



PLANT BIOLOGY

ROST • BARBOUR • STOCKING • MURPHY

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THOMAS L. ROST / MICHAEL G. BARBOUR
C. RALPH STOCKING / TERENCE M. MURPHY

*University of California
Davis, California*



WADSWORTH PUBLISHING COMPANY

ITP[®] An International Thomson Publishing Company

Belmont, CA • Albany, NY • Bonn • Boston • Cincinnati • Detroit • Johannesburg • London • Madrid • Melbourne
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BIOLOGY PUBLISHER: Jack C. Carey
PROJECT DEVELOPMENT EDITOR: Kristin Milotich
EDITORIAL ASSISTANT: Michael Burgreen
DEVELOPMENTAL EDITORS: Mary Arbogast, Elizabeth Zayatz
PRODUCTION EDITOR: John Walker
PRINT BUYER: Karen Hunt
PRODUCTION: Mary Douglas, Rogue Valley Publications
DESIGNERS: Carolyn Deacy; Gary Head, Gary Head Design
ART COORDINATOR: Myrna Engler
ARTISTS: Page Two; Precision Graphics; Illustrious Interactive
PHOTO RESEARCH: Roberta Broyer, Stephen Forsling
COVER DESIGNER: Gary Head, Gary Head Design
COVER PHOTOGRAPH: Carr Clifton/Minden Pictures
COMPOSITION AND COLOR PROCESSING: American Composition & Graphics, Inc.
PRINTING AND BINDING: Courier/Kendallville

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Printed in the United States of America
1 2 3 4 5 6 7 8 9 10

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Library of Congress Cataloging-in-Publication Data
Plant biology / Thomas L. Rost . . . [et al.].
p. cm.
Includes bibliographical references and index.
ISBN 0-534-24930-2
1. Botany. I. Rost, Thomas L.
QK47.P57 1997
580—dc21

97-44578

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PREFACE

There has never been a time when the importance of plants has been clearer and our understanding of them has been more urgent. This century's history of regional famine and global population growth has had a profound impact on the course of politics, research, and land-use management. In the 1970s, a "green revolution" resulted in the development and promotion of astonishingly productive new varieties of grains, using the principles of plant physiology, pathology, and genetics. For a while, the result was indeed an increase in food supply, a reduction of land devoted to agricultural use, and an avoidance of famine. These benefits, however, came at a cost—an increasing dependence on mechanized farming and use of fertilizers, a decreased diversity of crop genotypes, and a (still) increasing human population. Ultimately, the rising population brought per-capita food production back down to pre-revolution levels. Now we are entering a "gene revolution," which no doubt will result in another round of food production increases. Will we pay the same costs again, or can we instead learn more about plants, the environment, and ourselves to avoid repeating this unprofitable loop? At the same time, now late in the twentieth century, we face additional serious problems of pollution as it alters the world's atmosphere and climate. Will the Earth's carrying capacity for humans (and all other species) decline or expand as a result of these changes? We who are writing this book do not have the answers; we hope and trust that you, who are about to read it, will find the solutions.

This book is the capstone to a series of plant biology textbooks that share a lineage of related authors. That lineage is probably lengthier than for any other existing biology textbook in the world. The ancestral book, *A Textbook of General Botany*, was co-authored in 1924 by Richard M. Holman, at the University of California, Berkeley, and Wilfred W. Robbins, in the Botany Division of what was then called the University Farm, located in the small town of Davis. The book was widely adopted through its four editions. After Richard Holman passed away, Professor Robbins invited a young faculty member in the Farm's Botany Division to be co-author with him of a 1950 book, *Botany: An Introduction to Plant Science*. That faculty member was T. Elliot Weier, a cytologist and pioneer in the use of the electron microscope. After Wilfred Robbins' death, Dr. Weier invited a plant physiologist colleague in the department, C. Ralph Stocking, to

become co-author of the second and third editions. Michael Barbour, a plant ecologist, joined Weier and Stocking on the fourth (1970) and fifth (1974) editions and Tom Rost, a developmental anatomist, joined for the sixth edition (1982). Plant physiologist Robert Thornton helped them write two editions of a smaller book called *Botany: A Brief Introduction to Plant Biology* (Rost et al., 1979 and 1984). Now, Terence Murphy, a molecular plant biologist, has become co-author number eight in a story that has wound through 13 versions/editions, 74 years, hundreds of thousands of books printed, two publishers, and four generations of readers. Welcome to you, the fourth generation!

What is new and characteristic in this edition? Although the coverage of material is complete, its level of detail will not overwhelm students taking a one-quarter or one-semester course. An entirely new art program provides pedagogically useful and attractive illustrations, including more than 70 full-color micrographs in the plant anatomy chapters alone. Throughout the text many interesting boxed essays introduce applied topics ranging from bee pollination, harvesting peat bogs for the generation of electricity, and the use of botany in forensic medicine, to the making of oak wine barrels.

