



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*, eighth edition, was written to reinforce and enhance our readers' enchantment with marine life while providing a rigorous introduction to marine biology as a science.

Marine Biology is used by high school, undergraduate, graduate, and adult-education students, as well as by interested laypersons not enrolled in formal courses. We are gratified that even many professional marine biologists use the book. While keeping this range of users in mind, the text is primarily written 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 marine science career. 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 becomes increasingly relevant with each passing year is the interaction of humans with the marine environment.

Marine Biology, eighth 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 EIGHTH EDITION

Coverage of worldwide declines of fisheries stocks, including three new figures, and the global loss of habitats has been added to *Special Report: Our Changing Planet*, a major new feature on global change introduced in the seventh edition. We have also updated the information on climate change, ocean acidification, the nitrogen cascade, and stratospheric ozone depletion to reflect the torrent of new research on global change. Examples include new findings on the accelerating rate of climate change, loss of Arctic sea ice, and ecological impacts, for example on polar bears. These topics are not new to *Marine Biology*, but we feel that highlighting them in an integrated way emphasizes the many anthropogenic stresses acting in concert on the global ocean. We hope this conveys to students the magnitude, immediacy, and potential impacts on society of human-induced global change. Most of all we hope that in future editions we will be able to highlight more success stories about humanity's progress toward a sustainable existence on our home planet.

In response to positive feedback from instructors and reviewers on our "Eye on Science" boxes—brief vignettes of major research programs or individual research projects—we have added six new ones:

- CSI: Ocean (use of the VENUS sea-floor observatory in forensic research on how bodies decompose in the ocean)
- Microbes and Minerals (the role of chemosynthesis in forming Earth's diverse array of minerals)
- Monitoring of Marine Microbes in the Open Ocean
- Biological Mixing of the Ocean (how organisms may contribute to mixing processes)
- Ecology and Economics
- Exploring the Cayman Trench

The other Eye on Science boxes have been extensively revised and updated to reflect new developments since the seventh edition. "Bearing Sea Ecosystem Studies" for example, has been rewritten

to reflect the commencement of field expeditions that were only in the planning stage in the seventh edition and the harmonization of parallel research programs, as well as the initiation as part of the International Polar Year of PolarTREC, an outreach program that allows school teachers to participate in the research cruises.

We have continued to strengthen the coverage of organismal biology, both in Part 2, which surveys the groups of marine organisms, and also in covering the ecology of different communities in Part 3. Examples of this include expanded coverage of mangroves, kelps, and seagrasses in Chapters 6, 12, and 13, new material on sea turtles, seabirds, seals, and whales in Chapter 9, and a new Figure 8.19 showing the ampullae of Lorenzini.

As in every edition we have made revisions and additions in response to new research findings and suggestions from instructors who have reviewed the book and whose inputs we greatly appreciate. There are too many such changes to list here, but some examples include:

- The discovery of the earliest evidence to date of human consumption of seafood
- The relevance of the geological delineation of the continental shelf to national jurisdictions, including the recent high-profile example of oil and mineral rights in the Arctic Ocean
- Modification of Figures 4.7 and 4.8 to indicate the cytoskeleton
- A new Table 4.3 summarizing and clarifying the distinctions between endotherms, ectotherms, poikilotherms, and homeotherms
- Additional information about marine fungi
- Descriptions of stabilizing and directional selection
- Revision of Figure 10.12 to make the major subdivisions of the marine environment more clear
- Additional material on mangrove forests and salt marsh ecology
- New research about species diversity in *Nautilus*
- New research on the importance of viruses in carbon cycling in deep-sea sediments
- A new Figure 17.11 showing a consumer "ocean friendly" guide to sustainable seafood
- Additional information on tidal power and desalination
- Modification of Fig. 13.4 to make different spatial distributions more clear
- Updated information on the effects of farmed salmon on wild fish populations
- Expanded information on pollution from stormwater runoff, septic-tanks, sewage, dredging and the melting of ice
- Addition of marine protected areas on the foldout map of North America.

- We have also revised the text for readability and clarity, corrected and updated facts and figures, and made adjustments to the balance and organization of material. We have tried to improve the illustrations, photographs, and design to be clearer and more visually inviting.

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 is critical that students understand how and why science works, 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 in 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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