Biophysics of DNA

Surveying the last 60 years of research, this book describes the physical properties of DNA in the context of its biological functioning. It is designed to enable both students and researchers of molecular biology, biochemistry and physics to better understand the biophysics of DNA, addressing key questions and facilitating further research.

The chapters integrate theoretical and experimental approaches, emphasizing throughout the importance of a quantitative knowledge of physical properties in building and analyzing models of DNA functioning. For example, the book shows how the relationship between DNA mechanical properties and the sequence specificity of DNA–protein binding can be analyzed quantitatively by using our current knowledge of the physical and structural properties of DNA. Theoretical models and experimental methods in the field are critically considered to enable the reader to engage effectively with the current scientific literature on the physical properties of DNA.

Alexander Vologodskii began his research career as a theorist, pioneering theoretical studies of knots and links in circular DNA and designing statistical mechanical models and computational methods to predict the appearance of alternative structures in supercoiled DNA. He later ran a research laboratory at New York University, where he made important contributions to topics related to DNA topology and supercoiling, DNA topoisomerases and the physics of DNA bending.

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Preface

This book presents a comprehensive survey of DNA physical properties. Over the last 60 years physical properties of DNA molecules have been studied in detail, and the author believes that it is the right time to review them. The book is intended for molecular biologists, biochemists and physicists who want to know more about DNA biophysics. In addition, the book briefly considers physical aspects of DNA interaction with proteins that bind DNA specifically and nonspecifically. The level of presentation assumes some knowledge of molecular biology and physical chemistry, mainly at the level of introductory courses.

In accordance with the author's own research experience, the book combines theoretical and experimental approaches to the properties. Wherever it is possible, the chapters start from the theoretical descriptions of the phenomena followed by the application of these descriptions to experimental studies of particular problems.

There are no descriptions of methods that are used in DNA studies, except short remarks on the application of the major biophysical methods in this field. These major methods have been described in detail in other books on molecular biophysics (van Holde *et al.* 1998, Bloomfield *et al.* 1999). Excellent descriptions of general principles of the physical chemistry, often used in this book, as well as descriptions of many methods can be found in the book by Tinoco *et al.* (1995). However, we analyze the methods that were developed specifically for DNA studies.

I am grateful to my colleagues, who made very valuable comments on the chapters of this book, Maxim Frank-Kamenetskii, Neville Kallenbach, Ioulia Rouzina, and to my wife, Maria Vologodskaia, for her help during the book preparation.

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