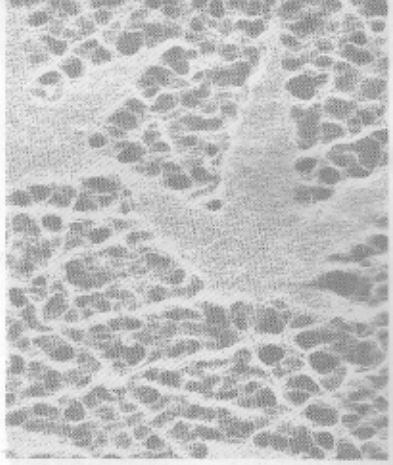
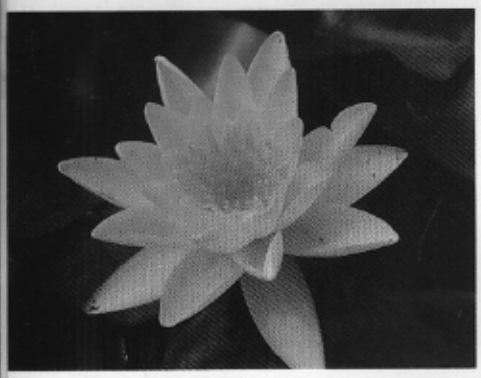


Preface

In recent years, teachers and students of general botany have had several excellent textbooks available. They vary in their approach and emphasis; some offer more diversity of topics, others give greater depth of detail, and others have superb artwork. It seems, however, that in the last few years, a philosophy of compartmentalization has dominated the writing and perhaps the teaching of introductory biology and botany: each individual topic is separated into its own chapter and is not fully integrated into the rest of the material. For most topics compartmentalization is no problem, and without it, textbooks and lectures might be chaotic. But three topics are so important, so fundamental, that they must permeate every aspect of introductory botany and biology and must somehow be mentioned or alluded to on every page: they are *evolution by natural selection, analysis of botanical phenomena,* and *diversity of organisms and their components.*

Emphasis on evolution by natural selection

Evolution by natural selection is the basis of botany and all other fields of biology. It is possible, without understanding natural selection, to memorize botanical terms, to learn enzyme mechanisms and metabolic pathways, to solve problems in genetics, and so on. But without a knowledge of evolution by natural selection, it is not possible to *understand* biological structures or processes. We instructors teach that the discovery of Darwin and Wallace revolutionized biology, but it can be difficult to explain natural selection such that students really understand how powerful the concept is. In this book, I introduce natural selection in general, nontechnical terms that students new to biology should be able to understand. It is not covered in detail at the outset because I believe students must have some familiarity with organisms, anatomy, physiology, and genetics before they can truly appreciate the subtleties of evolution, natural selection, selective advantage, and competition. Beginning with Chapter 1, selective advantage and fitness are referred to or discussed in every chapter (even in Chapter 2 on chemical principles) and on almost every page. It should be impossible for students to forget about evolution for even a few minutes. In Chapter 17, after students have become



Water lily. (Nymphaea).

rather sophisticated in their knowledge of plants and botanical phenomena, natural selection is covered in detail.

Natural selection and diversity

By emphasizing natural selection throughout the book, it has been possible to incorporate the other two important topics — analysis of botanical phenomena and diversity — into every subject as well. By diversity, I do not mean only the kingdoms and divisions of organisms, but the diversity of alternative adaptations, the diversity of ways that plants can be adapted to their environments. There are many types of stems, leaves, and flowers; many types of respiration, storage molecules, and methods of transporting material; many types of pollination, rewards for pollinators, and types of seeds and fruits. By emphasizing the diversity of microhabitats and microclimates; the numerous pests and pathogens; the many types of stresses, scarcities, and excesses that plants must face; and by using the principles of evolution by natural selection, it is possible for instructors to guide students through an analysis of biological phenomena. There are several types of stem and leaf structures: Which are selectively advantageous under certain conditions and which are adaptive under other conditions? Many types of pollination have evolved, but it is possible to analyze this diversity in terms of the selective advantage each type offers under particular conditions. This kind of analysis is carried out throughout this book.

