Preface

Biophysics or Biological Physics or Statistical Physics of Biological Matter or Quantitative Biology or Computational Biology is a large and rapidly growing interdisciplinary field with many names at the boundary between physics, biology and mathematics. It is neither clear where this field starts nor where it ends nor where it will eventually lead to. It is clear, however, that there has been tremendous progress in this field during the last two decades. This book has been the result of various attempts to teach this subject in a variety of settings to audiences with a wide range of backgrounds at various stages in their studies. It started with courses (typically 4 hours long) at winter and summer schools in Denmark, Netherlands, Belgium, South Korea, South Africa, France and Mexico. The material was expanded at a theoretical biophysics course given to Master students at Leiden University. A script prepared for a course at the Casimir graduate school between Delft and Leiden University was a short first version of the book.

When I decided to write a whole book on the subject, I wanted it to be self-contained (avoiding phrases like "one can show"), especially because I noticed that some students in my courses did not know much about molecular biology whereas others had no background in statistical physics. To allow for the book to reach some depth without becoming too thick, it was necessary to make a couple of tough decisions up front. I decided that everything in this book should be related to what I consider as the heart of the molecular biology of the cell, the central dogma of molecular biology, which states that information flows from DNA via RNA to proteins. By restricting myself to that subject, I had to deal with only three types of molecules, all of them polymers, that are all found inside the nucleus of eukaryotic cells. Using these molecules

as examples, I dealt with a wide range of biophysical topics, most of which are also relevant in many other branches of biophysics. I chose examples that make clear what is special about biophysics as compared to other areas of physics. A second decision was to restrict myself to "paper and pencil" theories demonstrating how they can be used to understand experimental observations but not to discuss computer simulations. I stress here that simulations are as crucial as theory and experiments but for this textbook I chose subjects where a purely theoretical treatment is sufficient—as in most textbooks on more classical subjects.

The book contains 8 chapters. The first few chapters have a more introductory character, are shorter with fewer examples allowing the reader to grasp the structures of the theories. The later bring in more and more experimental examples and help the reader to develop the physical intuition necessary to grasp the complex physics behind the systems under consideration. Also the problems considered become more recent, many being still the subject of intense debate in the current literature. I have tested preliminary versions of all the chapters of the book in various courses: Chapters 2 and 7 with physics bachelor students, Chapters 1, 3, 4, 5 and 7 with physics master students and Chapters 1, 4, 6, 7 and 8 with PhD students and postdocs, most of them physics students but some with a background in chemistry or biology. I hope that this book will be useful in such a variety of settings.

I would like to acknowledge the people without whom this book would not have been possible. The late Jonathan Widom had been extremely kind in sharing his deep insights about biological matter with me when I just got started into this field. Never again I have met any one who could combine so seemingly effortless the biology and physics perspectives. It was Robijn Bruinsma and Bill Gelbart with whom I made my first steps in this new field. Robijn's lecture at a winter school in Vancouver opened my eyes for what is special about biophysics; I tried to preserve some of this excitement in the section on protein-target search in the last chapter of the book. From working with Philip Pincus I gained a more intuitive understanding of electrostatics that I tried to explain in the chapter on that subject; discussions from that time with his student Andy Lau had also an impact on that chapter. John Maddocks had been very kind to

critically read large parts of the manuscript and helped to remove inconsistencies in my explanations on Euler elasticas; if there are still some left, it is entirely my fault. My former student Igor Kulić is the person whose work has found its way into this book at more places than anybody's else; his clean approaches to problems related to DNA and nucleosomes have proven to be ideally suited for a textbook. Also Martin Depken's work on chromatin fibers and kinetic proofreading during transcription seemed to fit too nicely into this book that they could have been left out. Ralf Everaers has strongly influenced my views on chromatin fibers and large scale chromatin organization.

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