



Preface

The beauty, mystery, and power of the sea fascinate people all over the world, including, of course, students enrolled in undergraduate marine biology courses. For many students taking marine biology is the natural expression of an interest in marine life that began by visiting the shore, scuba diving, recreational fishing, aquarium keeping, or viewing one of the many superb television documentaries about the ocean. Many students are also concerned about the increasing impacts of humans on marine ecosystems. *Marine Biology, Sixth Edition*, was written to reinforce and enhance our readers' enchantment with marine life while providing a rigorous introduction to the science of marine biology.

Marine Biology is used by high school, undergraduate, graduate, and adult education students, and by interested laypersons not enrolled in formal courses. We are gratified that even some professional marine biologists find the book useful. While keeping this range of users in mind, we have written the text primarily to meet the needs of lower-division, non-science majors at colleges and universities. For many of these students, marine biology will be their only tertiary science course, often taken to satisfy a general education requirement. We have therefore been careful to provide solid basic science coverage including some principles of the scientific method, the physical sciences, and basic biology. Our aim has been to integrate this basic science content with a stimulating, up-to-date overview of marine biology. We hope this approach demonstrates the relevance of the physical sciences to biology and makes all sciences less intimidating. To this end, we use an informal writing style that emphasizes an understanding of concepts over rigorous detail and terminology.

We recognize that general science content is not a requirement for all marine

biology courses, either because the course is not intended to satisfy general education requirements or because students already have a background in science. To balance the needs of instructors teaching courses with and without prerequisites in biology or other sciences, we have designed the book to provide as much flexibility as possible in the use of the basic science material, the order in which topics are presented, and overall emphasis and approach. We have tried to meet the needs and expectations of a wide variety of students, from the scuba diving philosophy major to the biology major considering a career in marine science. We hope a variety of readers other than university students also find the book useful and enjoyable.

Four major themes run through *Marine Biology*. One is the abovementioned coverage of basic science applied to the marine environment. Another is an emphasis on the organisms themselves, and their vast diversity not only in taxonomic terms but also in structure, function, and ecology. A third theme is an ecosystem approach that integrates this organismal diversity with the challenges imposed by the surrounding environment, both physical and biological. A final theme that, for better or worse, becomes increasingly relevant with each passing year is the interaction of humans with the marine environment.

Marine Biology, Sixth Edition, adopts a global perspective to emphasize that the world's oceans and seas are an integrated system that cannot be understood by looking in any one person's own backyard. For many students this is a new perspective. One aspect of our global approach is the deliberate inclusion of examples from many different regions and ecosystems so that as many students as possible, not just in North America but around the world, will find something relevant to their local areas or places they have

visited. We hope this will stimulate them to think about the many relationships between their own shores and the one world ocean that so greatly influences our lives.

Changes in the Sixth Edition

We have introduced a new feature to the sixth edition of *Marine Biology*: each chapter includes an **Eye on Science** box; a vignette of a particular piece of ongoing or planned research. Rather than simply presenting factual information and summarizing results, the emphasis is on giving students a glimpse of what scientists actually do—the questions being asked, their significance, and how a scientist or research team has set about answering them. We hope this helps science seem less remote and gives students better insight into the daily process of scientific enquiry.

As in previous editions we have updated the text throughout to reflect recent events, new research, and changes in perspective, and to include information requested by reviewers. A few examples of such revisions or additions are:

- Larger, more attractive, and more detailed maps of the sea floor and the major coastal habitats of North America, now as an end-piece foldout
- A description of the importance of the United States Exploring Expedition (the Wilkes Expedition), which predated the *Challenger* expedition, to the history of marine biology
- A rewritten "Waves That Kill" boxed reading with in-depth coverage of the December 2004 tsunami in the Indian Ocean
- Updated coverage of the origin of chloroplasts by endosymbiosis
- Thorough revision of Table 5.1 on prokaryote metabolism to make it simpler, less imposing, and easier to understand

- New cladograms depicting phylogenetic relationships within both the invertebrates and the vertebrates
- An expanded Figure 9.18 showing various whale species
- A new boxed reading on deep-water coral communities and human impacts on them
- New findings about the benefits to hosts in the anemone-anemonefish symbiosis
- Additional information about trophic cascades
- Coverage on the effects of Hurricane Katrina

In addition to these and many other changes we have as usual updated facts and figures, corrected errors, and reorganized some sections to improve balance and logic flow. In every edition we seek to improve the illustrations and photographs, and in the sixth edition we have adopted a more colorful and open interior design that we think will better engage students and reinforce their fascination with marine life.

