutionary biology seeks to provide explanations for four conspicuous patterns that are manifest in nature. The first three concern living species, whereas the fourth relates to fossils.
2. Genes are linked to how organisms look and behave: Genetic variation. There is tremendous genetic diversity within almost all species, including humans. No two individuals have the same DNA sequence, with the exception of identical twins or clones. This genetic variation contributes to phenotypic variation-that is, diversity in the outward appearance and behavior of individuals of the same species.
3. Organisms must adapt to their environment to survive: Adaptation. Living organisms have morphological, biochemical, and behavioral features that make them well adapted for life in the environments in which they are usually found. For example, consider the hollow bones and feathers of birds that enable them to fly, or the cryptic coloration that allows many organisms to hide from their predators. These features may give the superficial appearance that organisms were designed by a creator (or engineer) to live in a particular environment. Evolutionary biology has demonstrated that adaptations arise through selection acting on genetic variation.
4. Evidence for Evolution, and its Significance in our Lives: It is impossible to review all the evidence for evolution in a short article such as this. However, the following offers a sample of the kinds of evidence that have been discovered and confirmed repeatedly by scientists. These examples also illustrate the importance of this evidence for science and society more generally.

Fossils Are the Most Easily Observed Evidence for Evolution

Evidence from fossils. Based on myriad similarities and differences between living species, evolutionary biology makes predictions about the features of ancestral forms. For example, numerous features indicate that birds are derived from reptilian ancestors. By contrast, these data reject the possibility that birds were derived from other groups, such as flying insects. Scientists have discovered fossil birds with feathers and legs like modern birds, but which also have teeth, clawed digits on their forelimbs, and a tailbone like their reptilian ancestors. Fossils are especially important evidence for evolution because, with little effort, each of us can use our eyes and minds to observe and interpret the dinosaur and other ancient fossils in public museums.

DNA Profiles Show Evolutionary Relationships Among Species

Evidence from genetics. The genomes of all organisms contain overwhelming evidence for evolution. All living species share the same basic mechanism of heredity using DNA (or RNA in some viruses) to encode genes that are passed from parent to offspring, and which are transcribed and translated into proteins during each organism's life. Using DNA sequences, biologists quantify the genetic similarities and differences among species, in order to determine which species are more closely related to one another and which are more distantly related. In doing so, biologists use essentially the same evidence and logic used to determine paternity in lawsuits. The pattern of genetic relatedness between all species indicates a branching tree that implies divergence from a common ancestor. Within this tree of life, there are also occasional reticulations where two branches fuse, rather than separate.

(For example, mitochondria are organelles found in the cells of plants and animals. Mitochondria have their own genes, which are more similar to genes in bacteria than to genes on the chromosomes in the cell nucleus. Thus, one of our distant ancestors arose from a symbiosis of two different cell types.) The genetic similarity between species, which exists by virtue of evolution from the same ancestral form, is an essential fact that underlies biomedical research. This similarity allows us to begin to understand the effects of our own genes by conducting research on genes from other species. For example, genes that control the process of DNA repair in bacteria, flies, and mice have been discovered to influence certain cancers in humans. These findings also suggest strategies for intervention that can be explored in other species before testing on humans