



# PLANTS

## Basic Concepts in Botany

WATSON M. LAETSCH

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*To my parents, who encouraged and supported my interest  
in biology, and to Sita, John, and Krishen for their  
aid and tolerance during the preparation of this book*

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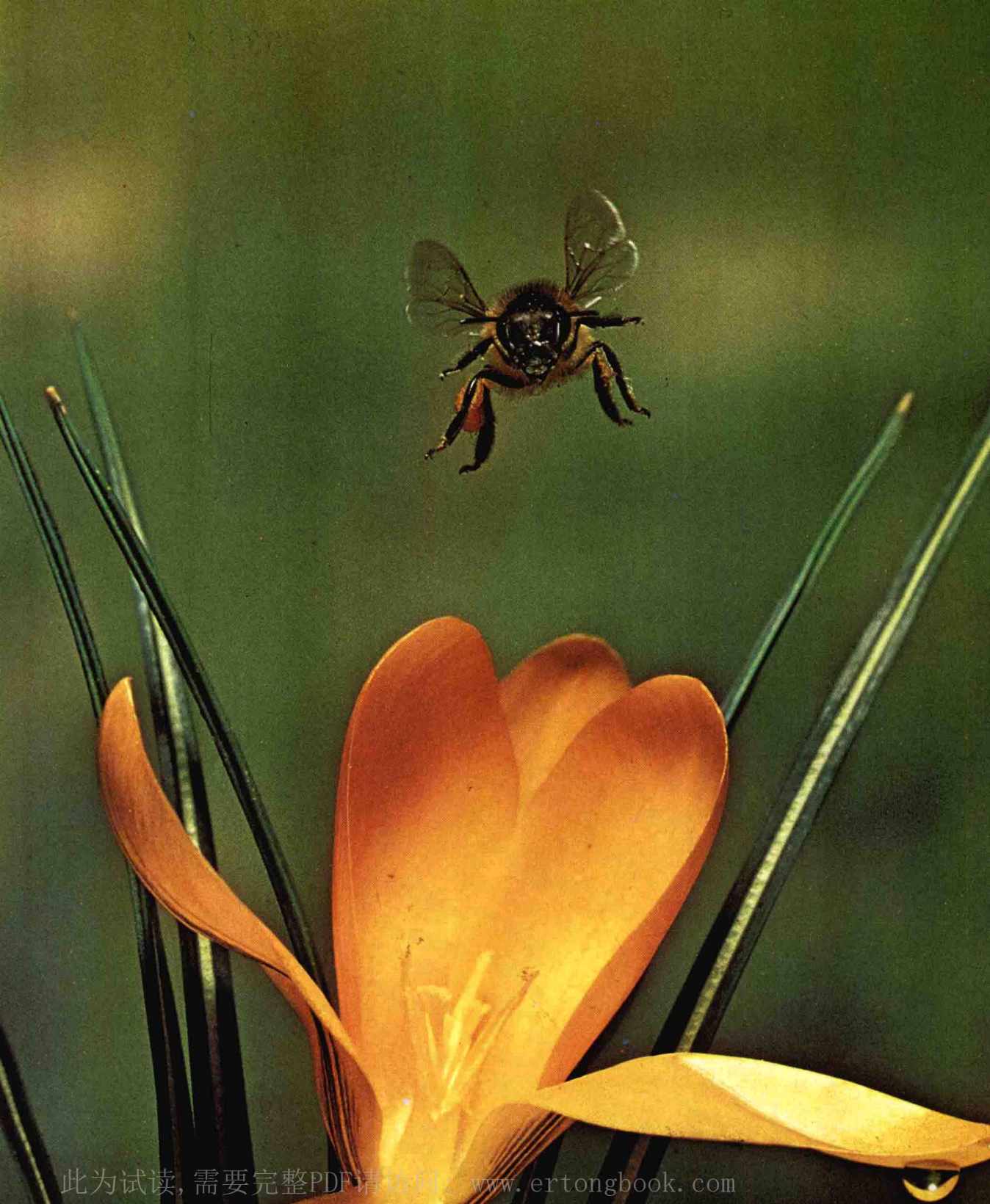
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# PLANTS

