Allan Charles Wilson (1934-1991) [1]

By: Haskett, Dorothy


Allan C. Wilson studied genes [5], proteins, and body structures of animals and humans [6] in the US during the second half of the twentieth century. Wilson also studied human evolution [7], although morphology [8] and behaviors of humans [6] (Homo sapiens [9]) and great apes differ, Wilson found that they have biochemical and genetic similarities. Wilson and his colleagues calculated the time period of humans [6] and African apes' common ancestor. Wilson and his team also studied DNA outside of the nucleus [10] in the cellular energy producing particles, called mitochondrial DNA (mtDNA), to study when different human groups evolved from each other.

Wilson was born on 18 October 1934 in Ngaruawahia, New Zealand, to Eunice B. Wood and Charles Wilson. Wilson grew up on a cattle ranch in Pukekohe, New Zealand, with his sister Coleen, and his brother Gary. He attended secondary school at King's College in Auckland, New Zealand. There, he met Campbell P. McMeekan, who advised Wilson to study biochemistry and go to Otago University in Dunedin, New Zealand. Wilson obtained a undergraduate degree in biochemistry from Otago University in 1955. After graduating, he left New Zealand for the University of Washington in Pullman, Washington, where in 1957 he received a Master's of Science degree in zoology with the supervision of Donald Farner, and Wilson received a PhD in 1961 in biochemistry from the University of California at Berkeley [11] with Arthur Pardee as an advisor.

Wilson married Leona Greenbaum on 13 September 1958, and they had two children, a daughter Ruth and a son David. After postdoctoral work from 1961 to 1964 at Brandeis University in Boston, Massachusetts, working with Nathan Kaplan, Wilson returned to Berkeley for the remainder of his career and built a molecular evolution [7] laboratory. Wilson was assistant professor from 1964 to 1968, associate professor from 1968 to 1972 and full professor at Berkeley from 1972 until his death.

Wilson combined his background in biochemistry and zoology to study the evolution [7] of different species. In the 1960s many claimed that African apes were humans' closest living relatives. For more than a hundred years, scientists had debated the time of origin of a distinct hominid linage. The fossil record yielded estimates that a common ancestor of African apes and modern humans [6] lived from four million to thirty million years ago. Rather than relying solely on fossils, Wilson studied the genetic relationships of currently living species.

In the 1960s and early 1970s, technologies to directly determine DNA sequences did not exist. Wilson instead used proteins to study the relatedness of humans [6] and apes. He separated and purified proteins from one species and injected them into another unrelated species to induce the production of proteins known as antibodies, which react with the foreign proteins and create an immune response. The antibodies resulting from this experiment are specific to the proteins used to generate them and, when compared to other antibodies, can be used determine the relatedness of proteins from different species. Wilson used electrophoresis, a technique that sends a constant electric current through a mixture of proteins suspended in a gel, to compare the size and acidity, or surface charge, of proteins from humans [6] and apes different species. He assumed that the more alike protein molecules are from different species, the more recently they shared a common ancestor.

In the mid 1960s, Wilson and his doctoral student Vincent Sarich used antibodies to study the differences between blood proteins in African apes and modern humans [6]. In 1967, Sarich and Wilson published "Immunological Time Scale for Hominid Evolution," in which they proposed the hypothesis of a molecular clock to calculate the time of species divergence. Sarich and Wilson compared the blood protein albumin from humans [6] and chimpanzees, presupposing that mutations accumulate within a species over time at a steady rate. They used the concept of a molecular clock to compare the differences between human and chimpanzee albumin, and calculated that humans [6] and African apes shared a common ancestor as recently as five million years ago. Those results challenged the fossil-derived figure of fifteen to twenty-five million years ago.

