

## Timeline to the Human Genome Project

Deciphering the human genome is one of mankind's great achievements. Below are some selected quotes from the authoritative accounts on the origin of the Human Genome Project. They chronicle the seminal role played by the search for the breast cancer gene.

Year	Quotes and Commentary	Source
1974	Dr. Mark Skolnick "came to Salt Lake in 1974 to help organize and preserve its family records, the one million Mormons ... the extensive, meticulous records of family medical history going back 150 years."	<i>Breakthrough</i> <sup>1</sup>
1974	"Skolnick's hope was to check the genealogies against hospital records of breast cancer patients..."	<i>The Gene Wars</i> <sup>2</sup> page 54
1976	He was "setting the stage for a groundbreaking insight that would change the history of gene hunting."	<i>Curing Cancer</i> <sup>3</sup>
1977	Dr. Walter Gilbert co-developed A new method for sequencing DNA for which he won the Nobel Prize.	<i>Proceedings of the National Academy of Sciences of the United States of America</i> <sup>4</sup>
1978	In Alta, Utah, (meeting #1), Dr. Skolnick gathered his graduate students with visiting professors, David Botstein and Ron Davis, to review their gene discovery efforts. One student "lamented how frustrated the Utah researchers were in their search for a breast-cancer susceptibility gene..."	<i>Genome</i> <sup>5</sup> page 60
1978	"what they really wanted was a marker for the breast cancer gene"	<i>Breakthrough</i> <sup>1</sup>
1978	"If one could only find enough genetic linkage markers spanning the chromosomes, a full-blown map should be possible."	<i>The Gene Wars</i> <sup>2</sup>
1980	The Alta session produced the first gene mapping technique. "We describe a new basis for construction of a genetic linkage map of the human genome...no method of systematically mapping human genes has been devised."	<i>The American Journal of Human Genetics</i> <sup>6</sup>

1980	From this mapping technology, known as RFLP (pronounced riflip), "...a revolution began in human genetics. The manifesto of this revolution was a 1980 joint paper published in The American Journal of Human Genetics."	<i>The Gene Wars</i> <sup>2</sup>
1980	"The riflip map proposed by Skolnick, Botstein, White and Davis was the key to...mapping of the human genome."	<i>Genome</i> <sup>5</sup>
1980	"Thanks to the RFLP technology and DNA polymorphisms, scientists searching out genes decided to launch a major effort to identify all 100,000 or so genes, eventually creating the international Human Genome Project and the National Center for Human Genome Research run by the U.S. Federal government."	<i>Curing Cancer</i> <sup>3</sup> page 126
1980	"There is no way to overstate the importance of the (riflip) discovery....it eventually persuaded biologists that the tools were at hand to undertake the so-called Human Genome Project, the ambitious global effort to identify all 100,000 genes -- the set of instructions for human biology." --Quote from Francis Collins, Director of the NIH and Director of Human Genome Research	<i>Curing Cancer</i> <sup>3</sup>
December 1984	A second seminar was held at the ski resort where Dr. Skolnick and his colleagues conceived of their genetic mapping technique (Alta #2). Here scientists presented the first few RFLPs and reviewed the other DNA techniques available at that time.	<i>Gene Wars</i> <sup>2</sup> page 94
May 1985	A conference dubbed "Genesis: the Sequel" was held to assess the feasibility of a genome sequencing institute at the University of California at Santa Cruz. The group of scientists gathered there "decided that it made sense to systematically develop a genetic linkage map". At this meeting, Dr. Walter Gilbert realized the possibility of sequencing the entire human genome. "Gilbert became the principal spokesman for the Human Genome Project."	<i>Gene Wars</i> <sup>2</sup>
June 1986	Renato Dulbecco, Nobel Laureate and President of the Salk Institute wrote "A Turning Point in Cancer Research: Sequencing the Human Genome".	<i>Science</i> <sup>7</sup>
June 1986	"The article, as published, was considerably shortened from a draft that expanded on how sequence information might tease	<i>Gene Wars</i> <sup>2</sup>