We have included a new chapter on the chemistry of life which integrates and spans basic inorganic chemistry and biological molecules. The four chapters on plant anatomy are now arranged from meristems and tissues to organs in a sequence that better captures plant function and facilitates comprehension by the reader. Metabolic chapters immediately follow anatomy chapters and continue to focus on the links between form and function. Three new chapters—plant life cycles, genetics, and biotechnology—provide an important conceptual framework for the last third of the book. Also, the classification system we follow is more modern, taking advantage of recent research about plant phylogeny.

What else is new? The text has been thoroughly updated and some sections have been expanded. The new coverage of positional information theory explains cell differentiation on the basis of position. The discussion of meristem structure and function is expanded. We include new information on rhizospheres and on the relationships between roots, soil, and microorganisms as well as information on root function and specializations. We have expanded the discussion of monocot stems and updated our treatment of leaf specializations as related to environmental adaptations and responses to stress. The presentation of photosynthesis shows both the historical development of research and our current understanding of the intracellular locations of various steps in this complex process. This edition includes expanded coverage of the various strategies to cope with environmental stresses, such as trapping CO₂ at night by succulent plants, and variations in the carbon cycle exhibited by decreasing the water potential of their guard cells. Recent principles of membrane transport are applied to the question of how roots take up

minerals. The treatment of reproduction and pollination, as well as seed dispersal, is all new. The topic of stress signals as newly recognized plant hormones, along with the relation of hormones and signal cascades to gene expression, is thoroughly updated. The coverage on the critical comparison of two hypotheses to explain cell wall expansion—microfibril breakage and re-attachment and “extending” is newly revised. The new chapter on biotechnology has a thorough discussion of the methods of transforming plant cells, the uses of transformation in plant improvement (actual and contemplated), and questions regarding the dangers of transformation. The presentation of endosymbiosis as a source of evolutionary variety, with an outline of the molecular evidence for endosymbiosis is expanded. There is an updated discussion of the cellular aspects of the establishment of the *Rhizobium*/legume symbiosis. The text includes new material on the hypersensitive response as one method by which plants defend themselves against parasites. It also includes major expansion of the plant ecology chapters, with a unique emphasis on the ecological and adaptive value of fungal traits. The chapters on plant diversity and the evolutionary connections of the plant groups have been upgraded with many new photographs.

Several pedagogic practices pervade each chapter of the text. (1) Topics are intimately integrated so that form is immediately linked with function, environment, and evolutionary significance. (2) Summary statements are used as headings to alert the reader to the main point of the section to come. (3) We have reduced jargon to those terms we consider absolutely essential, and each term is defined the first time it is used. (4) Only illustrations that complement and clarify the text are used. (5) Connections between basic science and applied science (technology) are explicitly made, and boxed essays focus on topics of general interest. (6) At the end of each chapter, major conclusions are highlighted in summary and question sections. We have tried to choose the most reader-friendly literature to recommend for further reading, rather than merely the most recent—but less accessible—references. (7) Our common goal has been to devote space to each topic in proportion to its complexity and difficulty.

We have also listened to our reviewers regarding the breadth and sequence of topics they require to support the general botany/plant biology courses they teach. Consequently, structure, function, reproduction, behavior, and biology of flowering plants precede chapters on other organisms because the flowering plants are more familiar to readers, making the new information more easily absorbed. Our survey of the plant world includes detailed excursions into the Protista, Fungi, Monera, and viruses as well as into the Kingdom Plantae. The overall sequence of major subjects in the book builds from metabolism to whole plant function to reproduction within flowering plants, then from primitive to advanced plants in a series of survey chapters, concluding with an ecological segment that ties together the entire book.

SUPPLEMENTS

InfoTrac College Edition. This online library is available free with each copy of *Plant Biology*. It gives students access to full articles—not abstracts—from more than 600 scholarly and popular periodicals dating back as much as four years. The articles are available through InfoTrac’s impressive database that has such periodicals as *Discover*, *Science*, *BioScience*, *Horticulture: The Magazine of American Gardening*, *Agricultural Research*, *Journal of Soil and Water Conservation*, and *The American Midland Naturalist*.

Student Guide to InfoTrac’s College Edition. This guide is on the Wadsworth Biology Resource Center site on the World Wide Web. It has an introduction to InfoTrac and a set of electronic readings for each chapter, updated frequently.

Biology Resource Center. It contains hyperlinks and practice quiz questions for each chapter. It also includes flashcards for all glossary terms, botanical clip art, and links to botanical organizations. The address for the Wadsworth Biology Resource Center is

<http://www.wadsworth.com/biology>

Introduction to the Internet. This 80-page booklet helps students learn how to get around on the Internet when using a browser such as Netscape, search engines, e-mail, setting up home pages, and related topics. It lists useful sites on the net that correspond to book chapters.

The Botanical Society of America Website. This site will be maintained on the Wadsworth web page at

<http://www.thomson.com>

BioLink 2.0. With this presentation tool, instructors can easily assemble art and database files with lecture notes to create a fluid lecture that may help stimulate even the least-engaged students. It includes almost all diagrams from the text, animations and films from the general biology CD, and art from other Wadsworth biology textbooks. BioLink 2.0 also has a Kudo Browser with an easy drag-and-drop feature that allows file export into such presentation tools as Power Point. Upon its creation, a file or lecture with BioLink 2.0 can be posted to the Web, where students can access it for reference or for studying needs.

