

# James Dewey Watson (1928–): Co-discoverer of the structure of DNA

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James Dewey Watson was born in Chicago in Illinois, United States, on 6 April 1928, the son of a businessman tailor. He grew up an avid bird watcher and planned to be an ornithologist. His life ambition changed, however, after reading the book *What is Life* by Erwin Schrödinger, which convinced him to trade in his binoculars for a microscope to study genetics instead. Watson completed his Bachelor of Science in Zoology in 1947 at the University of Chicago and began graduate work in the genetics laboratory of Salvador Luria at Indiana University, Indiana. Luria was a member of the Phage Group of investigators who used bacterial viruses as a tool to investigate genes. Although the conventional view of the time was that proteins were genes and able to replicate themselves, Luria and his colleagues were aware of studies suggesting that DNA, not protein, was the genetic mastermind. For his graduate work, Watson used X-rays to inactivate bacterial viruses and earned his Doctor of Philosophy at age 22. Convinced that he needed to learn tools of physics and chemistry in order to uncover the structure of DNA, he moved abroad to the Cavendish Laboratory at the University of Cambridge in the United Kingdom. There, he met Francis Crick, with whom he shared a fascination with genetics and inheritance.

**RACE FOR THE DISCOVERY** As detailed in Watson's book *The Double Helix*, the path to discovering the structure of DNA was filled with drama, competition and controversy. The key players in the DNA story were Watson, Crick, Maurice Wilkins, Rosalind Franklin and Linus Pauling. Wilkins was the first investigator to take on the study of DNA and had been working painstakingly for years at King's College in London, United Kingdom. Franklin was a postdoctoral fellow in Wilkins' lab. Her data and insights were crucial for disproving Watson and Crick's first DNA model proposed in 1951 and informing their revised model. Finally, Linus Pauling, the great American chemist, was portrayed in Watson's book as their greatest competitor, and some believed he would have beaten Watson and Crick to their conclusion if he had had access to Franklin's data.

The story of Watson and Crick begins with their meeting at Cavendish. In November of 1951, Watson attended a seminar given by Franklin at which she presented her X-ray diffraction

data, indicating that DNA was structured as a helix. Following the seminar, Watson and Crick presented their first attempt at cracking the structure of DNA – a helix with the phosphate and sugar backbone inside of the helix. Franklin, however, saw a flaw in their model. She understood that the hydrophilic phosphate and sugar backbones of the nucleotide chains should be positioned outside of the molecule so as to interact with water, and the hydrophobic bases should be on the interior. The head of the Cavendish laboratory, Sir Lawrence Bragg, was embarrassed by Watson and Crick's blunder and put a halt to their work. Fortunately, a series of events caused Bragg to change his mind. Franklin was leaving Wilkins' lab for another post, and it was

unclear who would take her place in DNA research. Meanwhile, Linus Pauling was hot on the trail in the race to decipher DNA structure. He had proposed a model for DNA in early 1953, although the model incorrectly contained three helices. Since he and Pauling were bitter rivals, Bragg permitted Watson and Crick to resume their DNA work. Crick's advisor, Max Perutz, allowed him to read a summary report of Franklin's data. Although Watson

had seen the same data back in 1951, when he had attended Franklin's lecture at King's College, he lacked the background in X-ray crystallography necessary to interpret Franklin's data. With Crick's background in X-ray diffraction, he understood the data as providing evidence for a double helix ('twisted ladder' configuration), with two nucleotide chains running in opposite directions.

