Surprising Wilkins' error (Nature 1953, 172: 755–762)

Nikita Khromov-Borisov

Independent Researcher, Saint Petersburg, Russian Federation

Address correspondence and requests for materials to Nikita Khromov-Borisov, nikita.khromovborisov@gmail.com

Abstract

The Nobel Prize in Physiology or Medicine 1962 was awarded jointly to Francis Harry Compton Crick, James Dewey Watson and Maurice Hugh Frederick Wilkins "for their discoveries concerning the molecular structure of nucleic acids and its significance for information transfer in living material". Building the scale atomic-molecular models and applying strong inference Watson and Crick (1953a,b) presented convincing evidences for the following features of the spatial structure of the DNA molecule: (i) this structure has two helical chains each coiled round the same axis; (ii) both chains follow right-handed helices; (iii) the sequences of the atoms in the two chains run in opposite directions; (iv) the two chains are held together by hydrogen-bonded purine and pyrimidine bases; (v) the planes of the bases are perpendicular to the fibre axis; (vi) only specific pairs of bases can bond together: adenine (purine) with thymine (pyrimidine), and guanine (purine) with cytosine (pyrimidine). X-ray evidence obtained at the same time by Wilkins et al. (1953a,b), and Franklin et al. (1953a,b) gave qualitative support to this structure and was incompatible with all previously proposed structures. Wilkins et al. (1953b) built molecular models of the type described by Watson and Crick (1953a) and adjusted them to conform with their experimental data. However, it appeared that the paper by Wilkins et al. (1953b) contains a curious and inexplicable error. Namely, in their Figure 3 DNA is schematically drawn as a left-handed helix, which, as Crick and Watson (1954) explained, is stereochemically impossible and must be right-handed. The fact stated here was mysteriously not noticed before and, fortunately, had no detrimental effect on the development of science.

Keywords: DNA double helix, chirality, M. H. F. Wilkins, error, science history

Citation: Khromov-Borisov, N. 2024. Surprising Wilkins' error (Nature 1953, 172: 755–762). Bio. Comm. 69(1): 47–49. https://doi.org/10.21638/spbu03.2024.105

Authors' information: Nikita Khromov-Borisov, PhD, orcid.org/0000-0001-6435-7218

Manuscript Editor: Anton Nizhnikov, Department of Genetics and Biotechnology, Faculty of Biology, Saint Petersburg State University, Saint Petersburg, Russia

Received: August 28, 2023;

Revised: December 16, 2023;

Accepted: December 16, 2023.

Copyright: © 2024 Khromov-Borisov. This is an open-access article distributed under the terms of the License Agreement with Saint Petersburg State University, which permits to the authors unrestricted distribution, and self-archiving free of charge.

Funding: No funding information provided.

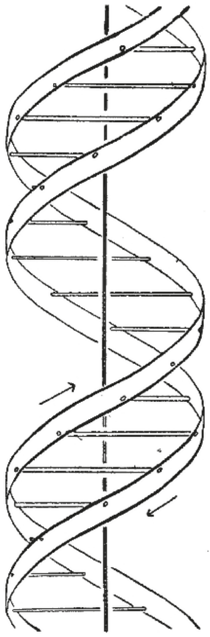
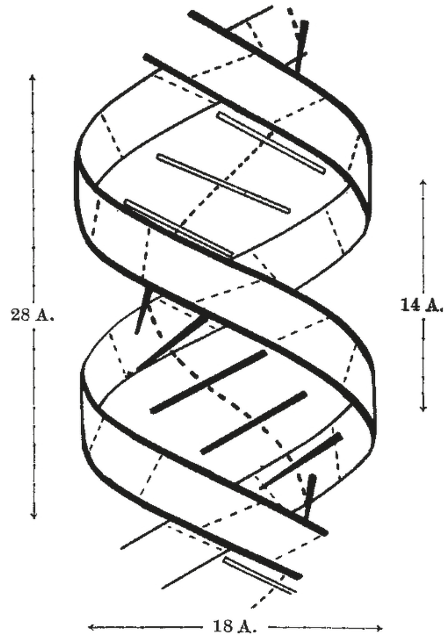
Ethics statement: This paper does not contain any studies involving human participants or animals performed by any of the authors.

Competing interests: The authors have declared that no competing interests exist.

It is well known that the seminal papers on the spatial structure of DNA were published in 1953 in the journal Nature — three papers in the issue of April 25 (Watson and Crick, 1953a; Wilkins et al., 1953a; Franklin and Gosling, 1953a) and one each on May 30 (Watson and Crick, 1953b), July 25 (Franklin and Gosling, 1953b), October 10 (Jacobson, 1953), and October 24 (Wilkins et al., 1953b).

The main features "of considerable biological interest" were suggested in the first paper by Watson and Crick (Watson and Crick, 1953a):

1. "The novel feature of the structure is the manner in which the two chains are held together by the purine and pyrimidine bases. … it is found that only specific pairs of bases can bond together. These pairs are: adenine (purine) with thymine (pyrimidine), and guanine (purine) with cytosine (pyrimidine). … if only specific pairs of bases can be formed, it follows that if the sequence of bases on one chain is given, then the sequence on the other chain is automatically determined."
2. "This structure has **two helical chains** each coiled round the same axis (see diagram). Both chains follow **right-handed helices**, but owing to the dyad

April 25, 1953. (Watson and Crick, 1953a)	October 24, 1953. (Wilkins et al., 1953b)	July 1, 2013. Monument to the laboratory mouse*
		
This figure is purely diagrammatic. The two ribbons symbolize the two phosphate-sugar chains, and the horizontal rods the paths of bases holding the chain together. The vertical line marks the fibre axis.	Fig. 3. The type of structure of the helical unit deduced from X-ray data of crystalline deoxyribonucleic acid. One helix of diameter approximately 10 A. is formed by a system of eleven inclined rods per turn of the helix. This helix is surrounded by two 18 A. diameter helices, each of which is also formed of eleven units per turn.	The monument commemorates the sacrifice of the mice in genetic research used to understand biological and physiological mechanisms for developing new drugs and curing diseases.