Instructor’s Manual with Test Items, written by Drs. John Jackson and Joseph McCulloch, has an outline, objectives, key terms, detailed lecture outline, presentation suggestions, and 40 test questions per chapter. The test bank is also available in electronic form for IBM and Macintosh in a test-generating data manager.

Laboratory Manual, written by Dr. Deborah Canington, University of California, Davis, contains 22 experiments and exercises, with numerous labeled photographs and diagrams. Many experiments are divided into parts for individual assignment, depending on available time. Each consists of objectives, terminology, discussion (in-

roduction, background, and relevance), a list of materials for each part, procedural steps, and laboratory quizzes.

Instructor's Manual for the Lab Manual, also written by Dr. Deborah Canington, contains lists of materials and equipment, instructions for preparations of lab materials, the sources of botanical materials, planting schedules, and suggested lab schedules to fit different academic calendars and lab lengths.

Study Guide and Workbook: An Interactive Approach, written by Dr. Cherie Wetzel, lets students write answers to questions and label diagrams, which are arranged by chapter section with references to specific text pages.

Transparencies. Full-color acetates and black-and-white masters are available.

Photo Atlas for Botany. In full-color, it includes more than 600 labeled photographs and photomicrographs utilizing light, transmission, and scanning electron microscopy, allowing students to recapture what they have seen in lab.

ACKNOWLEDGMENTS

We offer our profound gratitude to many individuals who helped this project reach completion. First on the list is Jack Carey of Wadsworth, who enthusiastically adopted our project several years ago and who relentlessly (yet tactfully) pushed us to complete it according to a vision we jointly shared. Mary Arbogast of Wadsworth and Mary Douglas and Myrna Engler of Rogue Valley Publications oversaw the difficult and complex process of meshing illustrations with text in the galleys and proofs. Never once did they get rattled or cranky with the authors. We thank them for their thoroughness, professionalism, and good humor. We thank Dr. Robert Thornton, Senior Lecturer in the Section of Plant Biology at the University of California, Davis, for his preparation of two chapters in this text: Fungi and Evolution. Dr. Thornton has received several honors for his excellence as a teacher, and his work here illustrates that excellence.

We acknowledge the reviewers who consistently gave positive, detailed advice, which led to numerous significant improvements. They are: Joseph Ammirati, University of Washington, Seattle, WA; Rolf W. Benseler, California State University, Hayward, CA; Maynard Bowers, Northern Michigan University, Marquette, MI; Richard G. Bowmer, Idaho State University, Pocatello, ID; James Dawson, Pittsburg State University, Pittsburg, KS; Roger del Moral, University of Washington, Seattle, WA; Stephanie Digby, St. Cloud State University, St. Cloud, MN; H. W. Elmore, Marshall University, Huntington, WV; Michael Gardinar, University of Puget Sound, Tacoma, WA; John Green, Nicholls University, Thibodaux, LA; William Harris, University of Arkansas, Fayetteville, AR; John D. Jackson, North Hennepin Community College,



Tom Rost, Ralph Stocking, Michael Barbour, and Terry Murphy

Brooklyn Park, MN; Michael Marcovitz, Midland Lutheran College, Fremont, NE; Robert Mellor, University of Arizona, Tucson, AZ; Harvey A. Miller, University of Central Florida, Orlando, FL; H. Gordon Morris, University of Tennessee at Martin, Martin, TN; Loyd Ohl, Eau Claire, WI; P.C. Pendse, California Polytechnic State University, San Luis Obispo, CA; James Raines, North Harris College, Houston, TX; Professor Barbara Schumacher, San Jacinto College-Central, Pasadena, CA; Nancy Smith-Huerta, Miami University, Oxford, OH; John Stucky, North Carolina University, Raleigh, NC; Cherie Wetzel, City College of San Francisco, San Francisco, CA; Terry F. Werner, Harris-Stowe State College, Saint Louis, MO.

Our families exhibited gracious patience and support—especially our wives Ann Rost, Valerie Whitworth, and Judith Murphy. Many colleagues who contributed illustrations, information, or other resources are unfortunately too numerous to list individually here, but we trust that they know we deeply appreciate their help.

Meeting our objective for this book was not easy. We've been refining the text for half a dozen years, and before that we tried out our ideas in books brought out by other publishers, and before that we began the long process of developing our own approaches to plant biology in the classroom and in our research. Collectively we represent 110 years of teaching, and a portion of virtually every one of those years was spent individually or team-teaching an introductory plant biology class. This book is a distillation of our experiences and efforts over that long time. We think that our separate areas of research have helped us write with a knowledgeable, personal voice. We hope that reading our book will make your own learning and teaching as rewarding and exciting as those same activities have been for us.

We dedicate this book to T. Elliot Weier (1903–1991), our wise, kind, and energetic mentor. We miss him and we wish he were here to celebrate this moment with us.

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