This approach of analyzing diversity of structures and metabolisms on the basis of evolution by natural selection should help students to feel involved in botany, to be a part of it. It is so easy to ask "What is the selective advantage of this process compared to that process?" that students will soon realize that not everything in biology is known and understood, and rather than leaving questions for some group of unknown scientists to answer, students themselves can think about them. With natural selection as an analytical tool, students can create their own hypotheses, their own potential explanations. Often, thought experiments or simple observations can indicate whether hypotheses might be feasible and plausible.

Organization

The topics and chapters are organized in a sequence that I find to be the easiest to follow, beginning with the most familiar — structure — then proceeding to the less familiar — metabolism — then finishing with those topics that are probably least familiar to most beginning students — genetics, evolution (in detail), the diversity of organisms, and ecology. Three initial chapters, on chemistry, cell structure, and cell division, are not familiar but are so basic they must come first. Because this order may not be preferred by all instructors, sections have been written to be self-contained so they can be taken up in various orders. In courses that emphasize metabolism, the sequence could be Chapters 1, 2, 3, 10 to 15. Courses emphasizing plant diversity could follow a sequence of Chapters 1, 2, (16, 17), 18 to 25. Gene action is discussed in the growth and development section, whereas gene replication is included in the genetics section. Although both topics are based on the DNA molecule, it does not seem necessary to cover DNA replication and Mendelian genetics prior to teaching about mRNA, protein synthesis, and gene regulation. These topics, along with the techniques of recombinant DNA analysis, are covered in considerable detail; I believe that beginning students are fully capable of understanding these subjects, which are already becoming central to most fields of biology.

Features

The following features are used throughout *Botany* to help your students learn.

Part openers

Each of the book's four parts opens with a brief summary of all the chapters in that part. The part opener ties together the main themes and shows how botany is a unified science, not just a series of facts to memorize.

Concepts

A Concepts section opens each chapter and introduces the student to the main topics and themes. It sets the stage for the sections that follow.

Plants and People

A *Plants and People* section designed to guide students into thinking about plants in less botanical ways appears in about half the chapters. Several are oriented toward economics — the importance of plants in providing food, fiber, and medicines. Others discuss the role plants have played in world politics, and others explore the ways in which botanical discoveries have affected the evolution of scientific thought and concepts, such as the lack of spontaneous generation and vital forces.

Boxes

Boxes elaborate on subjects that, while not essential to the study of botany, help make the material more interesting and understandable. Among them are a key to plant identification using common fruits and vegetables, usable by any student who has ever been to a grocery store, and a discussion of the misclassification of cyanobacteria, which throws light on the scientific method.

Illustrations

The botanical world is full of color, and so is this text. Each chapter contains color photographs and line drawings, every one chosen to illuminate a point made in the text. Appropriate chapters have both light and electron micrographs, often paired with line drawings to make the cellular world more understandable.

Other features

Marginal notes. Frequent marginal notes clarify important points and make connections with other topics. They often provide concise summaries of difficult concepts.

Summary. The summary at the end of each chapter consists of numbered paragraphs that succinctly list the major topics and concepts discussed.

Review questions. Following the summary are review questions, which also serve to help the students review the chapter material. The questions are often open-ended, forcing students to think about the concepts and synthesize the material, rather than just plugging in an answer.

Anthurium.

Additional readings. Concluding each chapter is a list of books and articles that go into greater detail on the topics presented in that chapter. These readings are good places to start for students who have to write research papers.

Glossary. A comprehensive glossary defines major botanical and general biological terms. Each definition is keyed to the chapter where the principal discussion occurs.

Endpapers. The endpapers in the front and back of the book summarize in full-color line drawings the evolution of plants and the major biological divisions.

