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EVOLVING OF 'EVOLUTION' – ITS IMPLICATION

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The earliest explanations of the natural world were supernatural. Science was the tool for explaining it. Philosophy developed during the 6th century B.C. The ancient Greeks' explanation was based on observation and thinking, though metaphysics played an important role. Many of the great philosophers, even Kant, included God in their explanations. Prior to Darwin, God was also accepted as an explanatory factor by most biologists.

In the scientific initiation of search for the truth regarding how the natural world exists, the names of Charles Robert Darwin and Jean Lamarck have to be mentioned. Though their studies have been different, they both earnestly desired the extension of knowledge, which in the long run would benefit mankind.

Darwin brought natural history into science. In fact, the modern philosophy of biology was founded by Darwin.

Evolution has since long been discussed by Erasmus Darwin (1796), father of Charles Darwin, James Hutton (founder of modern geology) (1785) and Jean Lamarck (1809).

Lamarck**,** best known for his *Theory of Inheritance of Acquired Characteristics*, first presented in 1801, said that, if an organism changes during life in order to adapt to its environment, those changes are passed on to its offspring. He said that change is made by what the organisms want or need. Lamarck also said that body parts that are not being used, such as the human appendix and little toes, are gradually disappearing. Eventually, people will be born without these parts and these happen according to a predetermined plan and the results are predecided. He avoided the term 'Evolution' by using 'Transmutation' and his idea was taken up by the radicals[1].

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Jean-Baptiste Lamarck (1744-1829) was a French naturalist. According to him, it is the environment which produces change in Nature. So, giraffe's neck is tall as the animal reaches up for food. This served as the precursor to the Theory of Evolution offered by Darwin and Wallace[2].

Briefing about Darwin, he revolted against the brutality of surgery and thus neglected medical studies. Initially, his prime interest was in geology. He learnt taxidermy from a freed black slave who told him exciting tales of the South American rainforest. He joined Plinian Society, a student group interested in natural history and finally became a keen pupil of Robert Edmund Grant, a strong proponent of Lamarck's theory of evolution[3].

John Stevens Henslow, an English botanist and geologist, a pioneering meteorologist, able surveyor and hydrographer, achieved everlasting fame as the captain of H.M.S. Beagle voyage with Charles Darwin. Captain FitzRoy and Darwin left the board on December 27, 1831, which continued over five years[4].

Darwin collected both flora and fauna. He regularly wrote notebooks to record observations, even noted the slight variations among population of birds and tortoises on neighboring islands in the Galapagos Islands. The Beagle returned to England on October 2, 1836. Darwin came back with large number of collections[5].

Henslow advised him to make complete catalogue of the collections and agreed to work on the botanical specimens. The well known anatomist, Richard Owen, working in Royal College of surgeons agreed to work on fossil bones collected by Darwin. Charles Darwin edited and superintended *The Zoology of the Voyage of H.M.S. Beagle* (1838-1843) with the help of the others, in five volumes:

Part 1: Fossil Mammalia by Richard Owen

Part 2: Mammalia by George R. Waterhouse

Part 3: Birds by John Gould

Part 4: Fish by Leonard Jenyns

Part 5: Reptiles by Thomas Bell

The book on the origin of species by means of *natural selection, or the Preservation of favoured races in the struggle for life (1859)*, was printed up to the 6th edition till 1872, after which the name of this book changed to *The Origin of Species*[6].

By early 1837, Darwin was speculating on transmutation in a series of secret note books. He compiled volumes also on:

- Fertilization of Orchids (1862)
- The Variation of Animal and Plants under Domestication (1868)
- The Descent of Man (1871)
- The Expression of the Emotions in Man and Animals (1872)
- Insectivorous plants (1875)
- The Different forms of Flowers on Plants of the Same Species (1877)
- The Power of Movement in Plants (1880)
- The Formation of Vegetable Mould, through the Action of Worms (1881)
- Life and Letters and Autobiography (1887)[7].

Darwin's theory has been supported by a lot of evidence. Lamarck's *Theory of Inheritance of Acquired Characteristics* has been disproved. We have seen through many real examples and observations that the changes that occur in an animal during life are not passed on to the animal's offspring. If someone exercises every day, runs marathons, eats well, and is generally very healthy, the fitness is not inherited. On 1st July 1858, Wallace and Darwin presented at the Linnean Society a paper entitled 'On the tendency of species to form varieties' and on the 'Perpetuation of varieties and species by natural means of selection'. That was impressive though it ruffled many feathers.

Darwin believed that organisms, even of the same species, are all different and that those which happen to have variations help them to survive in their environments and have more offspring which are born with their parents' helpful traits. As they reproduce, individuals with that trait make up more of the population. Other individuals, that are not so well adapted, die off[8].

