

Preface

Cell membranes are frontiers between cells' surroundings and their interiors. They not only serve a structural and containment role for the cell but they also regulate many essential cellular activities, such as material transport, signal transduction, cell–cell interaction, and enzymatic reactions. From the first lipid bilayer membrane structure proposed in 1925, to the widely accepted fluid mosaic model put forward by Singer and Nicolson in 1972, our understanding of the structures and functions of cell membranes is continuing to improve as well. The membrane is a very complicated supramolecular liquid crystalline structure that is composed of phospholipids, proteins, and sugars. Each component has a variety of types and functions, for example, membrane proteins. About a third of all cellular proteins are membrane proteins which are involved in transport, catalysis, and recognition. Thus, when different components organize together in the relative ratio and composition, the structural complicacy and functional distinctiveness it brings to the cell membrane is conceivable. Moreover, the highly dynamic property of the membrane also makes it more difficult to study. Therefore, the exploration of the structure and function of cell membranes has never ceased over the years.

Consistent with other scientific studies, every major breakthrough in the field of cell membranes is due to the application of new techniques and approaches in biophysics, cell biology, biochemistry, and molecular biology. Particularly in recent years, many traditional techniques have been continuously improved and perfected, such as light microscopy, electron microscopy (EM), x-ray crystallography, nuclear magnetic resonance (NMR), mass spectroscopy (MS), infrared (IR), and Raman spectrum. These techniques have allowed researchers to gain spectacular insights into the biological and physical properties of cell membranes. Moreover, emerging technologies, including high-resolution atomic force microscopy (AFM) and super-resolution fluorescence microscopy (SRFM), are being used as appropriate tools by which the characteristic of the membrane can be better understood. Besides these experimental tools, computer simulation of detailed atomic models based on realistic microscopic interactions represents a powerful approach to explore the structure and dynamics of cell membranes.

The idea for this book was to introduce a broad collection of methods to study the biophysics and function of cell membranes including materials, protocols, and notes, and present the recent advances and new insights into the field of membrane science. The book is divided into thirteen parts. General membrane composition, functions, and other properties are summarized in Chap. 1. Chapter 2 reviews the major historical discoveries and theories that tackled the existence and structure of cell membranes, and discusses the strengths and weaknesses of the related techniques by which different membrane models have been proposed. From Chap. 3 to Chap. 12, different classic and cutting-edge techniques of biophysics and chemistry are presented in detail, including the basic principle of the technique, the overall situation and development trends of the technique, the typical and successful applications of the technique in studying membrane science, and how to utilize the technique to solve related problems. At last, Chap. 13 describes some other modern methods for studying biomembranes which are more targeted.

Our aim was to provide readers with a comprehensive but still concise collection of methods to study membrane biophysics including both basic protocols of general applications and more specialized methods for novel techniques that were not presented systematically before. We sincerely hope that readers will gain further understanding of membrane organization and the relationship between membrane structure and functions. Meanwhile, the detailed procedures of each approach will serve as a laboratory guide to both students of biophysics and expert researchers.

We would like to thank all the authors for their concise and clear contributions which make working with them a great pleasure. We also want to express our deepest gratitude to the editors, for their patience and encouragement throughout the editing process.

This book is dedicated to Harry and Memary for the lifelong investigation of cell membranes.

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Hongda Wang

Membrane Biophysics

New Insights and Methods

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