



P R E F A C E

As authors, we are honored to play a key role in the instruction of future generations of zoologists, ecologists, wildlife managers, and other life scientists. We undertook the revision for the seventh edition with this privilege, and the responsibility for content integrity, in mind.

The preparation of the seventh edition of *Zoology* involved careful evaluation of the previous editions and the features that contributed to the understanding of zoology as an exciting and dynamic scientific field. Our goal in preparing the seventh edition of *Zoology*, as in previous editions, was to prepare an introductory general zoology textbook that we believe is manageable in size and adaptable to a variety of course formats. We have retained the friendly, informative writing style that has attracted instructors and students to previous editions.

The shorter format of previous editions was well received by users as being less expensive and easily adapted to a one-semester course format. The seventh edition retains that format. The shorter format does mean that some general biological topics were eliminated from the book. These chapters are, however, still available, along with numerous other resources, in an electronic format on the book website and are free to adopters of the book. (Chapters found online only are indicated in the Table of Contents by an asterisk.)

CONTENT AND ORGANIZATION

We have maintained from the inception of this text that evolutionary and ecological perspectives captivate students and are fundamental to understanding the unifying principles of zoology. These perspectives are incorporated into *Zoology* in a number of ways. For example, animal structure and function are considered in the context of the environment, the animal phyla are described in the context of their roles in ecosystems, and most of the “Wildlife Alerts” that first appeared in the fourth edition, and were expanded in the fifth and sixth editions, have been retained. These boxed readings depict the plight of selected animal species or broader ecosystem issues relating to preserving various animal species.

We believe that the seventh edition of *Zoology* presents evolution as an exciting and dynamic field of study—a field of study that is vital for understanding all of biology. In addition, the continuing and expanding pseudoscientific attacks on biology make it a necessity that evolutionary concepts be presented clearly and convincingly throughout the biology curricula. We have attempted to do just that. Animal survey chapters begin with an “Evolutionary Perspective” and end with “Further Phylogenetic Considerations.” These sections describe evolutionary relationships within each phylum and evolutionary connections to animals of previous and following chapters. Updated cladograms are

used to depict taxonomic relationships. Evolutionary connections and animal adaptations are stressed in the structure and function sections.

To further explain and support evolutionary concepts, a second set of themed boxed readings (in addition to “Wildlife Alerts”) entitled “Evolutionary Insights” was added to the sixth edition and has been expanded in this new edition. These boxes provide detailed examples of principles covered in a chapter and provide insight into how evolutionary biology works. For example, chapter 4 includes a reading on big-cat biogeography that illustrates how a variety of sources of evidence are used to paint a picture of the history of one group of animals. Chapter 5 has a reading on the speciation of Darwin’s finches that illustrates how and why speciation occurs. Other readings describe ideas regarding animal origins, the debates that occur among taxonomists who try to sort out evolutionary relationships within animal groups, and the evolution of animal organ systems.

To help students understand that science is a process, not just a body of facts, a new type of boxed reading has been added to the seventh edition. These “How Do We Know” boxes highlight research results that provide insight into biological processes. For example, chapter 3 has a box entitled “How Do We Know About the Function of Genes—Mutagenesis Screening?” This box discusses how biologists use mutations as a tool for investigating the function of genes. Chapter 14 has a box entitled “How Do We Know about Spider Silk?” This box discusses methods for measuring the tensile strength and elasticity of spider silk and the possible uses of engineered silk. The boxed readings in each chapter are listed following the table of contents.

Zoology is organized into three parts. Part One covers the common life processes, including cell and tissue structure and function, the genetic basis of evolution, and the evolutionary and ecological principles that unify all life.

Part Two is the survey of protists and animals, emphasizing evolutionary and ecological relationships, aspects of animal organization that unite major animal phyla, and animal adaptations. All of the chapters in Part Two have been updated. The presentation of taxonomic principles in chapter 7, and the taxonomic relationships in chapters 8 through 22, have been carefully revised and incorporate some of the flavor of the exciting changes occurring in the field of taxonomy. You will see some of these changes listed under “New to the Seventh Edition.” Cladograms have been updated and, as in previous editions, full-color artwork, photographs, and lists of phylum characteristics are used to highlight each phylum.

Part Three covers animal form and function using a comparative approach. This approach includes descriptions and full-color artwork that depict evolutionary changes in the structure and function of selected organ systems. Part Three includes an appropriate balance between invertebrate and vertebrate descriptions.