* Sources: https://en.wikipedia.org/wiki/Monument_to_the_laboratory_mouse
https://lh3.googleusercontent.com/p/AF1QipO_aGZvjOAN1h8U2WQ0G1esO1rgqMUSM-PmLCzy=s1360-w1360-h1020

the sequences of the atoms in the two chains **run in opposite directions**" (emphasis added — N. Kh.).

A year later they clarified (Crick and Watson, 1954):

"… we find by trial that the model can only be built in the **right-handed sense**. Left-handed helices can be constructed only by violating the permissible van der Waals contacts" (emphasis added — N. Kh.).

Evidences for the helicity and double-strandedness based on the X-ray analysis were reported immediately in the subsequent Nature papers (Wilkins et al., 1953a; Franklin and Gosling, 1953a, 1953b; Wilkins et al., 1953b) and later in many others. In the paper from October 24 Wilkins et al. (1953b) described "in a preliminary way further three-dimensional data" suggested "that proof is now available that deoxyribonucleic acid consists of two helical intertwined polynucleotide chains" and shown, "as a result of molecular model building, that this structure may be of the type suggested by Watson and Crick (Watson and Crick, 1953a)." Authors "have found no difference in the diffraction patterns of crystalline deoxyribonucleic acid obtained from" different biological sources. "These facts, combined with the irregularity of sequence of nitrogen bases and the hydrogen bonding between bases, produce a contradiction which is only resolved by a simplifying concept such as the specific pairing of bases suggested by Watson and Crick (Watson and Crick, 1953a)".

The authors concluded (Wilkins et al., 1953b): "The structure of the helical system therefore begins to become clear and its probable form is shown diagrammatically in Fig. 3."

Surprisingly and inexplicably, the double helix in this diagram turned out to be **left-handed**. It is especially surprising that in this article Wilkins et al. have informed that they "have built molecular models of the type described by Watson and Crick (Watson and Crick, 1953a) and have adjusted them to conform with our experimental data." Moreover, they did not say a word about the chirality of the helical system under discussion. As was noted above a year later Crick and Watson (1954) emphasized:

"… we find by trial that the model can only be built in the **right-handed sense**. Left-handed helices can be constructed only by violating the permissible van der Waals contacts" (emphasis added — N. Kh.). Perhaps, Wilkins et al. did not attach much importance to the chirality of the DNA double helix at that time.

Since then, no one seems to have noticed this fundamental mistake.

It is amusing that 60 years later the same mistake was made by the sculptor of the Monument to the laboratory mouse in Akademgorodok ("Academic Town") in the city of Novosibirsk (Siberia, Russia). The mouse is knitting a **left-handed** DNA molecule.

Fortunately, this unfortunate mistake in one of the first articles on the spatial structure of DNA did not affect the further development of science. If one looks at modern textbooks and encyclopedia (including Wikipedia), they show the proper, right-handed helix. However, the facts stated here may be of great historical interest, or at least historical curiosity.

Acknowledgements

The author thanks Natalia Broude, Andrey Ermolaev, Vasily Ptushenko and three anonymous reviewers for their valuable comments and suggestions.

References

Crick, F. H. C. and Watson, J. D. 1954. The complementary structure of deoxyribonucleic acid. *Proceedings of the Royal Society of London*. *Series A, Mathematical and Physical Sciences* 223(1152):80–96. https://doi.org/10.1098/rspa.1954.0101

Franklin, R. E. and Gosling, R. G. 1953a. Molecular configuration in sodium thymonucleate. *Nature* 171(4356):740–741. https://doi.org/10.1038/171740a0

Franklin, R. E. and Gosling, R. G. 1953b. Evidence for 2-chain helix in crystalline structure of sodium deoxyribonucleate. *Nature* 172(4369):156–157. https://doi.org/10.1038/172156a0

Jacobson, B. 1953. Hydration structure of deoxyribonucleic acid and its physicochemical properties. *Nature* 172(4380):666–667. https://doi.org/10.1038/172666a0

Watson, J. D., Crick, F. H. C. 1953a. Molecular structure of nucleic acids: A structure for deoxyribose nucleic acid. *Nature* 171(4356):737–738. https://doi.org/10.1038/171737a0

Watson, J. D. and Crick, F. H. C. 1953b. Genetical implications of the structure of deoxyribonucleic acid. *Nature* 171(4361):964–967. https://doi.org/10.1038/171964b0

Wilkins, M. H. F., Stokes, A. R., and Wilson, H. R. 1953a. Molecular structure of deoxypentose nucleic acids. *Nature* 171(4356):738–740. https://doi.org/10.1038/171738a0

Wilkins, M. H. F., Seeds, W. E., Stokes, A. R., and Wilson, H. R. 1953b. Helical structure of crystalline deoxypentose nucleic acid. *Nature* 172(4382):759–762. https://doi.org/10.1038/172759b0