It is debatable whether Watson and Crick should have seen Franklin's summary report without her permission. In Watson's book, *The Double Helix*, he admits that he and Crick obtained Franklin's data from her progress report to the Medical Research Council in 1952 and that she was not aware of it. Ethics aside, the pieces of the puzzle were rapidly falling into place. Franklin's X-ray diffraction data suggested to Crick the double helical form of the DNA molecule. Thanks again to Franklin, the investigators also now believed that the sugar-phosphate backbone was oriented on the outside, and the base pairs on the inside, of the double helix. The correct structures of the bases were revealed to them by an American chemist named Jerry Donohue, who just happened to share an adjoining office. The bases came in four



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flavours: adenine, guanine, thymine and cytosine, or A, G, T and C for short. Adenine and guanine shared a similar structure and were called purines, while thymine and cytosine were also similar and were called pyrimidines. Then, in 1952, Erwin Chargaff visited England and alerted them to the fact that in his experiments on DNA extracts, the ratios of A to T and G to C were near unity. In contrast, the amounts of other combinations of the bases were highly variable. To Watson and Crick, this finding – known as Chargaff's ratios – suggested a consistent pairing of the bases (A-T and G-C). Even more importantly, this pairing feature explained how a molecule of DNA could replicate itself, a feature that was crucial for any molecule designed to copy genetic information from cell to cell and from organism to organism. In their landmark paper, they wrote, "*It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material.*"

Their hypothesis of DNA structure was published in the journal *Nature* in 1953. The title by Watson and Crick was modest: 'Molecular structure of nucleic acids: A structure for deoxyribose nucleic acid', barely suggesting that they had solved a secret of life. For their momentous finding, they shared the 1962 Nobel Prize with Wilkins.

**AFTER THE DISCOVERY** Through 1976, Watson served on the faculty at Harvard University in Cambridge, Massachusetts, United States. In 1968, he was a director at the Cold Spring Harbor Laboratory (CSHL) in New York, and in 1994, became its President and afterwards, its Chancellor. Under his leadership, CSHL rose to its current status as a world-class institute of science in tackling cancer, neurological disease and other causes of human suffering. In 1989, he was appointed to head the Human Genome Project at the National Institutes of Health, but left in 1992 due to conflict with Dr Bernadine Healy, its new director. Watson had opposed attempts to patent gene sequences, which he believed were not subject to ownership because they were 'laws of nature'. Watson also published the fully sequenced human genome online after it was presented to him on 31 May 2007 and authored *The Double Helix*, which became one of Modern Library's 100 best non-fiction books. In addition to countless honorary degrees and awards, he also wrote the classic textbook, *Molecular Biology of the Gene*.

**PERSONAL LIFE** Watson married Elizabeth Lewis in 1968. They had two sons, one of whom was diagnosed with schizophrenia. He wrote this about his son's disease: "*... as I know all too well, genetics can be cruel. My own son may be one of its victims. Warm and perceptive at the age of 37, Rufus cannot lead an independent life because of schizophrenia, lacking the ability to engage in day-to-day activities. For all too long, my wife Ruth (Elizabeth) and I hoped that what Rufus needed was an appropriate challenge on which to focus. But as he passed into adolescence, I feared the origin of his diminished life lay in his genes. It was this realisation that led me to help to bring the human genome project into existence.*"

Considered abrasive and arrogant, Watson boldly entitled his personal memoir, *Avoid Boring People: Lessons from a Life in Science*. In a controversial lecture to Berkeley students in 2000, he presented data purporting to show that melanin boosted libido, suggesting a link between skin colour and sex drive: "*That's why you have Latin lovers.... You've never heard of an English lover. Only an English patient.*" He was reported as saying that stupidity is a disease that ought to be eradicated, and conversely, that beauty should be selected for. His portrayal of Franklin in *The Double Helix* has been criticised by feminists and others because of its unnecessary attention to her appearance. Journalists also jumped on the anti-Watson bandwagon. Due to his remarks on race and intelligence, Watson was suspended from his position at CSHL in October 2007. He retired a week later, and accepted a position as advisor for the Allen Institute for Brain Science in Seattle, Washington, whose ultimate goal is to create an integrated gene atlas of the brain and publish it online for universal access. In 2014, Watson auctioned his Nobel prize medal to raise money for scientific research. It fetched USD 4.1 million, but the medal was returned to him by the buyer. Injured in a car accident in 2019, Watson is currently still living at age 92, but is reportedly barely cognitive.

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