NEW TO THE SEVENTH EDITION

Major additions to the seventh edition focus on evolutionary principles and taxonomy. Evolutionary concepts must be presented clearly and convincingly in biology courses. We believe that changes we have made will help instructors to accomplish that goal by providing more evidence of evolution, more examples to illustrate evolutionary principles, and more detail on evolutionary mechanisms. Recent, fast-paced changes in animal taxonomy require constant reevaluation of the presentation of evolutionary relationships between animal taxa. Because the taxonomy of many animal groups is unsettled, we have tried to take a conservative, yet up-to-date, position on taxonomic revisions. The following are major additions to this edition.

- “How Do We Know” boxes appear in most chapters. These boxes provide insight into how biologists have arrived at conclusions regarding a variety of biological processes.
- “Evolutionary Insights” boxes have been expanded into Part Three. These boxes describe ideas regarding the evolution of animal organ systems and processes.
- All chapters have been carefully edited. All chapter revisions include minor to substantial changes in wording, artwork, photographs, and content. The following chapters have substantial changes.
 - Chapter 4 has expanded coverage of molecular biology and phylogeny.
 - Chapter 5 has expanded coverage of the role of mutations in evolutionary change and documentation of sympatric speciation events.
 - Chapter 8 has been completely reorganized by the inclusion of the most recent taxonomic relationships among protists as revealed by molecular studies. A new figure has been developed that shows the tentative phylogeny of the protozoan-like eukaryotes based on 18S rRNA sequence comparisons.
 - Chapter 11 has been revised to reflect the division of the aschelminths into lophotrochozoan and ecdysozoan groupings.
 - Chapter 18 has updated taxonomy and coverage of the evolution of tetrapod limbs, including evidence from both paleontology and Hox studies.
 - Chapter 19 now includes expanded coverage of amphibian skin glands and feeding.
 - Chapter 20 includes updated taxonomy, an expanded discussion of turtle navigation, and new information on endangered turtles.
 - Chapter 21 has been revised to include more information on the evolution of birds and feathered dinosaurs. It also includes the latest information on feather development and evolution. The new title of this chapter, “Birds: Reptiles by Another Name,” reflects the content revisions present in this chapter.
 - Chapter 22 has undergone major revision with the addition of a new section on human evolution. New information on the evolution of mammary glands is also included.
 - Chapter 23 includes new information on the function of vitamin D₃ in the skin, the molecular basis of amoeboid movement, and animal movement.

- Chapter 24 contains new information on the role of graded potentials in the nervous system. The section on the sense of smell has been completely rewritten based on new findings in the physiology of olfaction.
- Chapter 25 has a new section on autocrine and paracrine agents, and newly discovered hormones have been added to the table that describes major mammalian tissues and hormones.
- As with the previous edition, chapters on cell chemistry, energy and enzymes, embryology, and animal behavior—along with numerous boxed readings and pedagogical elements—have been moved to the Online Learning Center. This content-rich website is located at www.mhhe.com/millerharley7e

ACKNOWLEDGMENTS

We wish to thank the reviewers who provided detailed analysis of the text during its development. In the midst of their busy teaching and research schedules, they took time to read our manuscript and offer constructive advice that greatly improved the seventh edition.

REVIEWERS

Steve K. Alexander, *University of Mary Hardin-Baylor*
 Marjorie McCann Collier, *Louisiana State University—Alexandria*
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 Elise Van Ginkel, *Madison Area Technical College*

The publication of a textbook requires the efforts of many people. We are grateful for the work of our colleagues at McGraw-Hill, who have shown extraordinary patience, skill, and commitment to this textbook: Marge Kemp, our Publisher, has helped shaped

Zoology from its earliest planning stages. Her wisdom and skill are evident in the seventh edition. Debra Henricks, Developmental Editor, worked with this textbook on the latest revision. We are grateful for her skill in coordinating many of the tasks involved with publishing this edition of *Zoology*. Debra kept us on schedule and kept the production moving in the plethora of directions that are nearly unimaginable to us. April Southwood served as Project Manager for this edition. We appreciate her efficiency and organization. We also thank Carrie Barker for proofreading the entire textbook.

