

10.1 James Watson and Francis Crick

On February 28, 1953, Francis Crick entered the Eagle Pub in Cambridge, England and excitedly announced, "We found the secret of life." James Watson and Francis Crick cracked the puzzle that several other researchers tried so hard to solve—the structure of DNA. The two researchers were an unlikely pair with different educational backgrounds and a 12-year age difference. However, their enthusiasm for science and strong wills led to one of the greatest discoveries in molecular biology.



A whiz kid on Quiz Kids

James Dewey Watson was born in Chicago, Illinois on April 6, 1928. He was a very intelligent child who enjoyed spending his free time bird watching. By age 12, Watson starred on the popular radio show of the 1940s, The Quiz Kids. On the show, young contestants answered difficult questions. Watson finished high school in 2 years and entered the University of Chicago when he was only 15 years old. In 1947, Watson graduated with a degree in zoology (the study of animals).

In 1950, Watson earned a doctorate in zoology from Indiana University. Although Watson still had a strong interest in ornithology (the study of birds), he pursued research in genetics and microbiology. Between 1950 and 1951, Watson went to Copenhagen, Denmark where he studied bacterial viruses.

A first glimpse of DNA

In the spring of 1951, Watson attended a conference in Naples, Italy. Watson met Maurice Wilkins, a researcher from King's College in London. At the meeting, Wilkins presented photos of DNA using a special x-ray technique called x-ray crystallography.

To Watson's eye, Wilkins' blurry picture of DNA showed a regular, repeating pattern. This first glimpse of the molecule marked the beginning of Watson's quest to find the structure of DNA.

Two great minds team together

After the Naples conference, Watson tried to talk his way into Wilkins' research lab. However, Watson was denied entrance because he didn't know much about x-ray crystallography. In October 1951, the 23-year old Watson began working at the Cavendish Laboratory in England where there were many x-ray crystallography projects underway.

Already working at the laboratory was a researcher named Francis Harry Crick. Crick was born on June 8, 1916 in Northampton, England. In 1937, he received his degree in physics at University College, London. He then began his doctorate degree, but stopped at the outbreak of World War II in 1939. During the war, Crick designed mines for the British Admiralty.

In 1947, Crick left the Admiralty and decided to study biology and organic chemistry for the next several years. In 1950, Crick began his doctorate for a second time at Caius College, Cambridge. Crick was part of the Medical Research Council Unit at the Cavendish Laboratory of Cambridge.

Newcomer Watson had much to learn about x-ray crystallography. He was assigned to share an office with Crick who knew a lot about the subject. Although the two men seemed an unlikely pair because of their 12-year age difference, a strong friendship and working relationship began. Watson's biology background and Crick's expertise in x-ray crystallography was a perfect partnership.

The race begins

By 1951, Crick had been already interpreting the x-ray patterns of proteins. Within a few days of arriving at Cavendish Laboratory, Watson talked with Crick about using this technique on DNA. Crick became excited by the idea.

Meanwhile, the Nobel Prize winning chemist Linus Pauling had already published his model of proteins using x-ray crystallography. He found that many proteins spiral like a spring coil—an alpha helix. Pauling's next goal

was to solve the structure of DNA. Watson and Crick decided that they would imitate Linus Pauling's work and crack the structure of DNA before Pauling did.

Two other scientists at King's College in London were also searching for the structure of DNA. One was Maurice Wilkins, whose DNA photo Watson had seen at the Naples Conference. The other scientist was Rosalind Franklin. Watson decided to attend a lecture given by Franklin to learn more about her research.

Watson returned to Cambridge with a sketchy memory of Franklin's presentation. Watson and Crick created a model of DNA using this information, but it failed miserably. Watson and Crick's supervisor told them to stop their DNA research, but the two refused to give up.

Discovering the double helix

Although Franklin and Wilkins were conducting similar research, the two did not get along. Therefore, Franklin mostly did her research alone. She suspected that DNA had a helical shape, but wanted more evidence to support her theory. Wilkins was growing impatient with Franklin. Without Franklin's permission, he decided to show Watson her data. This was the key information that Watson and Crick needed to solve the DNA puzzle.

Watson and Crick took Franklin's data and realized that DNA was made of two chains of nucleotides forming a double helix. They found that one chain went up, while the other went down. They had also recently learned about matching base pairs (adenine, thymine, cytosine, and guanine) and added this concept to their model. The matching base pairs interlocked in the middle of the double helix, which kept the distance between the chains constant.

Watson and Crick also showed that each chain of the DNA molecule was a template for the other. When the DNA strands separate during cell division, new strands are built off of the existing strands.

On February 28, 1953 Francis Crick entered the Eagle Pub in Cambridge, England to share in their exciting news. He announced, "We found the secret of life."

