

PREFACE

This book is an introduction to the physics of biopolymers. After a brief overview of the basic properties, we will focus on the structure and dynamics of biopolymers subjected to various forms of confinement. Examples are biopolymers in nano-channels, exposed to external forces, grafted at an interface to form a brush or under crowded conditions at high concentrations in the semi-dilute regime. Special attention will be paid to the effect of charge and electrostatic screening (polyelectrolyte effect). Along the way, we will also discuss higher order secondary and tertiary structures and their transitions. Finally, we will consider the properties of biopolymers in congested and crowded states, which bear resemblance to the situation in living cells and organisms.

The book is primarily aimed at the development of physical intuition rather than mathematical rigor in order to prepare the reader to address complicated, real issues in the life sciences or other related fields such as material or food sciences. Most, if not all of the material has been treated with the simplest approach, without losing scientific significance. The mathematics is not too complicated and can be handled by anyone who has received a basic training in calculus. The book is intended to serve as a bridge between undergraduate textbooks in the area of physical (bio) chemistry and professional literature. Accordingly, it is targeted at the advanced undergraduate or postgraduate student, as well as the professional, who has already acquired a basic knowledge of physics, thermodynamics and molecular biology.

The book is based on my lecture notes for a course on biopolymer physics for fourth year students, which I teach at my home institution. Surely, the quantity of the material exceeds the amount which can be taught in a single

term and the lecturer might want to make a selection. For instance, one can drop the section on polyelectrolyte brushes or one can skip one of the more specialized topics, such as the compaction of the genome in the capsid of bacteriophages. I plan to post the answers to the questions, small computer script files and other relevant updates (including corrections) on my research group's website: <http://www.physics.nus.edu.sg/~bcf/>.

It is a pleasure to thank all those people who have contributed, either directly or indirectly, to the writing of this book. First, there are my former teachers and colleagues who have diligently explained to me the older and therefore perhaps less known literature on polymers and polyelectrolytes. Then, of course, I owe thanks to my former and present students. They have pointed out many mistakes in my lecture notes on which this book is based and they have forced me to explain the material in as transparent a way as possible. Special thanks are due to Claire Lesieur for informing me about the status of our understanding of protein folding. I thank Rudi Podgornik for enlightening discussions about the Poisson–Boltzmann equation for polyelectrolytes in the presence of salt. Furthermore, I am grateful to Daniel Blackwood for proof-reading the manuscript. It goes without saying that the responsibility for any possible remaining errors and/or inconsistencies lies entirely with the author. Finally, I thank Pascale, Anne and Lieve for their patience and I apologize for the many hours I took from our precious family time.

Singapore, July 2007.