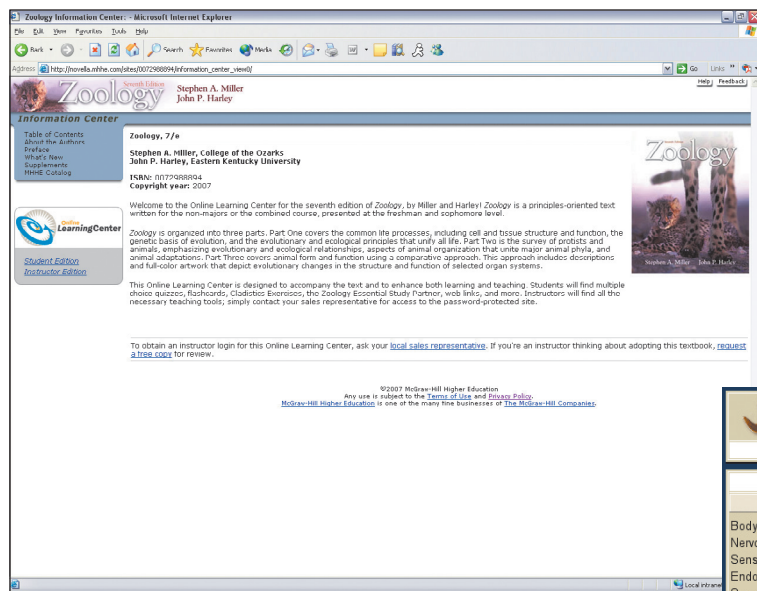
Finally, but most importantly, we wish to extend appreciation to our families for their patience and encouragement. Janice

A. Miller lived with this text through many months of planning and writing. She died suddenly two months before the first edition was released. Our wives, Carol A. Miller and Donna L. Harley, have been supportive throughout the revision process. We appreciate the sacrifices that our families have made during the writing and revision of this text. We dedicate this book to the memory of Jan and to our families.

STEPHEN A. MILLER
JOHN P. HARLEY

SUPPLEMENTARY MATERIALS

Zoology Online Learning Center www.mhhe.com/millerharley7e



The *Zoology* Online Learning Center is also home to the **Essential Study Partner**. This unique learning tool allows students to test their understanding of important zoology concepts through the use of animations, learning activities, quizzing, and interactive diagrams.

chapter 31

ENERGY AND ENZYMES: LIFE'S DRIVING AND CONTROLLING FORCES

Outline	Concepts
What Is Energy? The Laws of Energy Transformations Activation Energy Enzymes: Biological Catalysts Enzyme Structure Enzyme Function Factors Affecting Enzyme Activity Cofactors and Coenzymes ATP: The Cell's Energy Currency How Cells Convert Energy: An Overview	<ol style="list-style-type: none"> Energy drives all life processes in a cell. Energy is the capacity to do work. It can exist in two forms: Kinetic energy is actively involved in doing work, and potential energy is stored for future use. The cell obtains energy by utilizing chemical fuel and by obeying the first and second laws of thermodynamics. The speed of a chemical reaction depends on the activation energy necessary to initiate it. Catalysts reduce the amount of activation energy necessary to initiate a chemical reaction and, therefore, speed up the reaction. Cells use specialized proteins and nucleic acids (RNA) called enzymes as biological catalysts. Any factor (e.g., temperature, pH, and other chemicals) that alters an enzyme's shape affects the enzyme's activity. Cofactors are metal ions or organic molecules that facilitate enzyme activity. Specific cofactors that are nonprotein organic molecules are called coenzymes.

This convenient website takes studying to a whole new level. **Students** will find multiple choice quizzing, key term flashcards, web links, interactive cladistics exercises, boxed readings, and more!

Instructors will appreciate a password-protected **Instructor's Manual, Laboratory Resource Guide**, and access to all of the **illustrations, photographs, and tables** from the text organized by chapter in convenient PowerPoint files.

Animals

Topics

- Body Organization
- Nervous System
- Sense Organs
- Endocrine System
- Support & Locomotion
- Transport
- Respiration
- Digestion
- Osmoregulation
- Lymph and Immunity
- Reproduction
- Development
- Behavior
- Introduction
- Nature/Nurture
- Innate Behavior
- Learning
- Adaptive Value**
- Navigation

Program Tools

Adaptive Value

cross section of funnel cage

The underlying assumption in studies of animal behavior is that behaviors have **adaptive value**. Because **genes** influence behavior, behaviors can be shaped by **natural selection**.

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Additional Chapters

The following chapters (not printed in the text) are available in PDF format:

- Chapter 30: The Chemical Basis of Animal Life
- Chapter 31: Energy and Enzymes: Life's Driving and Controlling Forces
- Chapter 32: How Animals Harvest Energy Stored in Nutrients
- Chapter 33: Embryology
- Chapter 34: Animal Behavior