Ancillaries

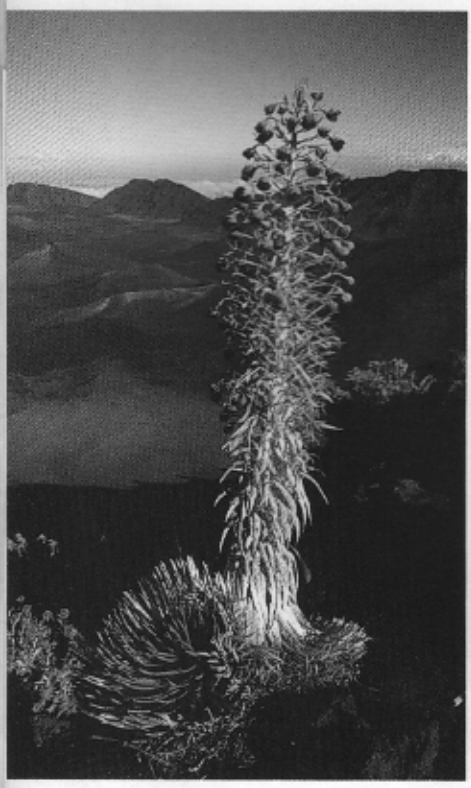
Several ancillaries have been prepared to accompany this text to support your teaching efforts. Dr. Ann M. Mickle of LaSalle University has prepared a *Test Bank* of multiple choice, true/false, matching, and short essay questions, available in both printed and computer versions (IBM and Macintosh).

Dr. Marshall D. Sundberg of Louisiana State University has prepared a detailed *Instructor's Resource Manual* that contains outlines, laboratory suggestions, and field work ideas. It also has a wealth of information that can be included in lectures to provide extra motivation for the students.

More than one hundred illustrations from the book have been selected and made available as full-color *overhead transparencies*. Each has been chosen because it represents an important complex concept that you may wish to discuss in lecture with a detailed illustration. About half of these are also available as *Bio Art*—illustrations printed without labels. These can be used as part of an exam or you can add your own labels to customize them for your needs. Many instructors will want to photocopy them and give them to students to help them take notes. *Bio Art* is found in the *Instructor's Resource Manual.*

Dr. Margaret Balbach of Illinois State University and Dr. Lawrence C. Bliss of the University of Washington have revised and updated their popular *Laboratory Manual for General Botany* and have provided a guide to using it with this text. The authors have included new material on ecology. The manual contains 32 experiments and is lavishly illustrated with line drawings, many of them new to this edition.

Silversword. (Stephen J. Krasemann, Nature Conservancy)



A *final word, just to students*

Plants are of vital importance to all of us in everyday life, providing us not only with food and oxygen, of course, but also with lumber, medicines, fibers, and even protection against high-energy radiation from space (Chapter 10). But plants are important to biologists in other ways, more subtle, interesting ways: most of the early discoveries of cell biology, including the discovery of cells themselves, were made in studies of plants, and many enzyme systems were first isolated from plants and were later confirmed to be present in animals as well. Even at present, when thousands of scientists analyze human metabolism and structure in ever greater detail, studies of plant metabolism and structure are essential as a means of truly understanding human biology. For example, when we are cold, we generate heat by shivering—a rapid contraction and relaxation of muscle cells that converts mechanical energy to heat energy. But certain plants have an unusual type of respiration (thermogenic respiration, Chapter 11) that generates heat more directly and efficiently. Would such a metabolism be beneficial to us? What kinds of

changes would have to occur for humans to have thermogenic respiration? Similarly, all organisms use only 20 types of amino acids in building proteins, but some plants have hundreds of types of amino acids, not just 20: if we humans were to eat them, our bodies would try to build our new proteins with those exotic amino acids, and we would die. But the plants can somehow tell the difference and are not killed by those amino acids in their cells. How do the plants distinguish between safe and poisonous amino acids? What does our inability to distinguish between them tell us about our protein-synthesizing metabolism, one of the most fundamental metabolisms we have? By understanding plant biology we can more fully understand and appreciate the details of human biology.

Commelina. *(Robert and Linda Mitchell)*

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During the course of this project, I have discovered than an author creates only a manuscript; it is the editorial staff that creates an attractive, usable book that actually is effective in transferring the information of the manuscript to the students. I am grateful to Ed Murphy and Julie Alexander for initiating, supporting and maintaining this project, always giving me steady help and reliable advice. Sally Kusch, Senior Project Manager, and Richard Koreto, Developmental Editor, always knew how to handle every problem, large or small. Carol Bleistine, Manager of Art and Design, and Ray Tschoepe, Art Developmental Editor, transformed my amateur sketches into a beautiful art program that should greatly increase the students' interest and their ability to understand the concepts presented. Similarly,

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