The other way that Lamarck's theory has been proven wrong is the study of genetics. Darwin knew that traits are passed on, but he never knew 'genes', which are grossly unaffected (except mutagens) by the outside world. The existing gene sets in a population, determined by which individuals die and which ones live, matters the most. Evolution couldn't take place without this heredity. The tongue rolling gene is passed along generations; therefore, it is a hereditary trait. Although Darwin didn't know of Mendel's discoveries, Darwin applied some of these ideas by suggesting that inherited traits can give individuals a better chance of survival, which is shown in Natural Selection[8].

So how does the name of Lamarck still shine to this day? Unlike most other people of that time, Lamarck and Darwin, both thought that life had changed gradually over time and that it was still changing, that living things change to be better suited and adapted to their environments and that all organisms are related. Darwin and Lamarck also agreed that life evolved from fewer, simpler organisms to many, more complex organisms[9].

Lamarck's introduction has been reinstated by Darwin in his Theory of Natural Selection which has today played an important role in patterning the human genome. Cai et al, from Stanford University showed that adaptation is a large part of human genomic evolution in the last 200,000 years of history[10].

Other unconventional ideas were sprouting too, but the lack of speed in communication could not sew all together simultaneously.

The work of Gregor Johann Mendel was initially very controversial when it disproved the popular concept of *blending inheritance* (individuals inherit a smooth blend of traits from their parents). He showed that traits are rather composed of combinations of distinct genes. Besides, there was Lamarck's Theory of Inheritance of Acquired Characteristics; the Theory of Pangenesis of Darwin (which had both acquired and inherited aspects) and Francis Galton's reformulation of pangenesis as both particulate and inherited[11.12]. Mendelian inheritance was published in 1865 and 1866 which was "re-discovered" in 1900. When they were integrated with the Chromosome Theory of Inheritance by Thomas Hunt Morgan in 1915, it became the core of classical genetics, the central organizing principle of modern biology, which provided a unifying explanation for the *diversity of life* on *Earth*[13].

In 1928, Frederick Griffth discovered the phenomenon of *transformation* - dead bacteria could transfer genetic material to "transform" other still-living bacteria! In 1944,

Oswald Avery, Colin Munro Theodore Macleod, Maclyn McCarty identified the molecule responsible for transformation as *DNA*[14]. The experiments of Nobel laureate Alfred Hershey and Martha Chase's in 1952 also showed that DNA (rather than protein) is the genetic material. Nobel laureates James Dewey Watson of US and Francis Crick of UK determined the structure of DNA in 1953, using the X-ray crystallography work of Rosalind Franklin that indicated DNA had a helical structure.

In the following years, scientists tried to understand how DNA controls the process of *protein* production, and realised that translation between nucleotide and amino acid sequences results from the genetic code.

With this molecular understanding of inheritance, an explosion of research became possible. The chain-termination *DNA sequencing* in 1977 by Frederick Sanger, allowed to read the nucleotide sequence of a DNA. In 1983, Kary Banks Mullis developed the *polymerase chain reaction*, providing a quick way to isolate and amplify a specific section of a DNA from a mixture. Through the pooled efforts of the Human Genome Project and the parallel private effort by Celera Genomics, these and other techniques culminated in the sequencing of the human *genome* in 2003.

The study of evolutionary biology began in the mid-nineteenth century, when studies of fossil records and biodiversity convinced that species changed over time. This, was wound up with knowledge of genetics, biophysics, bioinformatics, anchoring different technology to reveal the scientific cause of today's evolved existence.

When Charles Darwin visited the Galapagos Islands, he recorded the presence of several species of finch that all looked very similar except for their beaks. Darwin attributed this difference to a common ancestor that had migrated to the islands (adaptive radiation). In 2006, Harvard University's Arhat Abzhanov and his colleagues concluded that variation in calmodulin activity resulting from differing expression of the gene involved in calcium signaling is a contributory factor[15].

The Table here shows important milestones in the advancement of the Theory of Evolution

1785 - Evolution was discussed by James Hutton (founder of modern geology).

1796 - Evolution was discussed by Erasmus Darwin.

1801 - Lamarck first presented *Theory of Inheritance of Acquired Characteristics.*

1831 - 1836 Captain FitzRoy and Darwin on board H.M.S. Beagle.

1838 -1843 Darwin edited and superintended "The Zoology of the Voyage of H.M.S. Beagle"

1858 - Wallace and Darwin presented at the Linnean Society.

1859 - 'On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the struggle for Life' by Charles Darwin.

1865 /1866 - Mendelian inheritance was published.

1871 - 'Descent of Man and Selection in Relation to Sex' by Charles Darwin.