	<p>apart factors explaining the heterogeneity among breast cancer genes."</p>	
June 1986	<p>In the Science piece, "Dulbecco argued that cancer progression could only be understood once a map was prepared. The DNA sequence was such a map at its ultimate resolution."</p>	<i>Gene Wars</i> <sup>2</sup> page 108
June 1986	<p>Dulbecco wrote: "We can try to discover the genes important in malignancy by a piecemeal approach, or to sequence the whole genome...."</p> <p>"Its significance would be comparable to that of the effort that led to the conquest of space and it should be carried out with the same spirit."</p>	<i>Science</i> <sup>7</sup>
June 1986	<p>Dulbecco's Science article "provoked discussions in the laboratories of universities and research centers throughout the world." Jonas Salk suggested that Kevin Kimberlin read the paper.</p>	<i>Gene Wars</i> <sup>2</sup> page 107
June 1986	<p>At a landmark symposium at Cold Springs Harbor, Dr. Gilbert estimated the cost and time frame to produce a reference genome at \$3 billion spent over 15 years. Concerned over the estimate for full sequencing however, the symposium consensus suggested "a transition from emphasizing the sequencing of the human genome to a broader plan for genetic linkage mapping..."</p> <p>Dr. Skolnick's approach to the Human Genome took the early lead over Dr. Gilbert's sequencing plan.</p>	<i>Gene Wars</i> <sup>2</sup> page 113
October 1990	<p>Nobel Laureate James Watson, the first director of the \$3 billion Human Genome Project, announced the "...official start date for the genome project" on October 1, 1990.</p>	<i>Gene Wars</i> <sup>2</sup> page 315
November 1991	<p>One year later, in November 1991, the men who devised the tools which drove the Human Genome project (gene mapping and gene sequencing) joined with entrepreneur Kevin Kimberlin to search for the genetic basis for cancer. "Mark Skolnick and Dr. Gilbert, who brought with him Kevin Kimberlin" launch Myriad Genetics.</p>	<i>Breakthrough</i> <sup>1</sup> page 199

October 1994	Myriad Genetics discovered the breast cancer gene BRCA1. “A strong candidate for the breast and ovarian cancer susceptibility gene, BRCA1.”	<i>Science</i> <sup>8</sup>
December 1994	"...The level of reporting on the recent identification of BRCA1...suggest that this discovery is the most exciting breakthrough in modern times."	<i>The New England Journal of Medical</i> <sup>9</sup>
1995	About BRCA1, “There is no more exciting story in medical science.” --James Watson, Nobel Prize winner, co-discoverer of the DNA helix.	<i>Breakthrough</i> <sup>1</sup> cover
May 2007	“The full genome of James D. Watson, one of the discoverers of the structure of DNA in 1953, has been deciphered, marking what some scientists believe is the gateway to an impending era of personalized genomic medicine.” Dr. Watson published it so “our genomes can be used to identify and prevent disease.”	<i>The New York Times</i> <sup>10</sup>

Many deserve credit for the Human Genome Project including researchers (Renato Dulbecco, James Watson), academics (Ray White, Robert Sinsheimer), and government officials (Charles DeLisi, Francis Collins).

But special recognition should be awarded to Dr. Mark Skolnick for his role at the origin of this series of events. The gene-mapping tool that emerged from his breast cancer gene quest, made deciphering the human genome both conceivable and possible. As the sources above chronicle, Dr. Skolnick’s work stimulated Dr. Walter Gilbert to first conceptualize and then proselytize the Human Genome Project.

To derive practical value from the Human Genome Project, Dr. Skolnick and Dr. Gilbert (together with Peter Meldrum and Kevin Kimberlin) started the first company solely dedicated to finding disease-causing genome sequences. Their discovery of the breast cancer gene was a major breakthrough in the genome revolution. The breast cancer gene hunt was thus the impetus for the Project, while its discovery was its first major validation and a major breakthrough in the genome revolution.

**The Authoritative Sources:**

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2. Cook-Deegan, Robert M. *The Gene Wars: Science, Politics, and the Human Genome*. New York: W.W. Norton, 1994. Print.
3. Waldholz, Michael. *Curing Cancer: The Story of the Men and Women Unlocking the Secrets of Our Deadliest Illness*. New York, NY: Simon & Schuster, 1997, pg, 113
4. Gilbert, Walter, Md, and Allan Maxam, Md. "Biochemistry." *Proceedings of the National Academy of Sciences, USA*. Vol. 74. No 2. p 560-64.
5. Bishop, Jerry E., and Michael Waldholz. *Genome: The Story of the Most Astonishing Scientific Adventure of Our Time--the Attempt to Map All the Genes in the Human Body*. New York, NY: Simon and Schuster, 1990, p 60.
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9. Weber, Barbara, MD. "Susceptibility Genes for Breast Cancer." *The New England Journal of Medicine* 331.Dec (1994): 1523-524.
10. Wade, Nicholas. "Genome of DNA Pioneer Is Deciphered." *The New York Times* 31 May 2007: n. pag. Print.