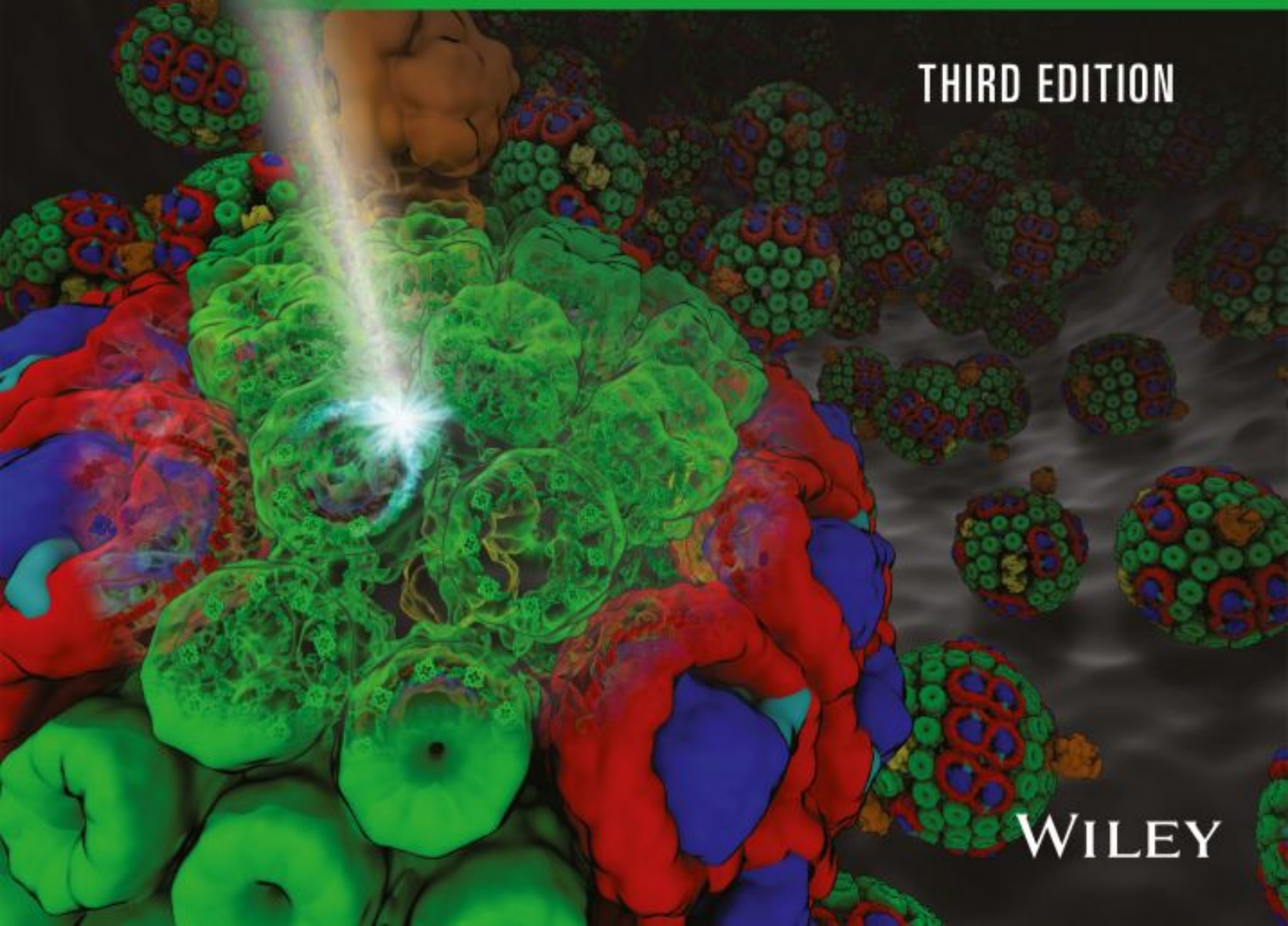




MOLECULAR MECHANISMS OF PHOTOSYNTHESIS

ROBERT E. BLANKENSHIP

THIRD EDITION



WILEY

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Molecular Mechanisms of Photosynthesis

Third Edition

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Tempe, AZ, USA

WILEY

This edition first published 2021
© 2021 Robert E. Blankenship

Edition History

Robert E. Blankenship (1e, 2002)

Robert E. Blankenship (2e, 2014)

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Library of Congress Cataloging-in-Publication data is applied for

ISBN 9781119800019

Cover Design: Wiley

Cover Image: © Cover image produced by Melih Sener, John Stone, and Barry Isralewitz using VMD. Shown is the atomic-to-cell scale organization of a photosynthetic purple bacterium and the energy conversion proteins therein.