A Nobel Prize is awarded

Watson and Crick's DNA model fit perfectly with the data and was quickly accepted. In 1962, Watson, Crick, and Wilkins were awarded the Nobel Prize for physiology and medicine.

Despite providing key data about DNA's structure, Franklin did not share in the prize. Unfortunately, she had already died of cancer in 1958 at the age of 37. The Nobel Prize can only be given to living recipients and can only be shared among three winners. The question remains whether Franklin would have been awarded the prize if she were still alive.

Life after solving the puzzle

After solving the DNA puzzle, Watson and Crick's careers took them in different directions. In 1956, Watson started his 20-year position as professor of biology at Harvard University. In 1968, Watson also served as director of Cold Spring Harbor Laboratory of Quantitative Biology in Long Island, New York. The laboratory became a key research center in molecular biology.

In 1968, Watson published his book *The Double Helix*, which described his firsthand account of the DNA discovery. From 1988 to 1992, Watson headed the National Center for Human Genome Research at the National Institutes of Health. Today, Watson continues to give public speeches and is chancellor of Cold Spring Harbor Laboratory.

Crick remained at Cambridge for 20 years and continued to study DNA. He made major contributions in solving how genetic information is coded. In 1962, Crick became director of Cambridge University's Molecular Biology Laboratory. He also held several visiting professor positions in the United States during this time. He later joined the Salk Institute for Biology Studies in La Jolla, California.

In 1966, Crick wrote *Of Molecules and Men*, which described the impact of recent biochemistry discoveries. He also developed an interest in neurobiology and did research on vision and the function of dreams. Crick died in July 2004 at the age of 88.

10.1 Rosalind Franklin



Rosalind Franklin was a physical chemist whose data helped solve the structure of DNA. She is also known for her research on coal and carbon during World War II and for her celebrated work on viruses.

A child who liked reasons and facts

Rosalind Elsie Franklin was born in London, England on July 25, 1920. She came from an educated and socially conscious Jewish family. Her father was a banker and her mother actively volunteered in the community.

As a child, Franklin didn't enjoy playing pretend games. Instead, she liked reasons and facts. Franklin attended St. Paul's Girls' School in London—one of the few girls' schools that taught physics and chemistry. By age 15, Franklin knew she wanted to be a scientist. However, her father didn't support higher education for woman and wanted Franklin to become a social worker. Franklin's mother and aunt convinced her father to pay for college.

Wartime research

In 1941, Franklin graduated from Newnham College, Cambridge. World War II was underway when Franklin began working for the British Coal Utilization Research Association in 1942. Through air raids, Franklin courageously bicycled each day to her job. She studied the physical structure of coal and carbon to find a more efficient way for England to use these resources. At the young age of 26, Franklin published five papers on the subject. In 1945, she earned a doctorate in physical chemistry from Cambridge University.

From 1947 to 1950, Franklin joined the Laboratoire Central des Services Chimiques de l'Etat in Paris. There, she mastered a special x-ray technique called x-ray crystallography.

X-ray crystallography and DNA

Franklin returned to England in 1951 to work as an x-ray crystallography expert at King's College in the University of London. Franklin was assigned to study the structure of DNA. She was under the impression that only she would be performing this research.

However, Franklin soon discovered that another scientist, Maurice Wilkins, was also assigned to the project. Unfortunately, Franklin and Wilkins had difficulty getting along.

To make matters worse, female scientists at King's college were treated differently than the men. They were not allowed to eat lunch with the men in the common room and were not invited to join in afterwork discussions.

Photo 51 and the DNA puzzle

Because of the strained relationship between Franklin and Wilkins, Franklin conducted her research alone. Franklin was growing very close to solving the DNA structure. She suspected that DNA had a helical shape, but wanted more evidence to support her theory. Wilkins was growing impatient with Franklin.

James Watson and Francis Crick were two other scientists from the Cavendish Laboratory of Cambridge who were also searching for the structure of DNA. Without Franklin's permission, Wilkins showed Watson her DNA data. This included a stunning picture Franklin labeled "photograph 51" that showed DNA's double helix structure. This information helped Watson and Crick solve the DNA puzzle.

Viruses and RNA

In 1953, Franklin left King's College and began her renowned work on viruses at Birkbeck College. Between 1953 and 1958, Franklin published 17 papers on the topic. Her research helped to establish the link between RNA and protein. Up until her death, Franklin also conducted research on the poliovirus.

An untimely death

Rosalind Franklin died at the age of 37 on April 16, 1958, of ovarian cancer. Four years after her death, the Nobel Prize for medicine and physiology was awarded to Watson, Crick, and Wilkins. Despite providing key data about DNA's structure, Franklin did not share in the prize. The Nobel Prize can only be given to living recipients and shared among three winners. Many wonder if Franklin would have received the prize if she had been alive.

