

Plants *fifth edition* & Society

Levetin
McMahon

Fifth Edition

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Plants & Society



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PLANTS AND SOCIETY, FIFTH EDITION

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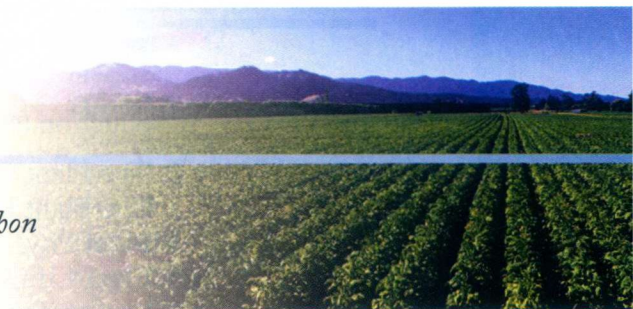
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In loving memory of our mothers

Pauline Levetin

& Dorothy Sink McMahon





Preface

As we enter the twenty-first century, plant science is once again assuming a prominent role in research. Renewed emphasis on developing medicinal products from native plants has encouraged ethnobotanical endeavors. The destruction of the rain forests has made the timing for this research imperative and has spurred efforts to catalog the plant biodiversity in these environments. Efforts to feed the growing populations in developing nations have also positioned plant scientists at the cutting edge of genetic engineering with the creation of transgenic crops. However, in recent decades botany courses have seen a decline in enrollment, and some courses have even disappeared from the curriculum in many universities. We have written *Plants and Society* in an effort to offset this trend. By taking a multidisciplinary approach to studying the relationship between plants and people, we hope to stimulate interest in plant science and encourage students to further study. Also, by exposing students to society's historical connection to plants, we hope to instill a greater appreciation for the botanical world.

AUDIENCE

Recently, general botany courses have emphasized the impact of plants on society. In addition, many institutions have developed plants and society courses devoted exclusively to this topic. This emphasis has transformed the traditional Economic Botany from a dry statistical treatment of "bushels per acre" to an exciting discussion of "botanical marvels" that have influenced our past and will change our future. *Plants and Society* is intended for use in this type of course, which is usually one semester or one quarter in length. There are no prerequisites, because it is an introductory course. The course covers basic principles of botany and places a strong emphasis on the economic aspects and social implications of plants and fungi.

Students usually take a course of this nature in their freshman or sophomore year to satisfy a science requirement in the general education curriculum. Typically, they are not biology majors. Although most students enroll to satisfy the science requirement, many become enthusiastic about the subject matter. Students, even those with a limited science background, should not encounter any problems with the level of scientific detail in this text.

As indicated, the primary market for this text would be a plants and society course; however, it would certainly be suitable for an introductory general botany course as well.

ORGANIZATION

We feel that *Plants and Society* is a textbook with a great deal of flexibility for course design. It offers a unique balanced approach between basic botany and the applied or economic

aspects of plant science. Other texts emphasize either the basic or applied material, making it difficult for instructors who wish to provide better balance in an introductory course. Another distinctive feature is the unit on algae and fungi. While other texts cover certain aspects of this topic, we have an expanded coverage of algae and fungi and their impact on society.

Plants and Society is organized into 26 chapters that are grouped into seven units. The first nine chapters cover the basic botany found in an introductory course. However, even in these chapters we have included many applied topics; some in the boxed essays but others directly in the chapter text.

UNIT I Plants and Society: The Botanical Connections to Our Lives. Chapter 1 stresses the overall importance of plants in everyday life. The properties of life and an introduction to chemistry are included. Flowering and non-flowering plants, algae, and fungi are introduced. The scientific method is explained as the process used by scientists to study and expand our knowledge of the natural world. The diversity and applications of phytochemicals is also presented.

UNIT II Introduction to Plant Life: Botanical Principles. This unit addresses basic botany. Chapters cover plant structure from the cellular level through the mature plant. Reproduction, including mitosis and meiosis and the life cycle of flowering plants, is discussed in two chapters. Other chapters cover genetics, evolution, plant physiology, plant systematics, and plant diversity. Some of the economic aspects of plants discussed in this unit are the importance of vegetables and fruits, the connection between sugar and slavery, plant essential oils and perfumes, phytoremediation, the applications of palynology, and species conservation.

UNIT III Plants As a Source of Food. This unit describes the major food crops. It begins with a chapter on the requirements for human nutrition and continues with a chapter on the origin of agriculture. Other chapters cover the grasses, the legumes, and starchy staples. The unit ends with a chapter on the Green Revolution, the loss of genetic diversity, the search for alternative crops, and the controversial development of transgenic crops.

UNIT IV Commercial Products Derived from Plants. This unit covers other crops that provide us with consumable products such as beverages, herbs and spices, and materials such as cloth, wood, and paper. The historical origin and societal impact of these crops are explored.