In 1975, Wilson and his graduate student Mary-Claire King published "Evolution at Two Levels in Humans and Chimpanzees." They used four different techniques to compare forty-four structural genes [5] from humans [6] and chimpanzees and estimated that the proteins synthesized from those genes [5] differed by only one percent. In the article, King and Wilson note that the one percent difference contrasts sharply with the huge morphological and behavioral differences between the species that evolved after the separation of human and chimpanzee lineages. King and Wilson hypothesized that mutations, gene rearrangements, and deletions probably occurred in regulatory genes [5] that affected gene expression or altering the nucleotide sequence of gene promoters. They based that hypothesis on François Jacob's and Jacques Monod's 1961 model for gene regulation [12], called the operon model. As techniques to directly compare DNA base pairs were not yet available, King and Wilson used protein amino
acid sequences to compare human and chimpanzee \textit{genes} \cite{5}. In 2005, after the Human Genome Project had described the entire human \textit{genome} \cite{13}, researchers compared the human \textit{genome} \cite{13} to the chimpanzee \textit{genome} \cite{13}. They concluded that the one percent difference noted by King and Wilson represented only point mutations, which are mutations to single bases in DNA, that occurred after the evolutionary split between \textit{humans} \cite{6} and chimpanzees.

In the 1980s, Wilson started to implement new techniques to isolate and purify DNA. By taking DNA from different animals, heating the DNA to separate the two strands, and hybridizing it with the other animals’ heated DNA, Wilson could see how well DNA from one species bonded with the DNA from the other. The introduction of enzymes that cut DNA molecules at precise points, called DNA restriction enzymes, and the ability to map known restriction sites to a sequence of DNA, called DNA restriction maps, enabled researchers to compare the DNA nucleotide sequences at high resolution. In Wilson’s laboratory, researchers refined techniques in which a small amount of DNA is replicated many times to make multiple copies of the original DNA sequence, called Polymerase Chain Reaction (PCR). Researchers used PCR to study DNA sequences in many species.

In the late 1980s, Rebecca L. Cann, Mark Stoneking, and Wilson used the technique of DNA restriction maps to analyze the mitochondrial DNA (mtDNA) from five different human geographic populations. MitDNA lies outside the \textit{nucleus} \cite{10} in a cell’s cytoplasm in the subcellular particles (organelles) called mitochondria, which produce energy for the cell. The small double stranded ring of mtDNA codes for thirty-seven \textit{genes} \cite{5}, compared to approximately 30,000 \textit{genes} \cite{8} coded in nuclear DNA (nDNA). MitDNA mutates at a higher rate than does nDNA. In the process of inheritance from parents to offspring, all of the mitochondria come from the egg \cite{14} cell (oocyte \cite{15}), unchanged from mother to offspring except for mutations.

In 1987, Cann, Stoneking, and Wilson published the results of their study as "Mitochondrial DNA and Human Evolution." By combining mtDNA sequence data from different human geographic populations and applying the molecular clock hypothesis, Cann, Stoneking, and Wilson traced the modern human gene pool to Africa and a common female ancestor who lived approximately 200,000 years ago. Mass media called this ancestor Mitochondrial Eve or African Eve.

As technologies became available to directly study DNA sequences, Wilson’s laboratory adopted them. Over the years, Wilson applied new techniques such as DNA restriction enzymes, DNA hybridization, and a technique amplifying small samples of DNA using PCR. Moreover, Wilson’s laboratory was the first to use PCR to amplify fossil DNA from extinct species and human mummies. That technique enabled researchers to compare ancient DNA with DNA from species living today.

Wilson published greater than 300 papers and articles with students and faculty members. He mentored greater than 100 undergraduate and graduate students, postdoctoral researchers, and visiting professors from six continents. With his direction, thirty-four doctoral students, seventeen women and seventeen men, obtained their PhDs.

Wilson received many awards, including two Guggenheim Fellowships and the MacArthur Fellowship in 1986. Wilson was an elected a member of the \textit{American Academy of Arts and Sciences} \cite{16} and, on 20 March 1986, he became a fellow of the Royal Society of London. In 1991, Wilson received the 3M Life Sciences Award from the Federation of American Societies for Experimental Biology (FASEB).


\textbf{Sources}

Allan C. Wilson studied genes, proteins, and body structures of animals and humans in the US during the second half of the twentieth century. Wilson also studied human evolution. Although morphology and behaviors of humans (Homo sapiens) and great apes differ, Wilson found that they have biochemical and genetic similarities. Wilson and his colleagues calculated the time period of humans' and African apes' common ancestor. Wilson and his team also studied DNA outside of the nucleus in the cellular energy producing particles, called mitochondrial DNA (mtDNA), to study when different human groups evolved from each other.