Four forces of evolution

Science, Biology

All cultures have origin stories or legends to explain their beginning and the beginning of the world. Some culture stories are based in creationism, and others are based in the science of evolution. Evolution is a widely accepted theory of how species change over time. There are four forces of evolution– mutation, gene flow, genetic drift, and natural selection– all of which have an effect on all species undergoing adaptation. From microevolution to macroevolution, change is happening to all the time. While it used to be widely believed in European countries that life was fixed and unchanging, the discovery of other animals around the world led to the theory of evolution. Upon discovery, the European explorers realized that all kinds of life are related in one way or another, and populations of organisms often have similarities to other populations in different areas, and the discovery of fossils throughout the world showed that the organisms of the past were different in varying levels from present day organisms, but that many of them seem related. These differences and the physical makeup of present-day organisms are used as evidence of evolution, and show how animals of different species may have common ancestors. Species is defined as the smallest unit in the modern classification system, and can be identified by the ability of two organisms in the same species to reproduce fertile offspring. Think of lions and tigers. A lion can breed with another lion to produce a lion cub, which will one day mate and produce another, and so can tigers. But while lions and tigers seem similar enough, an offspring of one lion and one tiger (a liger) cannot reproduce with another liger, so lions and tigers are not a part of the same species, despite visual and physical similarities. This is one way modern taxonomists are able to recognize

organism species across populations. The difference between a species and a population is that a species is based on organisms with similar genetics, and a population is a group of a species across space, like a large field containing several different breeds of horses. A species can experience evolution and populations can experience evolution within themselves and between each other through microevolution and macroevolution. Microevolution describes the variations found in organisms between generations, or how the offspring differ from their parents. Microevolution is what happens when two parent organisms, humans for example, have brown hair but all of their children are blonde. In macroevolution, the change occurs above the species level and occurs over thousands of generations. The oldest ancestor of a human is not a human itself, because so many small changes in the allele frequency of its offspring has changed our DNA significantly enough to say that we are not of the same species. When macroevolution results in the formation of a new species, as in the example above, it is called speciation. These evolutions have four forces that cause them: Mutation, gene flow, genetic drift, and natural selection.

Mutation is the only source of new material in an organism, and it occurs as a random change in the genetic code. It occurs because as an organism’s cells divide, the copying of the genetic code is rarely perfect and sometimes not correctable, and sometimes by the extreme relocation of DNA segments. It can also be caused by radiation, pollution, etc.. A mutation can look like an extra limb, an odd eye color, or muscular dystrophy. However negative a mutation might be for an individual, mutation is good for a population, as the drastic variations allow for better adaptability within a population. The next

force, gene flow, occurs an organism from one population travels to another population and then mates with one of the organisms from that population. It is an introduction of new alleles to nearby populations, and an introduction variation within a new population. A red bird may fly across the valley and mate with nearby blue birds from a different population and introduce his red color allele (among others) to this population. This can occur especially when animals are migrating. Gene flow increases similarities between populations, but increases the variations within them. Genetic drifts are chance fluctuations between of allele frequencies found in one specific gene pool. They are caused by random events which occur to individuals. The randomness of gene distribution and combination in chromosomes, catastrophes that occur during which no species can adapt, such as a person stomping on a more rare color of bug in a population, or a flood or fire, and the founder effect– when a small part of a larger population is separated from it– are all examples of genetic drift. Smaller populations feel the effects of genetic drift more than larger ones, and sometimes the alleles represented in the smaller population lose the variations in their gene frequencies. The final force is natural selection. The process of natural selection is the impact an environment has on a population. Because all organisms vary between each other within species, some are naturally better adapted to their environment than others. Every generation of a species will have the better adapted offspring produce more offspring than the lesser, whether the adaptation is on a biological or social level. In industrial cities, a white-barked tree can change color due to smog or pollution. White colored butterflies, which previously flourished in this area due to their ability to

blend in with the tree bark now face a problem. The butterflies who had a harder time blending in before, due to naturally looking more off-white now have the advantage, because their are better adapted to their new environment. Predators can now more easily see the purely-white butterfly, and consequently, this trait dwindles amongst this population of butterflies. Natural selection has favored the off-white butterfly, and this population has more of this color because survivability has increased and therefore so has their reproductive success. Looking at it in a social perspective, birds attract mates based on their feathers. Birds with more attractive plumes amongst a population attract more mates, and this bird's genes are passed onto the next generation, and its offspring will inherit its plumage, and as the next few generations of birds choose the same type of mate, the lesser attractive plumage variation will slowly diminish. These are the four forces of evolution, and there are forces that can impact them. Just as the environment can cause mutations, it can also affect gene flow with isolating mechanisms.

An isolating mechanism is anything that hinders or halts the force of gene flow. Such mechanisms include mutation, as certain variations amongst organisms can cause other organisms to not recognize them or to be unwilling to mate, geographic factors, like a river preventing two members of a population from mating, and social rules can be isolating mechanisms; intergroup conflict, and the inability of a species to travel to far places can interfere with gene flow. Territorial disputes between a pack of red wolves and a pack of gray wolves may interrupt mating between them. These isolating mechanisms often lead to populations undergoing evolution on their own, without interference from other populations, and may then lead to the

formation of a completely different species between them (depending on the population’s respective environments). As the changes within the populations become more prominent, the greater the variations become between generations, and the farther and farther apart the two different populations become genetically. Eventually, the wolves in the previous example are no longer wolves, but two different species. This is the process of speciation. This can occur through cladogenesis, when a species branches out from an ancestral population to give rise to two or more descendent populations, or through anagenesis, a sustained directional shift in a population’s general characteristics.