Organization

Marine Biology is organized into four parts. **Part 1** (Chapters 1 through 4) introduces students to marine biology and the basic sciences that underpin it. Chapter 1 describes the history of marine biology. It also explains the fundamentals of the scientific method. This feature emphasizes that science is a process, an ongoing human endeavor. We think it critical that students understand how and why science works, and also that science has limitations and that there is still much to be learned. Chapters 2 and 3 are a basic introduction to marine geology, physics, and chemistry. *Marine Biology* includes more information on these subjects, and places greater stress on their importance to understanding marine ecosystems, than other texts but we have kept Chapters 2 and 3 as short as possible and cover many abiotic aspects of the marine environment in the chapters where they are most relevant to the biology. Wave refraction, for example, is described in conjunction with intertidal communities (Chapter 11) and estuarine circulation is discussed as part of the ecology of estuaries (Chapter 12). This approach emphasizes the importance of the physical and chemical environment to the organisms of the sea

throughout the book. At the same time, it provides flexibility for instructors to make best use of the material in light of general education requirements, course prerequisites, and students' backgrounds. Chapter 4, "Fundamentals of Biology," briefly reviews some essential biological concepts. In covering basic biology we have tried to balance the needs of a spectrum of students ranging from those with no prior university-level instruction to those who have taken a number of biology courses. Depending on the level of their students, instructors may choose to cover Chapter 4 in class, assign it as review reading, or omit it and rely on the In-Text Glossary entries in later chapters to remind students of the definitions of key terms.

Part 2 (Chapters 5 through 9) surveys the diversity of marine life from the perspective of organismal biology. As in Part 1, we provide introductory information that is reviewed and expanded upon in later chapters. In discussing the various taxa we emphasize functional morphology, ecological and physiological adaptations, and economic importance or other significance to humanity. Classification and phylogeny are not stressed, though we do present cladograms illustrating widely-accepted phylogenetic schemes for invertebrates and vertebrates. As in the rest of the book we have selected organisms from around the world for illustration in photographs, line drawings, and color paintings, but organisms from the coasts of North America are emphasized. Organisms are referred to by their most widely accepted common names. One or two common or important genera are noted in parentheses the first time a group is mentioned in a chapter, but we have not attempted to provide comprehensive lists of genera. Nomenclature follows for the most part the FAO Species Catalog and Species Identification Guides for groups covered by these references.

Part 3 of the book (Chapters 10 through 16) presents an ecological tour of the major environments of the world ocean, commencing with an introduction to some fundamental principles of marine ecology in Chapter 10. As for Chapter 4, important concepts presented here are reviewed elsewhere in the In-text Glossary boxes. The remaining six chapters of Part 3 proceed from nearshore to offshore and from

shallow to deep water, describing the physical characteristics of each environment and the adaptations and interactions of the organisms that live there. This admittedly arbitrary sequence follows the teaching sequence of the greatest number of our reviewers, but the chapters are designed so that they can be covered in any sequence according to instructors' preferences and needs. Most chapters include generalized food webs with standardized color coding to indicate the nature of the trophic relationships.

Finally, **Part 4** looks at the many ways in which humans interact with the world ocean: our use of and impact on the marine environment, and the influence of the ocean on the human experience. The section presents an up-to-date, comprehensive view of issues and concerns shared by many students. The chapter on resource utilization (Chapter 17) looks not only at traditional uses such as fisheries and mariculture, but also at more modern aspects such as the pharmacological use of marine natural products and the application of genetic engineering to mariculture. Chapter 18 discusses human-induced degradation of the marine environment, balanced by an examination of marine conservation and habitat restoration. The book closes with an essay on the interactions between the ocean and the human culture (Chapter 19) that we hope will stimulate students to reflect on the past and future significance of the world ocean to all our lives.

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The following people have reviewed the fifth edition, and have provided useful commentary for preparation of the sixth edition:

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