Collaboration and Competition—Rosalind Franklin's Story

by Aimée Stephenson

Rosalind Franklin
(Cold Spring Harbor University Archives)

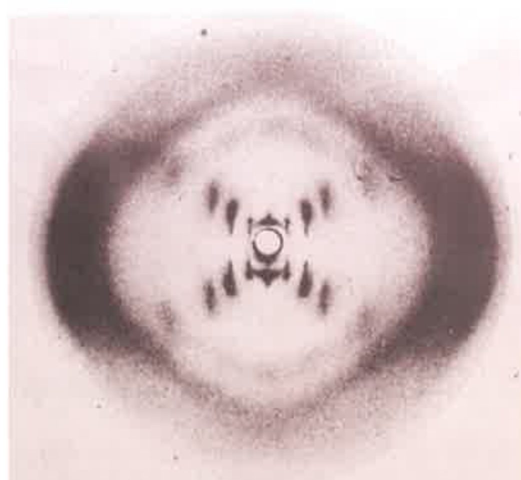
If one were only to encounter James Watson's depiction of Rosalind Franklin in *The Double Helix,* they would be left with an inaccurate portrait of a difficult and confrontational scientist who lacked the intellect to understand her own data. Fortunately, Anne Sayre in *Rosalind and DNA,* and later, Brenda Maddox in *Rosalind Franklin: The Dark Lady of DNA,* provide insights into Franklin's character and help illuminate her important contribution to the understanding of double-helical DNA.

In January 1951, after spending four years working in a French national chemistry laboratory, Franklin joined J.T. Randell's biophysics research group at King's College in London. It is well known that Franklin did not get along with Maurice Wilkins, assistant director of the biophysics unit, although he was a natural candidate for collaboration given that he, like Franklin, was assigned the task of using x-ray crystallography to obtain diffraction photographs of DNA fibers. A lesser known detail is that Randell deliberately manipulated a misunderstanding between Franklin and Wilkins "in order to push him [Wilkins] aside and himself get back into what was revealing itself as the most exciting project in biophysics"(Maddox, 150).

Despite the challenges she faced at King's College, Franklin produced superb x-ray photographs of DNA. Perhaps her early education contributed to this excellence. When Franklin was young, her Nanny taught her to knit and to be a perfectionist about her handiwork. School reinforced this value. "Science was taught to girls in a different way than to boys: an intellectual endeavor calling for neatness, thoroughness, and repetition rather than excitement and daring" (Maddox, 33). Jacques Merring, who taught Franklin x-ray crystallography when she was in France, "found in Rosalind the best student he ever had: brilliant, hungry to learn, incredibly dexterous in her research techniques and ingenious in experiment design" (Maddox, 96). Thus, it was no wonder that she was able to produce superbly clear x-ray photographs.

In the meantime, at the Cavendish Laboratory in Cambridge, James Watson was pursuing knowledge of what the gene was. His mentor, Max Delbruck, "had persuaded him that understanding the gene was the problem of the century. Whoever accomplished it would be covered with honor. Honor was what Watson wanted" (Maddox, 158). Along with Francis Crick, his approach was to build structural models of DNA. "Their operating principle was clear, and it was the opposite of Rosalind's: to incorporate the minimum number of experimental facts" (Maddox, 164). To Franklin, "The whole approach was unprofessional. The way to proceed was not to make a hypothesis until the experimental facts were in hand, then not to publish any results until the facts were absolutely certain" (Maddox, 165). She was extremely conservative in communicating her data. She was also reluctant to collaborate with Wilkins or anyone else.

Franklin's x-ray photographs were much sought after by Watson and Crick. Watson felt Franklin was "incompetent in interpreting x-ray photographs" (Watson, 106) and felt he could make better use of her data. Wilkins was an easy pawn. Pushed away by Franklin and "seeking sympathy for his situation, he was easily milked by Watson and Crick for information" (Creager, 66). It was from an x-ray photograph shown to them by Wilkins and an unpublished Medical Research Council (MRC) report that the two men were able to create their DNA model. Even more importantly, they were able to infer a replication mechanism—a daring revelation that required a leap of imagination on their part.



