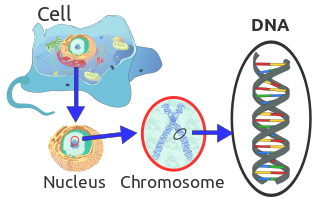
A Brief Guide to Evolution

The story of evolution began approximately 4 billion years ago with simple, single-celled microorganisms, which resulted from many biochemical interactions in large bodies of water. Since then, over incredibly long periods of time, the diverse forms of life evolved to inhabit myriad different environments. This guide will delve into the concepts and terminology behind evolutionary theory, as well as its important to the study of human and animal minds.

To begin with, we must address how genes stored in our DNA are vital to the process of evolution. Although the structure of DNA was discovered in 1953, long after naturalists began understanding how evolution works, this discovery has greatly broadened our understanding of how organisms change over time.

Each of the cells in your body contains genetic material in the form of deoxyribonucleic acid, or DNA. This compound serves as a ‘blueprint’ for how you develop over time, influencing your behavioural and physical traits, as well as the diseases to which you may be susceptible. Genes, however, are not always perfect indicators of how a person will look and behave; there are many environmental factors which also contribute to these things. Genes impact your body and behaviour, but your body and behaviour can also change the way your genes are expressed. For instance, if someone carries a gene that makes them more predisposed to having lung cancer, but they live healthily, they will probably never develop this disease. However, if they take up smoking, they will be much more likely than others to provoke the growth of a cancerous tumour. Genetic expression is a complex process with millions of interacting factors, but there is no doubt that genes are integral to how our bodies and minds come to function.

 Each individual inherits half of their DNA from their mother, and half from their father, and thus also contributes half of their DNA to the genetic material of their own children. This is important: the person with whom you choose to procreate influences half of your child’s genetic makeup. Because we want our children to be healthy, we will tend to choose partners who display healthy physical traits, which reflect more robust genes. Though we cannot look at someone and know their exact predispositions to every disease, we have evolved the ability to look at some features and determine how *likely* they are to be healthy. If you reproduce with someone whose genes give them healthy traits, your children will be healthier, and therefore more likely to pass on these genes to their children. And so on, and so on… Since the dawn of time.

You can think of evolution as a generational process of elimination. Individuals with genes that suit their environment live long enough to pass on their genetic material to their offspring, while those who do not swiftly exit the gene pool upon their earlier death. Charles Darwin, a nineteenth-century naturalist famous for his research into evolution, called this process *natural selection*: individuals unfit for their environment die off before reproducing. It is worthwhile to note that the organisms that survive are not necessarily the strongest, or the most intelligent—they simply need to be fit for their environment. In other words, if your environment is a coral reef, high levels of intelligence won’t help you if you have not evolved the means to breathe underwater.

**Charles Darwin (1809-1882)**

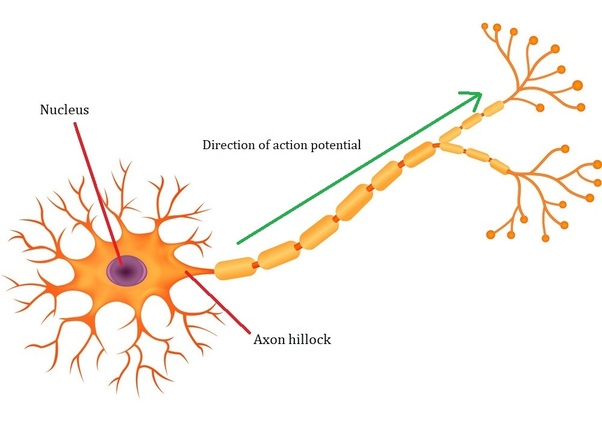
Evolution happens over the course of millennia, and it takes many iterations of natural selection for one species to evolve into something different, if environmental pressures demand it. This unfathomably intricate process is what has allowed for the millions of different species which exist today to evolve from the simple lifeforms that existed billions of years ago. Evolution can happen both slowly and in punctuated bursts, but compared to the human historical record, this ancient process progresses at a glacial pace. Humans are a very, very new species, as far as evolution is concerned. Our genus, *Homo*, evolved a mere 2.5 million years ago!