I dedicate this book to the memory of my mother, whose early and constant encouragement started me down the road to a career in science.

Introduction to the third edition

It is now nearly 20 years since the first edition and more than 7 years since the second edition of *Molecular Mechanisms of Photosynthesis* were published. In that time, the scientific understanding of how photosynthesis works has continued to progress. The success of the first and second editions has prompted numerous requests for a third edition, which I am pleased to provide. I have tried to update the text to reflect this new understanding.

This book is an introduction to the basic concepts that underlie the process of photosynthesis as well as a description of the current understanding of the subject. Because it is such a complex process that requires some knowledge of many different fields of science to appreciate, it can be intimidating for a person who is not already conversant with the basics of all these fields. For this reason, a brief overview is provided in the first chapter, introducing and summarizing the main concepts. This chapter is then followed by a more in-depth treatment of each of the main themes in later chapters.

Photosynthesis is perhaps the best possible example of a scientific field that is intrinsically interdisciplinary. Our discussion of photosynthesis will span time scales from the cosmic to the unimaginably fast, from the origin of the Earth 4.5 billion years ago, to molecular processes that take only a few femtoseconds. This is a range of over 32 orders of magnitude. Appreciating this extraordinary scale will require us to learn a range of vocabularies and concepts that stretch from geology through physics and chemistry, to biochemistry, cell and molecular biology, and finally to evolutionary biology. Any person who wishes to appreciate the big picture of how photosynthesis works,

and how it fits into the broad scope of scientific inquiry, needs to have at least a rudimentary understanding of all of these fields of science. This is an increasingly difficult task in this age of scientific specialization, because no one can truly be an expert in all areas. This book attempts to provide the starting point for a broadly based understanding of photosynthesis, incorporating key concepts from across the scientific spectrum. The emphasis throughout the book will be on molecular-scale mechanistic processes.

Many of the concepts that we will explore throughout the bulk of this book require an understanding of basic concepts of physical chemistry, including thermodynamics, kinetics, and quantum mechanics. It is beyond the scope of our broad, and therefore necessarily brief, treatment of photosynthesis to provide a comprehensive background in these areas that form the core of the mechanistic aspects of the subject. However, some modest understanding of these physical principles is essential to be able to appreciate the essence of the photosynthetic process. This is addressed in an appendix that introduces the physical basis of light and energy. This appendix can either be read as a preface to the bulk of the book or consulted as needed as a reference.

The book is aimed toward advanced undergraduates and beginning graduate students in a range of disciplines, including life sciences, chemistry, and physics, as well as more senior scientists seeking to learn about the remarkable process of photosynthesis. An understanding of basic principles of chemistry, physics, and biology is assumed.



Robert E. Blankenship

Acknowledgements

I thank my former advisors Ken Sauer and Bill Parson for initiating me into the fascinating world of photosynthesis. Their guidance, support, and friendship have been invaluable to me during the course of my career.

I thank the many friends and colleagues from around the world for reading and commenting on some material, for helpful discussions on specialized topics, and for kindly providing figures for publication. These include (in alphabetical order) Carl Bauer, Oded Béjà, Gary Brudvig, Don Bryant, Julian Eaton-Rye, Gyozo Garab, Govindjee, Beverley Green, Martin Hohmann-Marriott, Werner Kühlbrandt, Haijun Liu, Yuval Mazor, Johannes Messinger, Tom Moore, Jian-Ren Shen, and Junko Yano.

The beautiful graphic that adorns the cover of the book is courtesy of Melih Sener. This is an updated version of the graphics that were on the covers of the first and second editions.

Special thanks to my editor Rebecca Ralf and to Kerry Powell from Wiley-Blackwell for help with the production.

Finally, I thank my wonderful family, Liz, Larissa, and Sam, for their constant love and support.