

# What Difference did Darwin Make?

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This February 12th is a day for celebration. Why? Because, on this day in 1809, Charles Darwin was born. What difference did he make? His work was an enormous advancement to the development of science, especially in the last 150 years since the publication of his book, *On the Origin of Species*. He made a huge difference to our understanding of fundamental questions regarding who we are, where we came from, and why we exist. His work helped us to understand how life evolved (in the first place from non-life) through chemical reactions and physical processes. Since Darwin, it has become more and more clear that all of reality is constantly changing and can be understood in terms of physical processes.

Long before Darwin was born, many had realised that life on earth was evolving and that evolution has occurred. Even in ancient India there were some who said that the universe was not created by any external god — it developed as a process of internal evolution, or “ripening” — *parinaama*. But for a long time, such beliefs remained speculative and confused, without evidence to support and explain their meaning.

Charles Darwin changed this. Based on a lifetime of careful scientific study, he documented how evolution occurs. As he wrote in 1859, “Each new species arises by descending, with modification, from an ancestral species.”

Anyone who looks around at the enormous diversity of life that surrounds us will be struck not only by the variety, but also by the similarity between the different forms of life. The comparison is even more amazing when we also consider, as Darwin did, the millions of organisms that existed in the past, which we now know only through the fossil record that they left behind.

## Web of life

For example, careful study has shown that birds are related to dinosaurs. Birds and dinosaurs are related to crocodiles. Lizards are related to snakes. Lizards and snakes are related to crocodiles, all of which are related to turtles. And so on.

Such studies allow us to make sensible classification schemes, and we see that in fact, all living things are related to each other. Efforts to understand the inter-relationships and inter-dependencies between different species have been going on since ancient times in cultures across the world. Darwin built upon and greatly expanded this effort.

Nowadays, we know that all forms of life on earth are based on the same molecular biology. They all use the same genetic code to make proteins from their genes. All genes are made of DNA sequences. And even the DNA sequences of different organisms are closely related. For example, the genes of humans and apes have DNA sequences that are about 95-98 per cent identical. It is because humans and apes both evolved from a common ancestor. And yet, (despite our sometimes savage behaviour) we still feel reluctant to consider ourselves so closely related to the “savage apes”!

Despite the similarities, there is also an incredible variety — between different species, within a single species, and even within one population of a species. Some of this variation is inheritable — capable of being passed on from generation to generation. This is one of the things that struck Darwin and led him to discover a mechanism for evolution: natural selection.

Speculation that one species gave rise to another species has occurred throughout history. The achievement of Darwin was not only in recognising that evolution has occurred, but in discovering how it occurs through natural selection. Darwin once wrote that perhaps he chose the wrong word — perhaps he should have called this mechanism natural preservation. The problem with the word “selection” is that it may imply that evolution is driven by some purposely chosen path, or act of designing. It isn't.

The similarities to artificial selection also lead us to such a misconception. Since the beginning of agriculture, people have been designing and producing varieties of plants and animals for specific purposes. For example, some of the most important food plants that we eat today in India are cabbage, cauliflower, mustard seeds and *saag*, *mooli*, *moongra*, *kohlrabi*, and *shalgam* (also, less common in India are broccoli, brussels sprouts, radishes, red cabbage, and rutabaga). All of these were developed by farmers from the wild mustard plant. In any field of plants, there is some variety. Farmers chose seeds from mustard plants that had a desired characteristic — in one case large, closely packed leaves, in other cases thick roots, enlarged stems, or tightly condensed flower clusters. After thousands of generations of selecting for one particular characteristic, a very different looking plant arises.

As Charles Darwin pointed out, a similar process occurs in nature — but without any act of design.

In the last 200 years, natural selection has been observed in action. For example, in Britain, there were populations of peppered moths that were mostly white with black speckles. But, due to a chance gene mutation, a few of this species of moths were dark brown. The light coloured moths happened to be well camouflaged as they rested during the day on trees covered with pale lichens. The dark moths were easily seen and eaten by birds. With a large increase in industry and the resulting pollution, the trees became covered by black soot instead of lichens. Now the dark-coloured moths were camouflaged and the light coloured moths were more likely to be seen and eaten. Since more dark moths survived and reproduced, the population became mostly dark, with just a few light moths.



In this case, the process of natural selection did not form a new species — since both varieties of moth continued to be able to interbreed. But it did change the population.

This change did not occur by design. Some of the moths in the original population just happened to already have a mutation that caused them to be a different colour. This mutation did not occur because of the change in environment. The change in their environment resulted in a change in the colour of the moth population. But the moths did not change colour in order to adapt to the environment.

Thus, we see that natural selection is not a purposeful creative act — it is simply a mindless, editing mechanism. There is no goal in evolution. No form of life is more perfect than any other form of life.

The role of chance in evolution is one of the aspects that make it remarkable. When we say evolution happened by chance, we do not mean that it happened without reason — but that the reason was not designed to give the particular effect.

### Chance and necessity

Thus, the work of Darwin gives a new truth to the insight of Democritus (c. 350 BCE): “Everything existing in the universe is the fruit of chance and necessity.”

Darwin found evidence for evolution and natural selection by studying the varied forms of animals and plants he and others had collected from the Galapagos Islands, South America, and other areas. He saw how populations of organisms had evolved into new forms as they immigrated to new places, and as their environment changed. After decades of study, hundreds of publications in addition to *On the Origin of Species*, and thousands of letters to and from eminent scientists and intellectuals of his day, it was clear to him that nothing is fixed — all of life is constantly changing.

This realisation was a challenge to theology. The evidence of science countered some religious beliefs. We now know that life itself arose from simple self-reproducing chemicals. As life evolved, consciousness also evolved. As we investigate, we find out more and more about how the nervous system works in simple organisms, and how even human consciousness can be understood in terms of the same basic physical processes organised into very complex systems.

The elucidation of the mechanisms of evolution leads us to realise that life is more astonishing than we had ever imagined. As Darwin said, “from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved.”