**Evolution of the Mind**

In the same way that bodies evolve, so too do minds. The truth is, we don’t have much direct evidence about the physical organisation of ancient brains—while we have clear fossil records of ancient skeletal matter, we have no fossil records of the fleshy, fatty material found in brains, as it disintegrates before it can fossilise. However, we can still infer a lot from the physical attributes (such as skull size) and chemical compositions of the fossilised remains we do have, as well as the things that our own ancestors created and left behind.

The evolution of brains has its roots in the evolution of chemical signalling—something that has been around since the earliest existence of single-celled organisms. To maintain their function, regular cells in our bodies move different chemicals across their membranes, in a process that can take minutes. However, there is a faster way to accomplish this: by generating electric potentials. This is how brain cells (neurons) communicate with one another, and it is a process which can be observed in organisms as simple as the sea sponge. Indeed, many of the components needed to electrically transmit signals are even present in single-celled organisms called choanoflagellates, which evolved 850 *million* years ago! From that point forward, cells evolved to become more specialised in the types of electric messages they could convey, and the first nervous systems evolved not too long after.

 We also have evidence of the sophistication of our ancestors’ minds from the things they left behind. Tools like spears and oil lamps give us insight into how their communities were organised, and how they may have conducted their lives on an everyday basis. Things like cave paintings and burial sites illuminate some of the cultural tendencies of early humans, as well as the ways in which they may have communicated ideas to others.

**Propagation of an electric current (action potential) across a neuron**

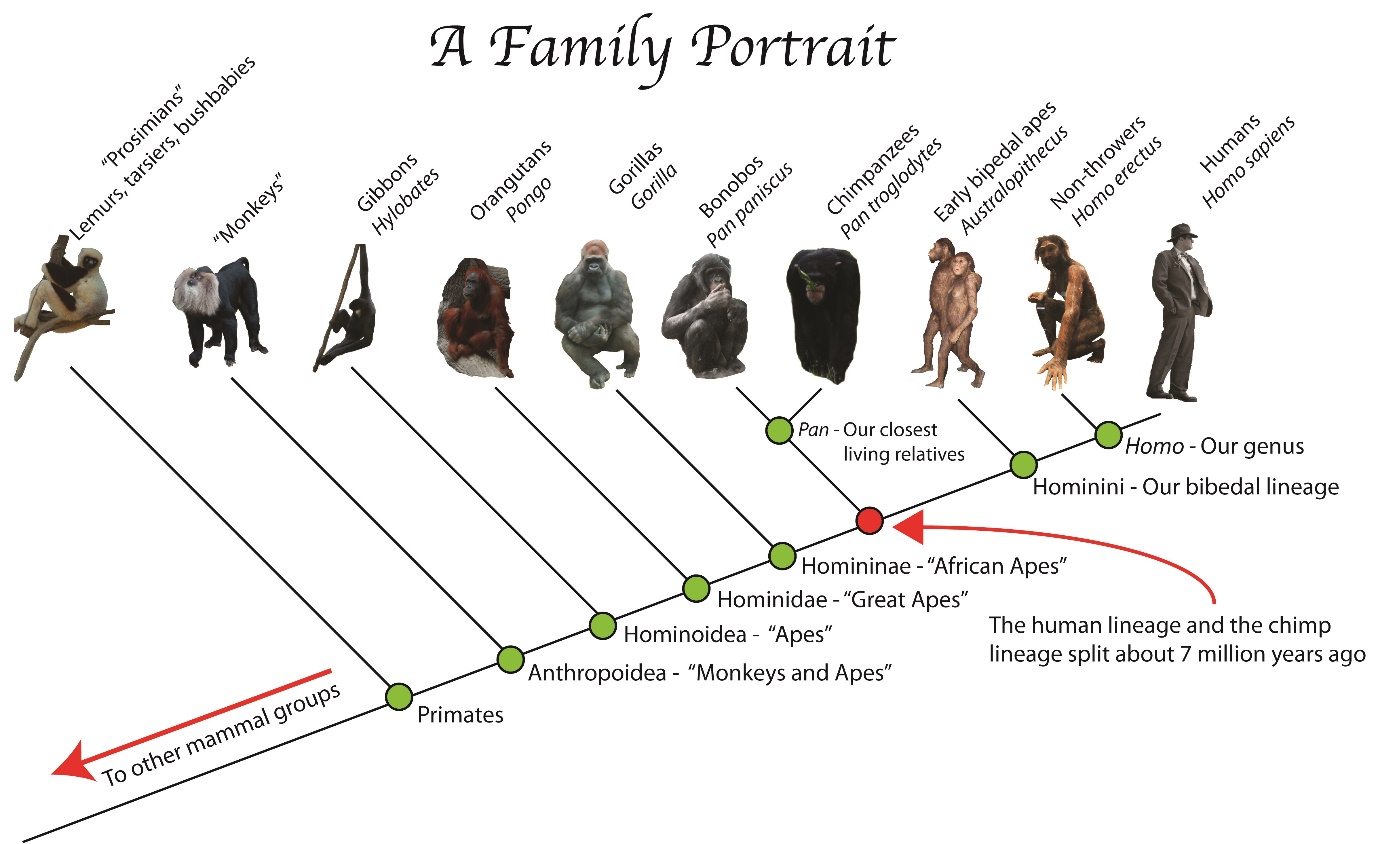
This also provides information relating to how the human mind may have evolved, as well as how ‘modern’ our brains truly are. What we know is that the human brain likely did not evolve much since *Homo sapiens* emerged as a species. While we are of course more technologically advanced than these ancient peoples, our minds are more similar than popular culture (and the trope of a ‘knuckle-dragging’ caveman) would have you believe. Humans, it seems, have specifically evolved the physical and mental faculties needed to make tools, innovate, produce language, and form social groups.

