Preface

The biological cell, the minimal unit of life, is an extremely complicated reaction web. The human genome project has revealed that 20,000–30,000 genes are encoded in single human cells; these genes are thought to produce more than 100,000 protein species through alternative splicing and chemical modification. The major challenge of biology in the post-genomic era is to address the issue of how such a multi-element system, composed of huge numbers of protein species and other macro- and micro-molecules, brings emergence of the complex and flexible reaction dynamics that we call "life."

Biological macromolecules such as proteins are themselves complicated systems made up of a huge number of atoms. Proteins often show complex structural and functional dynamics. It has been demonstrated that single-molecule techniques are powerful tools in the study of proteins, because time series of the individual events carried out by a single molecule provide information that cannot be obtained with ensemble-molecule measurements and that is indispensable in analyses of the complex behaviors of biological macromolecules. Single-molecule measurements have recently been extended to the study of multi-molecular systems and even living cells. Because these single-molecule techniques are so effective in resolving the complex reactions of individual molecules, they are now expected to offer a powerful technology for the study of the complicated reaction web in living cells.

This book deals with single-molecule analyses of the kinetics and dynamics of cell signaling reactions. Several other books have already introduced the techniques and applications of single-molecule measurements of various biological events. However, as far as we know, this book is the first to concentrate on cell signaling. Analysis of the cell signaling that regulates the complex behaviors of cells should provide the keys required to understand the emergence of life. We intend this book to contain as many kinetic analyses of cell signaling as possible. Although the single-molecule kinetic analysis of cellular systems is a young field compared with the analysis of single-molecule movements in cells, this type of analysis is important because it directly relates to the molecular functions that control cellular behavior. Because there have been many successful single-molecule kinetic studies

of purified proteins, future single-molecule kinetic analysis will be largely directed towards cellular systems.

In this book, we have included not only the results of single-molecule analyses of cell signaling in both living cells and in vitro systems, but also recent progress in the single-molecule technology required to study cell signaling and theories of single-molecule data processing. We would like to thank all the contributors to this volume for preparing these valuable manuscripts, despite busy schedules. We hope that the book is useful to a wide range of readers interested in cell signaling and single-molecule measurements. We would be delighted if this book advances our understanding of complex life systems.

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