

Ivanov V I, Minchenkova L E, Schyolkina A K & Poletayev A I. Different conformations of double-stranded nucleic acid in solution as revealed by circular dichroism. *Biopolymers* 12:89-110, 1973.
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A general classification of forms of the nucleic acid double helix according to families was presented. The physical mechanisms for the gradual change within the B and A families of forms and for interfamily B-A transitions were suggested. [The *SCI*® indicates that this paper has been cited in over 310 publications.]

The Many-Faced DNA

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One winter day in 1971, I was telling Egor Malenkov about the results on DNA that had just been obtained by my colleagues Anya K. Schyolkina and Lyuda E. Minchenkova. From analysis of circular dichroism spectra, it looked like an overwinding of DNA helix upon the increase in salt content in solution. Even more interesting was the observation that in the presence of methanol the alkaline ions acted specifically: the best "winder" was Cs⁺, then came Rb⁺, K⁺, and Na⁺. Li⁺ wound the DNA helix less than all the others. Malenkov, a geologist by background, said at once that quite a similar phenomenon occurs in the kingdom of minerals for clays and micas, whose negatively charged aluminosilicate layers, like DNA phosphates, are separated by water layers containing cations. The more hydrated the ion is, the wider the interlayer distance. For DNA it means stabilizing a helix with a wide minor groove by heavily hydrated Li⁺ and a helix with a narrow minor groove by the less hydrated Cs⁺. But, as was known to me, the decrease in width of the minor groove is correlated with the DNA winding angle

within the B type of structure. A similar behavior was found for the A family (RNA duplexes) by Andrei I. Poletayev, and we agreed to write a joint paper.

Besides this gradual, intrafamily change in the form of the helix, our attention was attracted to the interfamily B-A shift, induced in water/nonelectrolyte media. In the very first experiment, we understood that, like DNA melting, it is an abrupt, cooperative transition. It is this fact that forced us to introduce the concept of a family as a continuum of structures, the structures, belonging to different families, being connected by a cooperative transition. And only those structures could be called true forms. From this point of view, for example, the so-called B, C, and D forms are not true ones, because they are obtained from each other by a continuous (not cooperative!) winding. Families are DNA faces and helices of a family are different smiles of the family face.

Thus, a general picture of the forms and transitions of the double helix was revealing. This is why we wrote one paper rather than three that time, and it was the right decision. I think this paper has been frequently cited because it proved to be useful for scientists working in various fields of DNA physicochemistry.

What is more surprising to me is that our *Biopolymers* paper from 1973 is still frequently cited, in spite of the explosive development of DNA physics, a field where publications usually lose their attraction rapidly.

Rereading the paper while preparing my commentary, I noticed in it very many observations, thoughts, and other details that stimulated my further studies, both experimental and theoretical. Thus, computer analysis of conformational possibilities of DNA, which confirmed the existence of the discrete families of forms, was done together with Victor B. Zhurkin and Yuri P. Lysov.¹ Now it is a broad field that can be called "conformational mechanics and dynamics of DNA." The discovery of the Z forms has added one more family.² Sequence-dependent energetics of the B-Z³ and B-A⁴ cooperative transitions is being studied successfully. I am sure that we are now at the beginning of a new, exciting, cooperative transition—from the conformational mechanics to the conformational biology of DNA.^{2,5}

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