DNA B-Form
(Cold Spring Harbor University Archives)

Contrary to Watson's portrayal in *The Double Helix,* Franklin clearly understood the helical structure signified by her x-ray photographs. On February 24, 1953, close to two weeks before Watson and Crick completed their famous model of the double helix, Franklin reviewed her data and concluded that "the A and the B forms [of DNA] were both two-chain helices" (Maddox, 201). Nonetheless, Franklin did not completely understand the significance of her

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data and "everything in her education and background had taught her to be absolutely sure of her facts before she presented them to the world" (Maddox, 178).

Franklin's critical mistake was a failure to recognize the significance of the monoclinic C2 symmetry in the diffraction patterns of her "B" DNA. When Crick discovered this in the MRC report, he realized that this connoted anti-parallel strands. Combined with Watson's revelations about how the bases paired, the two men were able to make the intuitive leap and come up with the idea that anti-parallel strands could serve as templates for each other in a replication scenario. It is questionable, even if she had fully understood her data, whether Franklin would have ever made this connection. She "had been trained, as a child, as a Paulina, as an undergraduate, as a scientist, never to overstate the case, never to go beyond hard evidence. An outrageous leap of the imagination would have been as out of character as running up an overdraft or wearing a red strapless dress" (Maddox, 202).

In the end, are we to believe that Franklin was a victim of her education and training, never encouraged to take daring chances? While this is a possibility, what we know for sure is that she "provided all of the essential data for those who took the two brilliant leaps of intuition—to anti-parallel chains and base pairs—that cracked the problem" (Maddox, 202). Franklin was an excellent experimentalist and her data were "fundamental to the discovery" (Maddox, 210). Was she passed over for the Nobel prize? Perhaps. However, it was "awarded to Watson, Crick, and Wilkins four years after her death, and the prizes are never awarded posthumously" (Creager, 66). Regardless, we can be certain that Rosalind Franklin is among a distinguished few who contributed to our basic knowledge about the double helix.

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Rosalind Franklin (1920–1958)

Rosalind Franklin was born in London, England on July 25, 1920. She earned her doctorate in physical chemistry from Cambridge University in 1945. From 1947–1950 she visited the Laboratoire Central des Services Chimiques de l'Etat in Paris and learned about X-ray crystallography. From 1951–1953 Franklin worked at King's College studying DNA with x-ray crystallography. Franklin headed her own research group at Birkbeck College in London from 1953–1958. While there she began researching viruses, specifically the tobacco mosaic virus. Franklin died on April 16, 1958 of ovarian cancer. Two months after her death, two of her models of virus molecules went on display at the World's Fair in Brussels.

From the Double Helix to the Human Genome: A Journey of Discovery

by Mark V. Bloom

When Watson and Crick published the structure of DNA in 1953 they could scarcely have imagined how far it would advance genetics in the next fifty years. As scientists incorporated this new understanding about the structure of DNA into their thinking, new questions began to emerge. During the late 1950s, the big question in biology became how does the sequence of DNA encode information that is expressed as a sequence of amino acids? This was thought to be an intractable problem that might take fifty years to solve; however, the genetic code was completely worked out by 1966. Likewise, when rapid methods for sequencing DNA became available in 1977, the idea of sequencing the entire human genome seemed like science fiction. Yet it was only 24 years later on February 15, 2001 when a rough draft of the human genome was published in *Nature.* Some journalists hailed the achievement as publishing the "Book of Life." Many scientists were uncomfortable with that description of what they knew to be a still incomplete story. Nevertheless, we might consider these first descriptions to be the first sketchy "book reports" of our human story.

For the students now in elementary, middle, and possibly even high school, awareness of the human genome may seem ordinary and commonplace. For those who work to educate students of any age and the public, it is important to help develop an appreciation of the enormity of the project. This article, includes some of the initial observations about the

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