1915 - Mendelian inheritance was integrated with Chromosome Theory of Inheritance (Thomas H. Morgan).

1928 - Frederick Griffth discovered the phenomenon of transformation.

1944 - Oswald Avery, Colin Munro, Theodore Macleod, Maclyn McCarty identified the molecule responsible for transformation as DNA.

1952 - Alfred Hershey and Martha Chase's showed that DNA is the genetic material.

1953 - James D Watson and Francis Crick determined the structure of DNA in, using the X-ray crystallography work of Rosalind Franklin that indicated DNA had a helical structure.

1977 - Chain-termination *DNA sequencing* by Frederick Sanger.

1983 - Kary Banks Mullis developed the *polymerase chain reaction.*

2003 - Completion of sequencing of the human *genome*.

Evolution as conceived by Darwin, happens very slowly (microevolution), which, if extrapolated over long periods of time, would result in wholesale changes of form and function as seen with drug resistance.

Fossil records say that larger species-to-species changes, or macroevolution also occur, but are difficult to perceive in action. In 2005, Sean Carroll from the Howard Hughes Medical Institute in Maryland found that gain of a single spot on the wings of male flies of the species *Drosophila biarmipes* occurs due to newly acquiring of binding sites for transcription factors of an ancestral regulatory element of a gene involved in pigmentation and

also fundamental to development. This shows that a gene involved in one process can be co-opted for another, thus driving macroevolutionary change[16].

Research on evolution says that ape-like species *Australopithecus* probably became bipedal 4.5 million years ago, while continuing to climb trees and in another 3.5 million years *Homo sapiens* evolved from *them* by subtle shifts in gene function.

Studies reveal that roughly 10 million years ago, segments of genomic DNA of a common ancestor of gorillas, chimpanzees and humans began to form duplicate copies at a greater rate than in the past, thus creating an instability which persists in the present day genome, probably contributing to diseases like autism and schizophrenia. This gene duplication also may be responsible for genetic flexibility and unique human characteristics[17].

Till today, about 9 percent of the human genes examined are undergoing rapid evolution. In about 700 regions of the human genome, genes responsible for taste, smell, digestion, bone structure, skin color and brain function have been reshaped by natural selection, within the last 5,000 to 15,000 years. Those involved in immunity, gamete production and sensory perception have undergone more changes in humans than in chimpanzee, despite common ancestry. Darwin's theory may be today interpreted as, 'Nature *genetically* rewards those individuals who are better adapted to their environments, with survival and reproductive success'[18].

Only those genetic changes that alter protein structure are likely to be subjected to evolutionary pressure. It is now known that two genes, Microcephalin and ASPM are involved in the expansion of the human cerebral cortex and there is acceleration in the evolution of the protein sequence from simian ancestors to humans and chimpanzees. This partly accounts for the difference in brain size between humans and other primates[19].

A gene which makes an opiate-like protein called "proydnorphin," or PDYN is important for brain development and is more active (due to transcription factors) in humans than in apes. It is involved in perception, memory and susceptibility to drug dependence, deficiency of which increases proneness to drug addiction, schizophrenia, bipolar disorder and a form of epilepsy. There is a good amount of genetic variation in the PDYN promoter with respect to different humans races — Chinese, Papua New Guineans, (Asian) Indians, Ethiopians, Cameroonians, Austrians and Italians. This is evolutionary selection[20].

Gene losses also contribute to adaptation. Bioinformatics study on the comparison between the mouse and human genomes, searching for changes in genes rendering them nonfunctional during the 75 million years since the divergence of the two lineages, reveal 26 losses of long-established genes till now. Though acyltransferase-3 (ACYL3) exists throughout the whole tree of life, it is not present in humans! Comparative study between human, chimpanzee, rhesus monkey, mouse, rat, dog and opossum reveal that six genes were lost *only* in the humans[21].

Some genes examined showed evidence for *negative* selection, so that harmful mutations causing hereditary diseases, Usher syndrome (congenital blindness and deafness) are wiped out of the population.

Almost all genes hold variation in reserve that is released only when they are functionally compromised. The seeds of evolution are continuous in Nature, sprouting under congenial circumstances only.

Neither Lamarckism nor Darwinism could pinpoint any single cause for a particular variation, or unravel the mystery of evolution as a whole, but, Darwin's theory is satisfying because it showed the way in which simplicity could change into complexity, how unordered atoms could group themselves into ever more complex patterns until they ended up making *Homo sapiens*.

Though these revolutionary inferences couldn't take place without knowledge of heredity and modern technology; in the words of the noted Zoologist, George Gaylord Simpson, "Charles Darwin is the genius who, though fallible as all of us are, revolutionized scientific scrutiny and knowledge of our origins and of our physical relationship to Nature and the Universe." ❐

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