Introductory article

Rosalind Franklin played a key part in one of the greatest advances in science of the twentieth century, the discovery of the three-dimensional structure of deoxyribonucleic acid (DNA), the molecule of the genes that carry the hereditary information in all living organisms, from bacteria to humans. The structure is that of the famous double helix, first proposed by James Watson and Francis Crick in Cambridge in 1953. Much of the evidence on which this model of the molecular structure was based came from the studies of Rosalind Franklin at King's College, London, where she had been using X-ray diffraction analysis on fibres of DNA to try to determine the structure. See also: Crick, Francis Harry Compton; Watson, James Dewey; DNA Structure: A-,B- and Z-DNA Helix Families; Double Helix: Discovery and Properties; History of Molecular Biology

Rosalind Elsie Franklin, physical chemist and X-ray crystallographer, was born 25 July 1920 in London, the elder daughter and second of the family of five children of Ellis Franklin, merchant banker, and his wife Muriel Waley. Rosalind was educated at St Paul's Girls' School and at Newnham College Cambridge, where she read Natural Sciences, specializing in Chemistry. She graduated in 1941.

War-time constraints directed Franklin's PhD to an industrial problem with the Coal Utilization Research Association. In 1947 she moved to the Laboratoire Central des Services Chimiques de l'Etat in Paris, where, in a series of beautifully executed investigations using X-ray diffraction techniques, she discovered the fundamental distinction between carbons that turn into graphite on heating and those that do not, and she related this difference to the chemical constituents of the material from which the chars were made. These results later proved to be highly relevant for the development of industrially important carbon fibres.

In 1950 she was invited by Professor John Randall to build up an X-ray diffraction laboratory at the Medical Research Council (MRC) Unit in King's College London to study the structure of DNA. DNA is now almost a household word but in those days it was not at all clear that it alone carried genetic information, and certainly no-one suspected that knowledge of its three-dimensional structure would show how genes replicated themselves. See also: Medical Research Council (MRC)

Work on DNA at King's had been begun by MHF Wilkins, with his research student RG Gosling. Franklin was asked by Randall to undertake a systematic X-ray study of DNA fibres, and Gosling was placed under her supervision. Unfortunately, Randall left ambiguous the respective roles of Wilkins and Franklin, and this later led to dissension about the demarcation of the DNA research at King's, but a letter of Randall's to Franklin in 1950 makes it clear that on 'the experimental X-ray effort there would be for the moment only yourself and Gosling'. See also: Wilkins, Maurice Hugh Frederick
Within the first year Franklin transformed the state of the field. She produced much better X-ray patterns and, by introducing methods to control and vary the water content of the specimens, she was able to show that the DNA molecule could exist in two forms (A and B; Figure 1), and to define conditions for the transition between them. In May 1952 she obtained the superb patterns of the B form which are now found in textbooks, and which JD Watson saw early in 1953. Inspection of this helical pattern, together with the distribution in December 1952 of an MRC report of the work at King's (including Franklin's) gave crucial information to Watson and Crick for the final building of their DNA model in February-March 1953. See also: DNA Structure: A-, B- and Z-DNA Helix Families

Despite her discovery of the simpler B pattern, Franklin's attention was at first mostly directed to the more crystalline A form because it was easier to approach crystallographically; but by March 1953 she had taken the quantitative analysis of the B form patterns to the point where the paths of the backbone chains were determined. She wrote up her work in a typescript dated 17 March - one day before news of the Watson and Crick structure reached King's. The draft contains all the essentials of her later paper (with Gosling) in Nature in April, which, together with one by Wilkins and his colleagues, accompanied Crick and Watson's paper announcing their model for the structure of DNA. In Franklin's draft, she had deduced that the phosphate groups of the backbone lay on the outside, and the bases on the inside, of a double helix of two strands; and her notebooks show that she had already formed the notion of base interchangeability. The step from this to the specific base pairing postulated by Crick and Watson is a large one, but there is little doubt that she was poised to make it. The notebooks also show that she had grasped that the A form contained two strands running in opposite directions, but she had not then understood the exact relation between the A and B forms and that therefore the same was also true of the B form. Soon after the formulation of the Watson-Crick model, she and Gosling were able to demonstrate conclusively what this relation was, and to provide the first analytical demonstration of the correctness of the Watson-Crick model (Nature, July 1953). See also: Watson-Crick Base Pairs


In mid-March 1953, Franklin moved to Birkbeck College London, at the invitation of Professor JD Bernal, to work on the structure of the Tobacco mosaic virus. She first confirmed Watson's hypothesis that in the rod-shaped virus the small protein subunits were arranged in a helical fashion. Then, in the last four years of her life, working with a small group of students and collaborators, she succeeded in obtaining spectacular X-ray patterns of the virus that allowed her to determine the precise helical geometry of the array of protein subunits, and, above all, to show that the ribonucleic acid (RNA) of the virus - the
carrier of the genetic information, and hence the infectivity - formed a long single chain embedded deeply within the protein framework. See also: Virus Structure

On 20 March 1958 Franklin died of cancer, having been initially struck by the disease in 1956. She died at the height of her powers, but she had already made her mark: a crucial contribution to one of the most important discoveries of the twentieth century, and work on two major biological problems, and the techniques for solving them, that helped lay the foundations of structural molecular biology.

Further Reading


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