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# Preface

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*Plants* is a textbook for students encountering botany for the first time, whether fulfilling liberal arts requirements in the sciences or as prospective science majors. It is unconventional in many ways, perhaps most particularly in its attempts to build on the students' familiarity with plants to introduce them to botanical ideas, systems, and facts. My aim throughout has been to introduce botany as an intellectual discipline closer, more vital to the everyday world we perceive than most students may realize.

My approach in *Plants* derives from the principle that students can best assimilate the new and unfamiliar by working from the concrete to the abstract. It contrasts deliberately with a traditional approach in biology which asks students to understand things they cannot see before they consider familiar objects. In *Plants* the familiar and concrete comes first whenever possible; the "unseen" appears slowly and sparingly. For example, the survey of the plant kingdom begins with organisms the student easily recognizes, the flowering plants, and ends with microbes, organisms more remote from their senses. In a similar way, I treat the whole plant first before taking up cells and organelles; and I describe energy transfer by relating it to hydrogen, a known and demonstrable element. To further bridge the gulf between the concrete and the abstract, I use many recognizable examples and applications whenever possible.

Redundancy is equally important for effective learning of ideas and principles, and I have made an effort to build a measure of repetition into the structure of the text, so that important ideas re-emerge in different contexts. One theme, the origin of diversity and its relation to available energy and matter, I introduce in Chapter 1 and refer to in most other chapters. I also repeatedly bring up transfer of energy and genetic variation, ideas that require frequent exposure to be properly understood. The overall effect is like a spiral, with chapters building on each other and expanding ideas presented earlier. The spiral finally forms a loop as the last chapter brings the reader around to the first chapter, though now with a deeper sense of the complexity of the plant world. However, the parts need not be read in sequence. They can be rearranged to suit different course structures.

*Plants* deals with botanical facts as well as ideas and processes, but I have not attempted to explain everything there is to know about plants. It is easy to learn facts, but easier still to forget them. Then too, many facts in science change or become irrelevant. Rather than burden the student with an encyclopedia of information about plants, I have used factual information to illustrate general ideas, selecting facts for their interest to students as well as their appropriateness. I also avoid giving the impression that we know all there is to know about plants, frequently identifying controversies and unresolved questions, giving the uncertain and the unknown their due.

### The Organization of *Plants*

In developing the organization for *Plants*, I have presented botany to students by linking the discipline as we know it to the plant world as they have encountered it, moving from familiar to abstract and emphasizing the importance of plants to human life. In Part I, I stress the role of plants in providing energy for all living things, a function that has given plants a considerable impact on the shaping of human civilization. This Part includes an examination of the ecosystem in Chapter 1 and discussions of how transformation of energy and transfer of matter work, and how they influence patterns of consumption among living things. In the last chapter, we return to consider the ecosystem in detail, because community structure and adaptations of organisms to their environment will be more fully understood with the chapters on genetics and evolution as background. The second chapter also introduces a main theme of the book: the relationship of plants to human culture, politics, and philosophy.

Part II is the survey of the plant world, its classification and its history, as well as the structural features and relationships of the main plant groups. In Chapters 3 and 4 I describe kinds of plants and in Chapter 5 continue the theme of how people and plants are related by describing plants of special interest and importance to society. Examining these plants, I bring up terms and topics on plant growth, structure, and inheritance, but wait to cover them in detail in subsequent chapters. A brief introduction to cells appears in the Supplement to Chapter 3, providing a background for discussion of specific cell functions in Chapters 6 and 7.

