**Fundamentals of
Botany Series**

The Plant Cell

Second Edition

Fundamentals of Botany Series

edited by
William A. Jensen
University of California, Berkeley
Leroy G. Kavaljian
Sacramento State College

The Plant Cell
William A. Jensen, University of
California, Berkeley

Plant Variation and Classification
C. Ritchie Bell, University of North
Carolina

Reproduction, Heredity, and Sexuality
Stanton A. Cook, University of Oregon

Evolution and Plants of the Past
Harlan P. Banks, Cornell University

Nonseed Plants: Form and Function
William T. Doyle, University of
California, Santa Cruz

Vascular Plants: Form and Function
Frank B. Salisbury,
Utah State University
Robert V. Parke,
Colorado State University

Plants, Man, and the Ecosystem
W. D. Billings, Duke University

Plants and Civilization
Herbert G. Baker, University of
California, Berkeley

The Plant Cell

Second Edition

William A. Jensen

University of California, Berkeley

Macmillan

**Published by
THE MACMILLAN PRESS LTD**
London and Basingstoke
Associated companies in
New York Dublin Melbourne
Johannesburg and Madras

ISBN 978-0-333-04084-3 ISBN 978-1-349-00276-4 (eBook)
DOI 10.1007/978-1-349-00276-4

**© 1964, 1970 by Wadsworth Publishing
Company, Inc., Belmont, California.**

**All rights reserved. No part of this
publication may be reproduced or
transmitted, in any form or by any
means, without permission.**

**First published in the United States,
1964**

**First published in the United
Kingdom 1964**

First edition 1964

Reprinted 1968

Second edition 1973

The paperback edition of this book is sold subject to the condition that it shall not, by way of trade or otherwise, be lent, resold, hired out or otherwise circulated without the publisher's prior consent, in any form of binding or cover other than that in which it is published and without a similar condition including this condition being imposed on the subsequent purchaser.

Preface

Our knowledge of the cell is constantly expanding. Nothing more clearly illustrates this expansion than the data which have accumulated between now and the first writing of this book in 1964. The recent knowledge does not merely consist of minor information, polishing off rough corners or filling in blank spaces in the picture of some organelle; instead it contains data and concepts basic to our understanding of the cell. One example is the discovery of microtubules. Microtubules had not even been observed in plant cells at the time of the first edition, but they now loom large in our thinking on the development and function of cells. Another example is the microbodies. These had been seen, but their significance was completely overlooked. Only in the last few years, through independent but convergent research on their structure, development, and physiology-biochemistry, has their importance been realized. Our knowledge of the cell has increased not merely through the discovery of new cell parts but also through finding new processes and structures in well-known parts (such as the discovery of an alternate carbon fixation pathway in chloroplasts). Such changes have made the revision of *The Plant Cell* an interesting and challenging job.

As in the first edition, the structure and function of cell parts are considered simultaneously. For example, chloroplasts are studied in conjunction with photosynthesis, mitochondria with respiration, dictyosomes with secretion, walls with support, and so forth. This unifying approach has been strengthened by the addition of new material. Mitosis, meiosis, and cell development are considered in greater depth, by the inclusion of new data and more thorough consideration of the classical data.

Illustrations (both photographs and line drawings) are almost completely new. The spectacular advances in the last several years in electron microscope photography have rendered most of the earlier material obsolete. The number and the quality of electron microscope photographs have been increased in this edition.

Although the level of the text has been raised, it is still geared to the freshman introductory course for major and nonmajor students—as are all the books in the present series. As in the first edition, the information presented in the figures frequently goes beyond that given in the text, to give the instructor a choice as to the level at which he wishes to use the book.

The field of cell biology is a dynamic one. This makes it both interesting and difficult to teach, but it provides the instructor with the opportunity to give the student some idea as to how science advances. It is my hope that this volume reflects in some measure the challenges of cell investigation.

Series Foreword

Because of the immensity and complexity of the field of botany, the great diversity of plants, and the many methods of plant study, the problem of how to present to the student the highlights of botanical knowledge gained over centuries is not easy to solve. The authors and editors of the volumes in this series believe that an understanding of plants—their parts, their activities, and their relationship to man—is of fundamental importance in appreciating the significance of life. To stress this concept, the form and function of plants, tissues, and cells are treated together. At all levels of organization, in each volume, information gathered by morphologists, physiologists, cytologists, taxonomists, geneticists, biochemists, and ecologists is combined.

Thus, in the present volume on *The Plant Cell* by William A. Jensen, the structure and function of the various cell parts are discussed together—for example, mitochondria and respiration, photosynthesis and chloroplasts. The volume by Stanton A. Cook, *Reproduction, Heredity, and Sexuality*, combines the principles of genetics with the means of reproduction in the various plant groups. *Nonseed Plants: Form and Function*, by William T. Doyle, and *Vascular Plants: Form and Function*, by Frank B. Salisbury and Robert V. Parke, cover the major plant groups and discuss the plants in terms of morphology, physiology, and biochemistry. The relation of plants, particularly vascular plants, to their environment, to each other, and to man is covered in *Plants, Man, and the Ecosystem* by W. D. Billings. The form and distribution of plants of the past and their relation to the concepts of evolution are considered by Harlan Banks in *Evolution and Plants of the Past*. Herbert G. Baker, in *Plants and Civilization*, discusses

the importance of plants to man's social and economic development and the equally important consideration of man's role in the modification and distribution of plants.

In a series such as this, the editors are faced with the task of dividing a broad field into areas that can be presented in a meaningful way by the authors. There must be logic in the entire scheme, with few gaps and a minimum of overlap. Yet an instructor may not want to use the series of volumes in the sequence and manner preferred by the editors. Consequently, each volume must be usable alone and also in any sequence with the others. To achieve such a high degree of versatility is difficult, but we believe the series exhibits these features.

A concerted effort has been made by the authors and editors to maintain a consistent level of presentation. However, each author has been encouraged to approach his subject in his own way and to write in his own style in order to provide variety and to exploit the uniqueness of the individual author's viewpoint. Finally, while presenting the principles of botany we have tried to communicate the excitement of recent developments as well as the joy that comes with the extension of knowledge in any field.

Contents

1

**The World
of the Cell, 1**

2

**Wall, Membrane, Vacuole,
and Microtubules, 9**

3

**Chloroplasts
and Photosynthesis, 25**

4

**Respiration
and Mitochondria, 47**

5

**Dictyosomes, Lysosomes,
Sphaerosomes,
and Microbodies, 63**

6	The Endoplasmic Reticulum, Ribosomes, and Protein Synthesis, 73
7	The Nucleus, 85
8	Mitosis, 97
9	Meiosis, Chromosomes, and Genes, 111
10	The Problem of Cell Development, 121
	Suggestions for Further Reading, 133
	Glossary, 137
	Index, 143

**Fundamentals of
Botany Series**

The Plant Cell

Second Edition