

Preface

It has been said that “Systems Biology” is an important postgenomic challenge in biology to understand “life as systems”. That being said, what does it mean? What can be done with signaling pathways, metabolic pathways, and gene regulatory networks using computers? For those with similar concerns or questions, this should be the first book you consult for an understanding of *Systems Biology*.

The definition of *Systems Biology* varies from scientist to scientist. Some of you may have skimmed books or scientific papers with “Systems Biology” in the title and seen alien terms such as “robustness analysis”, “stochastic differential equations”, or “bifurcation analysis” fly by. Some may have felt that this is similar to lining up toy soldiers called differential equations and making them march. Those of you who have felt that way are the intended audience of this book.

Biological organisms consist of many molecules, such as proteins, which fulfill their functions and interact with others. One of the ways to understand this system is to construct the system in parts on a computer and analyze. Beneath the current attentions to Systems Biology is the compilation of large amounts of genomic data and biological knowledge on the parts that compose everything from bacteria to human beings. Since the basic mechanisms of these parts have been considerably well defined, it is now time to understand how the interactions between these parts create the high degree of complexity in biological systems.

On one hand, man-made systems such as electrical circuits and machinery can be made over and over once there are parts and blueprints, since the system is known from the beginning. On the other hand, organisms are made by nature and evolution, and there is a large gap between gathering the parts and understanding the system. Modeling and simulation are necessary technologies to close this gap. In order to understand this system, it needs to be modeled with a high-level language including mathematics and entered into a computer for computation. We should say a goodbye to messy (in Japanese, we say “Gochagocha”) printed diagrams with arrows and circles of various shapes with narrations. This is the point of entry of “Cell Illustrator”, which is a software tool for biological pathway modeling and simulation.

Reading the book and using Cell Illustrator bundled in the CD-ROM should make it possible to create highly complex pathways and simulations. There is no need for

prior knowledge in differential equations or programming. The prerequisites are interest in biology, ability to operate a cell phone (or equivalent), and mathematical ability of a standard middle school student or better.

Using Cell Illustrator, reading the book, and finishing the exercises—answers are provided—should make you realize how easy this can be “(^ o ^) v”. Although pathway drawing does not require any mathematical or programming skills, drawing pathways may require some artistic sense. In addition, just by drawing pathways using Cell Illustrator, pathway knowledge will become better organized, and the reader should feel a sense of accomplishment. The columns interspersed in the book are addendums and digressions; they can be skimmed at the reader’s discretion.

This book is designed and structured to be used for a semester-long course text at the undergraduate level or can be used as a part of graduate courses. Chapter 1 describes a minimum biological knowledge and Chapters 2 and 3 explain some of the important pathway databases and software tools together with their related concepts. Chapter 4 describes the detailed first steps and elements for modeling pathways with Cell Illustrator. The reader may find that graphical pictures representing biological entities and processes help understanding the elements of pathways. Chapter 5 will guide the reader to model three kinds of pathways in a step-by-step manner as exercises. Chapter 6 discusses the computational functionalities required for Systems Biology. This book is an English translation of the original Japanese version published by Kyoritsu Shuppan Co., Ltd. With this edition, the data on software and database versions are updated and Chapter 6 is enhanced with some new topics.

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Masao Nagasaki
Ayumu Saito
Atsushi Doi
Hiroshi Matsuno
Satoru Miyano



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Nagasaki, M.; Saito, A.; Doi, A.; Matsuno, H.; Miyano, S.

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