Moving on to the whole plant and plant processes, the five chapters in Part III cover plant structure and function, particularly in the flowering plants. Chapters 6 and 7 are on development, and I have explained features of plants that students may encounter daily. In these chapters, the cell is depicted in its growth along with the rest of the organism, leaving some cellular parts for later concentrated study. (It is not necessary to know about all the cell's organelles to understand basics of cell enlargement.) In Chapter 8 I develop the fine structure of energy transformation and cycling of matter introduced in Chapter 1, explaining all cell metabolism in terms of what the plant needs to grow.

Mineral nutrition of plants and the cycling of specific minerals is the subject in Chapter 9. The nitrogen cycle and the use of nitrogen in plants get full emphasis because the element is so vital to all organisms and because it is a limiting factor in agricultural productivity. This chapter also displays the effect of limitations of energy and minerals on adaptation of plants. Once the importance of mineral nutrition is established, we explore in Chapter 10 the basic anatomy and physiology required to appreciate how vascular plants transport materials. This section goes beyond coverage in previous chapters of specialized cell structure, energy requirements for uptake and movement of materials, and the plant's requirements for minerals.

The major themes of *Plants* are treated explicitly in Part IV. Because evolution occurs by selection of variants in populations, it is important to know how variation works to

grasp the idea of natural selection fully. In Chapter 11 I discuss variation by examining sexual reproduction and its significance. Pollination is treated here because this is the way most plants effect sexual reproduction, ensuring and promoting genetic variation. It also balances the complexities of Mendelian and molecular genetics. Genetics is treated historically, because it vividly shows science as an intellectual endeavor. Asexual reproduction (Chapter 12) appears in this Part because it is another reproductive strategy, and tissue culture comes in here rather than in the chapters on development because much current interest in this subject is aroused by its use in plant genetics.

Two chapters focus on evolution. I trace in Chapter 13 the establishment of geological time as well as past and present efforts to study former living organisms. In Chapter 14 I emphasize historical and current efforts to understand how life has evolved, giving many examples illustrating evolutionary phenomena in animals as well as plants. I have not shied away from introducing animals here because they illustrate some concepts more dramatically than do plants, and because it is important to emphasize the interrelationships of plants and animals. My approach to evolution takes me down the historical and natural-history path, rather than the more mathematical track that often confuses beginning students more than it enlightens.

Having established how plants and how organisms adapt, I go on in Chapter 15 to explore the structure of plant communities and the environmental factors shaping them, closely attending also to the human effect in managing ecosystems. This chapter closes the loop I referred to earlier, bringing the reader back to the broad view of the plant world described more generally in Chapter 1.

The text is equipped with varied instructional aids to help students understand the material. Each chapter has a summary and review questions. Many of these relate material and concepts from different chapters and encourage students to integrate their own experiences with discussions in the text. Many chapters end with special sections called Supplements, designed to entice students to look into a selected topic in some detail. Each Supplement is focused on a subject related to material in the preceding chapter, but considered here in more depth.

The text has a glossary at the end, as well as an extensive bibliography including both popular articles and texts, scholarly papers, and monographs. The Supermarket Taxonomy in the Appendix is a survey of species of common plants found in the grocery store, and the families to which they belong. It supplements the discussion of supermarket plants in Chapter 3, providing additional background that students will find interesting. An instructor's manual (*Instructor's Manual to Accompany Plants: Basic Concepts in Botany*, by Mary S. Manteuffel) is also available. It has an overview of every chapter, learning objectives, lecture suggestions, ideas and directions for laboratories and field trips, questions for discussion, and objective questions.

Botany is a visual science, and plants, like so much in biology, are often best presented with pictures rather than words. The numerous illustrations in this text were carefully selected for their value in motivating students and providing information; they form an important instructional medium. Most science books use pictures to illustrate an occasional point in the text, but in many cases I have attempted to use words to illustrate pictures.

### Acknowledgments

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I have expressed appreciation to family members elsewhere, but more specificity is only fair. Sita typed for critical deadlines, reviewed manuscript, and helped select photographs; John criticized manuscript and judged photographs, and Krishen helped with illustrations and did not complain loudly when I didn't take him places "because of the book."

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# Plants in the

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