George McDonald Church (1954- ) [1]

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Keywords: sequencing [2] synthetic life [3]

George McDonald Church studied DNA from living and from extinct species in the US during the twentieth and twenty-first centuries. Church helped to develop and refine techniques with which to describe the complete sequence of all the DNA nucleotides in an organism's genome [4], techniques such as multiplex sequencing, polony sequencing, and nanopore sequencing. Church also contributed to the Human Genome Project, and in 2005 he helped start a company, the Personal Genome Project. Church proposed to use DNA from extinct species to clone and breed new organisms from those species.

Church was born on 28 August 1954 to Virginia A. Strong and Henry S. McDonald III. His father was a lieutenant in the United States Air Force, and Church was born on MacDill Air Force Base near Tampa Bay, Florida. When Church was three-years-old, his parents allowed Peyton Jordan to adopt Church. In 1963, Church was again put up for adoption. This time, Gaylord Church adopted and raised Church. He completed high school at Phillips Academy in Andover, Massachusetts. He then completed undergraduate degrees in zoology and chemistry in 1974 at Duke University in Durham, North Carolina, in two years. He pursued his doctoral degree in biochemistry from Duke, but he was expelled due to failing grades in 1976.

Church then applied to Harvard University [5] in Cambridge, Massachusetts, and was accepted in 1977. In 1984, Church completed a PhD at Harvard in molecular biology while developing a direct genome [4] sequencing technique as a part of his dissertation. At Harvard, Nobel Prize recipient Walter Gilbert [6] advised his dissertation research. At that time, researchers described the sequence of nucleotides in strands of DNA, a process called sequencing, by using bacteria. They used the bacteria to replicate one strand of DNA into many strands with the same nucleotides, but the process lost genetic information. Researchers injected DNA into bacteria and allowed the bacterial cell to replicate the DNA, sometimes causing errors in replication. Church and Gilbert developed a technique that ameliorated some of those errors.

Church continued to develop new sequencing methods. In 1984, The Human Genome Project consulted Church about gene sequencing. In 1986, Church became an assistant professor at Harvard Medical School [7] in Boston, Massacussetts. While at Harvard in 1988, Church developed the method of multiplex DNA sequencing. Multiplex sequencing takes strands of DNA and gives them chemical tags and then sends them through an automated DNA sequencing machine. The machine can sequence multiple strands of DNA simultaneously, due to the chemical tags that the researcher attached. Multiplex DNA sequencing enabled a greater volume of sequences to be decoded in a shorter amount of time, making the Human Genome Project feasible.

In the 1990s, Church assisted in the development of another sequencing technique, called nanopore sequencing. For this technique researchers measure the change in electrical current at a nanopore, which is one nanometer in diameter, as each successive nucleotide on a DNA strand passed through it. Each kind of nucleotide registers a different voltage. In 1998 Harvard promoted Church to full professor in the medical school.

Polony sequencing further enabled researchers to use machines to automate the process of DNA sequencing. In conjunction, Church developed a commercially available sequencing machine, the Polonator G.007, which made DNA sequencing about one hundred times less expensive than it had been. Polony sequencing led Church to establish in 2005 the Personal Genome Project, an open source, open access genome [4] bank. Scientists used the information stored in such a bank to study genomic interactions with the environment, traits that the genes [8] express, and to better describe and explain the links between genes [8] and disease.


By 2015, Church had published greater than 400 scientific articles and dozens of patents. Church's work spawned twelve commercial enterprises using synthetic biology to produce, among other things, bio-fuels, synthetic photo-synthesizers, and pharmaceuticals.

Sources
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**Subject**
- DNA sequence
- Nucleotide sequence analysis
- Nucleotide sequence
- Genes
- Genomes
- Genetics
- Genomics
- Molecular genetics
- Harvard University
- Gilbert, Walter, 1932-
- Human Genome Project
- Sequence Analysis, DNA
- High-Throughput Nucleotide Sequencing
- Nanopores

**Topic**