UNIT V Plants and Human Health. This unit introduces students to the historical foundations of Western medicine, the practice of herbal medicine, and the chemistry

of secondary plant products. Descriptions of the plants that provide us with medicinal products and psychoactive drugs are discussed. The unit also covers the common poisonous and allergy plants that are found in the environment.

UNIT VI Algae and Fungi: The Impact of Algae and Fungi on Human Affairs. This unit describes the economic importance of the algae and fungi, including their biology and crucial roles in the environment. The algae are recognized as key producers in aquatic environments and as sources of human food, devastating blooms, and industrial products. Fermented beverages and foods from fungi are discussed, as is the medical importance of fungi as sources of antibiotics, toxins, and diseases affecting crops and people.

UNIT VII Plants and the Environment. Chapter 26 is an introduction to the principles of ecology: the ecosystem, niches, food chains, biogeochemical cycles, and ecological succession. The major biomes of the world are discussed, with an emphasis on the economic value of certain desert plants and the strategy of extractive reserves in the rain forest. The problems associated with rising levels of the greenhouse gas CO₂ and the environmental consequences of global warming are addressed.

APPROACH

This textbook is written at the introductory level suitable for students with little or no background in biology. Like any introductory book, this book uses a broad-brush treatment. The nature of the course dictates an applied approach, with the impact of plants on society as the integrating theme, but the theoretical aspects of basic botany are thoroughly covered.

LEARNING AIDS

In addition to the textual material, each chapter begins with a chapter outline and key concepts. Important terms are in boldface type throughout the text, and each chapter ends with a summary, review questions, suggested readings, and a reminder to visit the Online Learning Center (www.mhhe.com/levetin5e) for practice quizzes and links to chapter-related material. Concept Quizzes are inserted within the text to draw the attention of the students as they read the chapter. The quizzes begin with either a summary of the preceding text or an introduction to new information that is complementary to the chapter. The questions that follow are designed not only to test comprehension but, in many instances, also to promote critical thinking by asking students to apply their knowledge to real-life situations. The Concept Quizzes may also be assigned by instructors or used to initiate in-class discussions. Appendixes, which include the metric system, classification, and a glossary, conclude the text.

NEW TO THE FIFTH EDITION

Color is an essential part of the allure of plants, and we are extremely pleased that the fifth edition of *Plants and Society* now includes figures and tables in brilliant color. More than 350 photographs, many of them new, and nearly 200 drawings are in full color. We have updated and incorporated new information into most of the chapters. We have also tried to respond to many of the suggestions made by reviewers. The scientific method has been added as a new section in Chapter 1 to clarify the process of science and dispel misinformation about the scientific theory prevalent in the popular media. In Chapter 3, the discovery of the world's smallest genome in bacteria, which live inside insect pests, makes the case for the evolution of organelles from once free-living microbes. Additionally, this chapter includes a report on how the number of stomata in fossil tree leaves can be used to estimate altitude of populations in the geological past. The topsy-turvy role of carnivorous plants in food webs is expanded with the discovery of one species that digests leaf litter on the rain forest floor. Chapter 7 describes the knowledge learned from sequencing the first tree genome, and in Chapter 15, the development of genetically engineered trees for forestry and agriculture is promising. Knowledge from phylogenetics has brought updates to the classification system. The molecular classification of plants in the APG (American Phylogeny Group) system is introduced in Chapter 8, and Chapter 9 now includes a discussion on the three-domain system of Archaea, Bacteria, and Eukarya.

ADVANCES IN AGRICULTURE

Several chapters deal with recent discoveries and advances in agriculture. Chapter 11 documents how microfossils have been used to pinpoint the time and place for the domestication of chili peppers. Man's second best friend may be the cat, domesticated for agricultural services more than 10,000 years ago as evidenced by a burial site recently found in Cyprus. The non-shattering mutation, which changes wild rice to its domesticated form, has been identified. The importance of gene banks to agriculture is reinforced with the story of the doomsday vault and the resurrection of Carolina gold rice. The development of purple tomatoes (Chapter 6) and the first hybrid seed in legumes hold great promise (Chapter 13). New information on plant diseases that threaten commercial crops such as leaf spot of banana, plum pox, and *Fusarium* head blight and the development of GM varieties that are inherently resistant to these and other diseases is discussed. The availability of GM alfalfa, which is the first herbicide-resistant perennial crop, is some of the new information to be found in Chapter 15. The Fair Trade Coffee, a worldwide movement which attempts to insure that small farmers are paid a livable wage for the coffee beans they produce, is highlighted in Chapter 16. Allelochemicals are emerging as the next generation of herbicides for crops and lawns (Chapter 21).

