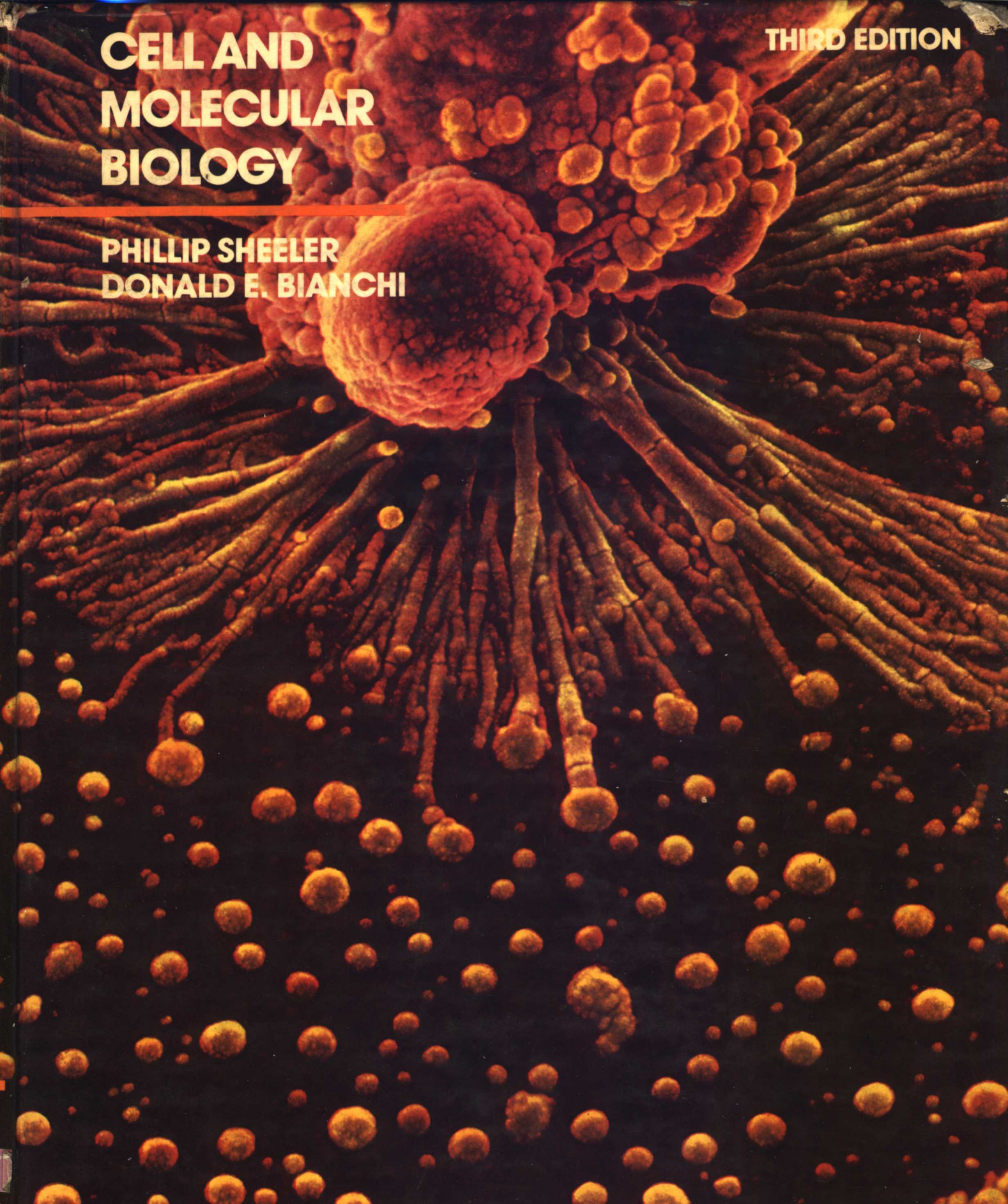


CELL AND MOLECULAR BIOLOGY

THIRD EDITION

PHILLIP SHEELER
DONALD E. BIANCHI



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JOHN WILEY & SONS, INC.

NEW YORK

CHICHESTER

BRISBANE

TORONTO

SINGAPORE

PHOTO CREDITS

PART 1: A cultured fibroblast cell just completing mitosis. (Courtesy of Drs. K. Feren and A. Reith. From *Scanning Electron Microscopy 1981*. Vol. II. p. 199. Copyright © 1981 by Scanning Electron Microscopy, Inc.)

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PART 3: A mitochondrion and surrounding endoplasmic reticulum and cytosol. (Courtesy of Dr. K. R. Porter.)

PART 4: An autoradiogram of radioactively-labeled proteins separated by polyacrylamide gel electrophoresis. (Courtesy of Drs. F. A. Eiserling and D. Coombs.)

PART 5: Transmission electron photomicrograph of intestinal epithelium. The cell on the far left is a mucus-secreting goblet cell. (Courtesy of R. Chao.)

PART 6: Sino atrial muscle tissue from frog heart. (Courtesy of Dr. A. Verna. From *Biol. Cellulaire 49*, 95, 1983. Copyright © Société Française de Microscopie Électronique.)

Cover Photo: Scanning electron photomicrograph of a human macrophage attempting to phagocytose a number of oil droplets. The cell, shown here at about 18,000 times its actual size, is an important member of the body's immune system. (Photo courtesy of Times (c) Boehringer Ingelheim International.)

Cover and text design: Karin Gerdes Kincheloe

Production: Elizabeth Meder

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Library of Congress Cataloging in Publication Data:

Sheeler, Phillip.

Cell and molecular biology.

Bibliography: p.

Includes index.

