HEADSTRONG

52 WOMEN WHO CHANGED SCIENCE— AND THE WORLD

RACHEL SWABY

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ROSALIND FRANKLIN

1920–1958

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THE DISCUSSION OF ROSALIND FRANKLIN'S LIFE AND WORK often rotates around one impossible question: Had she not died of ovarian cancer at the age of thirty-seven, would she have shared the 1962 Nobel with James Watson and Francis Crick? That answer is probably not.

The conclusion stings because there was some definite wrongdoing. In Watson's bestselling book *The Double Helix*, which recounts his and Crick's discovery of DNA, Watson caricatured Franklin cruelly. She was "Rosy" (a name she did not like), who "might have been quite stunning had she taken even a mild interest in clothes." *Rosy*, who was curt and reactive and caused everyone working with her misery. *Rosy*, who could not possibly be considered serious competition in the quest to nail down the structure of DNA.

Because she had been dead for a decade when *The Double Helix* was published, others spoke for her. It was "a mean, mean book," remembered the Nobel Prize–winning geneticist Barbara McClintock. Another geneticist, Robert L. Sinsheimer, called Watson's portrait of Franklin "unbelievably mean in spirit, filled with the distorted and cruel perceptions of childish insecurity." Anne Sayre, a friend and Franklin biographer, complained that Watson had "carelessly robbed Rosalind of her personality."

Watson's portrayal of Franklin, however, was made worse by this cavalier disclosure: Rosy "did not directly give us her data." And there it was, a stunning admission hidden between chapters of gloat. When others tugged on the dangling thread, the portrayal of Franklin began to unravel. Watson may have found her someone unpleasant to work with, but his experience was by no means universal. She was a competitor—and far ahead of Watson and Crick during much of the search for DNA. The rival pair simply wouldn't have made their discovery when they did had it not been for two crucial pieces of information passed from Franklin's lab at King's College in London to Watson and Crick's at Cambridge without her knowing it.

The first: a clear photo of the structure of DNA, calibrated and captured by Franklin. The second: an internally circulated report that recapped the results of her recent work. Watson and Crick had already made some headway into the structure of DNA, but they had gotten the water content and the location of the phosphate sugars wrong. Without Franklin's data, they wouldn't have had the essential pieces they needed to solve the puzzle. Franklin eventually would have come to the same conclusion as Watson and Crick—the helix, the base pairs, the direction of the phosphate chains—some say, had her work not been shared.

"All her life, Rosalind knew exactly where she was going," her mother recalled. Once her mind latched onto something, she was all in. At age six, Franklin was described by her aunt as "alarmingly clever. . . . She spends all her time doing arithmetic for pleasure, [and] invariably gets her sums right." Franklin was precise, literal, and always more at home with data than with speculation.

While Franklin was studying at Cambridge, her father complained that she felt about science as she should about religion. Franklin held her ground. "You frequently state . . . that I have developed a completely one-sided outlook and look at everything and think of everything in terms of science," she replied in a letter. "Obviously my method of thought and reasoning is influenced by a scientific training—if that were not so my scientific training will have been a waste and a failure. . . . Science and everyday life cannot and should not be separated."

How could she contribute to the World War II effort, since her father insisted? Science was the no-brainer. Following her graduation from Cambridge in 1941 and a research position, Franklin bicycled daily across prime air raid territory to a post she'd found at the British Coal Utilization Research Association. There her job was to figure out why some kinds of coal allowed gas and water to filter through and why others put up a more efficient blockade. (Charcoal had been used in gas masks, so it was important wartime research.) Franklin published five papers on the material's properties by the time she was twenty-six. Her thesis, which covered "solid organic colloids with special reference to coal and related materials," earned her a PhD. Additionally, her research in the 1940s would help advance the development of carbon fiber later on.

After the war, a friend recommended her for a job in Paris as a physical chemist, again working on coal. The three years she spent abroad were perhaps her happiest. She made friends, spoke the language flawlessly, and felt more at ease in her surroundings than she ever had at home. Tugged back to England by the feeling that London would accelerate her career, at age thirty Franklin returned to the UK.

She began work at King's College in London upon her arrival. There she took over the study of DNA, originally initiated by an interdisciplinary team that had set it aside for the better part of a year. The goal was to figure out DNA's molecular structure. To do so, Franklin lined up DNA fibers, bundled them together, and X-rayed the carefully prepared samples in 75 percent humidity and 95 percent humidity. At 95 percent, the molecules elongated, which Franklin called DNA's B-form. The pictures of DNA in this state looked like the lines of an X blinking in and out of focus—the sign of DNA's helical structure, though she didn't yet know it.

At King's College, Franklin didn't have any formal collaborators. The most obvious choice would have been Maurice Wilkins, also at King's, but an early misunderstanding about Franklin's role turned the colleagues into adversaries. Their relationship had consequences for Franklin when Wilkins, complaining to Watson about his colleague, pulled out her beautiful B-form and shared it with the American working at Cambridge without her approval.

This photograph—taken by Franklin—was a major revelation for Watson, who had been working from muddy images that were a mix of DNA's dry and wet forms. Franklin's clear image of DNA's wet form changed the way Watson and Crick understood DNA.

Watson and Crick's next breakthrough also came thanks to Franklin, and again without her knowledge. In 1952, Franklin was asked to summarize her previous year's work for a government committee. Max Perutz gave her summary to Watson and Crick. (The paper was not marked confidential, but the report also wasn't intended for any eyes outside the committee.) The report gave the pair from Cambridge crucial information about the dry and wet forms of DNA. Combined with their own research, Franklin's pieces were enough for Watson and Crick to form a solid understanding of DNA's structure. Announcing their discovery in *Nature*—that DNA was a helical ladder, with one side going up and the other going down—they claimed the prize for finding the solution without revealing Franklin's part in their discovery.

Franklin got scooped by the Cambridge team at the same time as she was on her way out at King's College. She felt that the environment wasn't good for her, and many of her colleagues agreed. As the discoverers were crowned, Franklin transferred to Birkbeck College and away from DNA research, as was stipulated in her transfer agreement.

At Birkbeck, Franklin set up a research group that looked

at ribonucleic acid's role in virus reproduction. For scientists studying a virus's molecular structure with X-rays, her group was the best in the world, revealing, among other things, how proteins and nucleic acids fit together to transmit genetic information. To study polio, Franklin convinced the wife of a colleague to sneak the virus in a thermos from the United States to London on a plane.

Despite problems with Watson, Franklin became good friends with Crick and his wife, who was French. In Franklin's last year alive, her work got a moment of public recognition. For the 1958 Brussels World's Fair, she constructed a massive six-foot-tall display of the tobacco mosaic virus, a pathogen that affects hundreds of different plants.

Word of Franklin's essential part in the discovery of DNA did not get out until Watson himself spilled it. Since then, she's become the subject of several biographies and a poster child for those who didn't receive the credit they deserved. Franklin, who was always deeply invested in data and facts, would have been happy to know that so many people cared about her concrete contributions.