CHAPTER 1

Introduction

1.1 Why This Book?

Shortly after I arrived at Duke, I met with an engineer who expressed an interest in biological networks. From that chance encounter developed a regular meeting of researchers who shared this interest. The "biological networks group" became the nucleus for a successful proposal to the National Institutes of Health to become a national Center for Systems Biology.

What characterized this group of researchers from the beginning was a nearly equal division among those trained as experimental biologists and those trained in one of the more quantitative scientific disciplines: mathematics, computer science, statistics, physics, and engineering. We realized that we would have to develop new means of educating each other across what is a fairly sizeable knowledge and cultural divide. It was not sufficient to tell our colleagues that they should read the standard textbooks in our respective fields. For the biologists, this would have meant using quantitative skills that had rarely been robustly acquired. For the theorists, it would have meant dealing with the standard biology textbooks, which tend to be off-putting in their size and level of detail. We experimented with various formats, and this book is the result of an approach that seemed to work for people who have backgrounds in the quantitative sciences but have had little or no formal training in biology. It has been used in a course at Duke University in which the students primarily major in electrical engineering, computer science, or mathematics.

1.2 How Is the Book Organized?

The goal of this book is to take the student quite rapidly from basic biological information to an understanding of cutting-edge technology and the results obtained from use of that technology. Each of the first four chapters is organized in a similar manner, beginning with the fundamentals of biological structure and how that structure is crucial for function. It then moves to a description of advanced-technology platforms used to analyze the biological entity. A final section addresses how data generated by each technology platform are analyzed.

The remaining chapters build on this knowledge base, with more in-depth exploration of examples of specific areas in which genomics and systems biology are having an impact. These include analysis of biological oscillators, the process of development from single cells to multicellular organisms, complex genetic traits, and insights into how the human genome is evolving. In a final chapter, I muse on the problem of using mathematics to analyze biological problems and look forward to a new era of quantitative "mathematical biology."