PLANTS AND HEALTH

There have been several developments in the connection between plants and human health. In Chapter 10, several studies are included that examine the effectiveness of dietary fiber, fresh fruits and vegetables, and antioxidant supplements in preventing certain diseases. Other updates include research on the spice turmeric as an adjunct therapy to fight cancer and other diseases and the link between lavender oil in personal care products and to hormonal imbalances in young boys (Chapter 17). Chapters 19 and 20 update legal issues concerning ephedrine use, medical marijuana, and tobacco products. More information on the health benefits of polyphenols, particularly resveratrol, in red wine are reported in A Closer Look 24.2—Alcohol and Health.

PLANTS AND ENVIRONMENT

Environmental issues are one of the themes in *Plants and Society* and are covered in several chapters. A population of mature American Chestnut trees left untouched by the Chestnut Blight invasion is a hopeful addendum to the story (Chapter 6). The promise and hype of soy biodiesel and corn ethanol as alternative fuels are debated in Chapters 13 and 15. Chapter 26 introduces ethnomapping, a new strategy undertaken by indigenous people to document and protect the inherent value of the Brazilian rain forest. Also in this chapter, recent data points to ocean acidification as another alarming consequence of rising carbon dioxide levels in the atmosphere.

ACKNOWLEDGMENTS

More than ten years ago, we had an idea for a textbook that would attract students to the study of plants by showcasing the many ways plants enhance our lives. The success of *Plants and Society* is a dream that became a reality with the invaluable support of the McGraw-Hill staff. We are deeply appreciative of the *dream team* who have guided us in the

production of the fifth edition: Patrick Reidy (Executive Editor), Debra Henricks (Developmental Editor), Joyce Watters (Project Manager), John Leland (Photo Researcher), and John Joran (Designer).

REVIEWERS

We are indebted to our colleagues who have taken time from demanding schedules to meticulously review *Plants and Society* for errors, inconsistencies, or omissions and to offer constructive feedback and suggestions. We thank you for making the fifth edition of *Plants and Society*, the best edition.

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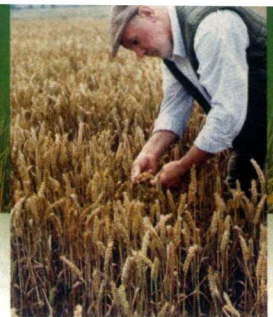
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Supplements



PLANTS AND SOCIETY ONLINE LEARNING CENTER

www.mhhe.com/levetin5e

The Online Learning Center to accompany *Plants and Society* offers a variety of additional resources for instructors and students. Instructors will appreciate full-color PowerPoint image slides that contain illustrations and photos from the text, and students will find multiple-choice quizzes, short-answer concept quizzes, and web links to chapter related-material. Also included is a listing of useful and poisonous plants, as well as tips for growing houseplants and home gardening.

THE LABORATORY MANUAL FOR APPLIED BOTANY BY LEVETIN, MCMAHON, AND REINSVOLD

The lab manual features 18 exercises that focus on examining plants and plant products that have sustained or affected human society. Although the manual includes standard information on plant cells and tissues, there is a practical approach to the investigations. Students extract plant dyes, make paper from plant fibers, and study starch grains used in archaeology. Several laboratory topics are devoted exclusively to economically important crops—grasses, legumes, starchy staples, and spices. Four additional appendixes are titled Science as a Process, A Field Trip to a Health Food Store, A Taster's Sampler of Caffeine Beverages and Foods, and Notes for Instructors, which provides additional information for each of the labs.

THE AMAZING LIVES OF PLANTS: THE REPRODUCTIVE LIVES OF MOSSES, PINES, FERNS, FLOWERS, AND LEAVES CD-ROM OR DVD

Available upon adoption, *The Amazing Lives of Plants* includes five independent segments: "Mosses," "Ferns," "Pines," "Flowers," and "Leaves." Their reproductive lives are presented in a vivid, full-color combination of live video footage and sharp animation. Subtitled text makes it easy to cue up for use in lecture, and the pace of the program is suitable for students taking notes.

MCGRAW-HILL'S BIOLOGY DIGITIZED VIDEOS

Licensed from some of the highest-quality life science video producers in the world, these brief video clips on DVD range in length from 15 seconds to two minutes and cover all areas of general biology, from cells to ecosystems. Engaging and informative, McGraw-Hill's digitized biology videos will help capture students' interest while illustrating key biological concepts, applications, and processes.



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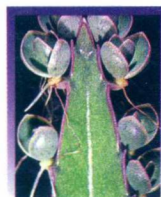
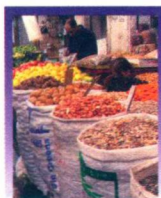
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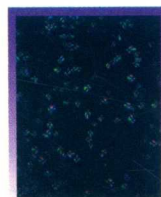
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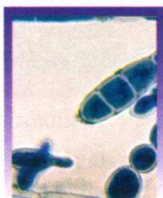
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