1. Cytology. I. Bianchi, Donald E., 1938-

II. Title.

QH581.2.S53 1987

574.87

86-28113

ISBN 0-471-81758-9

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

**To the memory of my father Barnett Sheeler,
to my mother Deborah,
to my wife Annette,
and to my children Wendy, Donna,
Lindsey, Paul, and Carly**

P.S.

**To my parents Ernest and Florence,
to my wife Georgia,
to my children Bill, Dave, Diana, and Jon,
and to my grandson Andy**

D.E.B.

PREFACE

This book was written for sophomore and junior level courses in cell biology, molecular biology, and cellular physiology. We consider in detail the fine structure of eukaryotic and prokaryotic cells (and viruses), the chemical composition and organization of cells, cell metabolism, and bioenergetics and, for each major cell organelle or structural component, its particular molecular and supermolecular organization and its functions. Special attention has also been paid to a description of the major research tools used by cell biologists to increase our knowledge of cell structure, biochemistry, and function.

In preparing this third edition of *Cell and Molecular Biology*, we have drawn upon more than forty-five years of our own collective university teaching experience as well as the help of more than 25 university professors who have used the first and second editions of this book. We are hopeful that our early training in different areas of cell biology, the expertise of each reviewer's specialty, and our involvement in active research programs have helped to present an up-to-date, thorough and balanced approach.

We have necessarily made certain assumptions with

regard to the background of students reading this book. For example, we have assumed that students have had courses in introductory biology and introductory chemistry. Most portions of the book dealing with physical or biochemical principles or concepts are preceded by a discussion of the requisite fundamentals.

We have revised, updated, and expanded this edition within the relatively short span of four years because of the rapid advances that have taken place in cell biology, especially in the fields of molecular genetics, genetic engineering, and immunology. Indeed, we have added a new chapter devoted specifically to the subjects of immunity and cancer. Concepts that are no longer tenable in the light of recent findings have been discarded, while newly developing ideas are presented and discussed. The clear and informative diagrams of the first and second editions of the book were among its major strengths; the best of these have been conserved, and a large number of new diagrams have been added. Once again, we have searched the literature to obtain the best and clearest electron photomicrographs depicting cellular organelles and other components, and this edition is replete with highly in-

formative photomicrographs that have been obtained using the most recently evolved laboratory techniques.

Some illustrations are presented in stereoscopic form and, although individual members of each "stereo pair" may be viewed without an optical aid, the perspective effect is best obtained with the use of a stereo viewer. Plastic-frame viewers with adjustable lenses are available in most college and university campus bookstores or where graphic supplies are sold.

Many individuals provided invaluable help, suggestions, and guidance during the preparation, writing, and production of this book. We are indebted to them. Individual chapters in this or a prior edition were reviewed and critiqued by Betty D. Allamong (Ball State University), Jeffrey Beckner (University of Tennessee), Gerald Bergtrom (University of Wisconsin), James Bowman (Utah State University), Richard Bowmer (Idaho State University), Allyn Bregman (SUNY, New Paltz), Dennis E. Buetow (University of Illinois at Urbana-Champaign), Marvin H. Cantor (California State University, Northridge), George Card (University of Montana), Joseph U. Cassim (Ohio State University), Janice E. Chambers (Mississippi State University), George B. Cline (University of Alabama, Birmingham), Steve Free (State University of New York, Buffalo), Rosemary Grady (Loyola University), William J. Grimes (University of Arizona), Robert Hamilton (University of California, San Francisco Medical Center), Thomas Hejkal (Murray State University), Ray Holton (University of Tennessee), H. James Harmon (Oklahoma State University), Konrad Keck (University of Arizona), Bonnie Lamvermeyer (Denison University), Harvard Lyman (SUNY, Stony Brook), Ray Lynn (Utah State University), Janet L. Morgan (University of Kentucky), Eldon H. Newcomb (University of Wisconsin), Sally Nyquist (Bucknell University), Daniel G. Oldfield (DePaul University), William Oostonink (Colgate University), James Ownby (Oklahoma State University), Lansing Prescott (Augustana College), David Rooney (Saint Louis University), Peter Snustad (University of Minnesota),

Hugh Stanley (Utah State University), Philip Stukus (Denison University), Glenn Todd (Oklahoma State University), Gerald Vaughan (University of Tennessee), Eugene Vigil (University of Maryland), Ted Weinheimer (California State College, Bakersfield), Fred Weyter (Colgate University), and Gary Whitson (University of Tennessee).

In this edition, as in the first and second, we are especially grateful to those investigators who provided us with the unique electron photomicrographs from their collections. Our special thanks to Keith Porter (University of Colorado), Keiichi Tanaka (Tottori University School of Medicine), John Possingham (CSIRO, Adelaide, Australia), and Richard Chao, Daisy A. Kuhn, and Edward G. Pollock (California State University, Northridge).

The entire manuscript for this edition was prepared using word-processing equipment, which greatly facilitated our need to edit continuously sections that deal with topics in which progress is so rapid. We are especially grateful to Lindsey Deborah Myers for entering the text onto diskettes and for providing us with her word processing expertise.

The staff at Wiley has always been most helpful and we are once again indebted to our past editor Frederick C. Corey for his help and encouragement. Our thanks also to our current editor Katie Vignery for carrying the project to completion. The extraordinary talents of our artist John Balbalis are once again evident in this edition and we owe him a special thanks for his attention to detail and accuracy. We should like also to thank Safra Nimrod for helping us to find the photographic materials that we needed, Karin Kincheloe who designed the book, and Joshua Spieler and Elizabeth Meder who nurtured the book through production.

We apologize for any errors that we may have allowed into print and thank our readers in advance for bringing them to our attention.

Phillip Sheeler
Don Bianchi

Northridge, 1986

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PART ONE

CELLS AND CELL GROWTH