**What can animals teach us about the evolution of the mind?**

To understand the evolution of human intelligence, it is sometimes helpful to look at how the minds of our closest evolutionary relatives operate. As we share as much as 98% of our DNA with other great apes (chimpanzees, bonobos, gorillas, and orangutans) and have a recent common ancestor, we can expect to share some cognitive and behavioural traits, too. Bonobos form very cohesive social groups, and chimps have been shown to use tools and engage in social learning. In 2018, researchers at the University of St Andrews even found that wild orangutans actively communicate about the past, vocally warning their offspring about a predator after the predator is gone.

Our minds, as well as the minds of all other animals, evolved to function appropriately in their given environments. By inspecting how animal minds operate, we can infer things about their environments—namely, how might they engage with other individuals and the resources to which they have access. Evolution functions on a basis of cost and benefit; after all, it takes a great deal of energy to run a big brain, so there must be a reason why certain animals have large, complex brains while others do not. The evolution of a large brain is justified if the enhanced cognitive capacity it gives helps an individual acquire more resources to maximise the chance of overall survival. Thus, brains and their environments influence each other: larger-brained species may be able to plan ahead, efficiently extract food, and outsmart predators, and these behaviours impact the organisation of the environment, further causing gradual changes in the brain.

The organisation of animal brains can also inform which neural areas help animals behave in certain ways. For instance, some researchers believe that a larger neocortical ratio (the ratio of the frontal section of your brain, called the frontal cortex, to the rest of your brain) explains why some species can integrate a large amount of social information and solve complex problems, whereas others cannot. The fact that we and other apes share the ability to form social groups and dominance hierarchies suggests that our common ancestor, an extinct primate which preceded modern species, also possessed these traits.



Evolution reveals the beauty and complexity of life of Earth. The fact that all biological change is driven by a few definable (yet inherently chaotic) forces shows that even a few mathematical rules governing the universe can generate dizzying, kaleidoscopic variety in everything we see. Patterns emerge from chaos, and webs of causal influence stretch to encapsulate all things in our incredible environmental macrocosm. Some may argue that evolutionary theory takes the wonder out of life—and this could not be farther from the truth. From single-celled prokaryotes to the astounding biodiversity we see today, constantly diverging and shifting according to environmental pressures, we witness a transformation billions of years in the making. In appreciating this fundamental process, and informing ourselves of the capabilities of animal minds, we can act with consideration for the environment, using our cognitive powers to promote good.