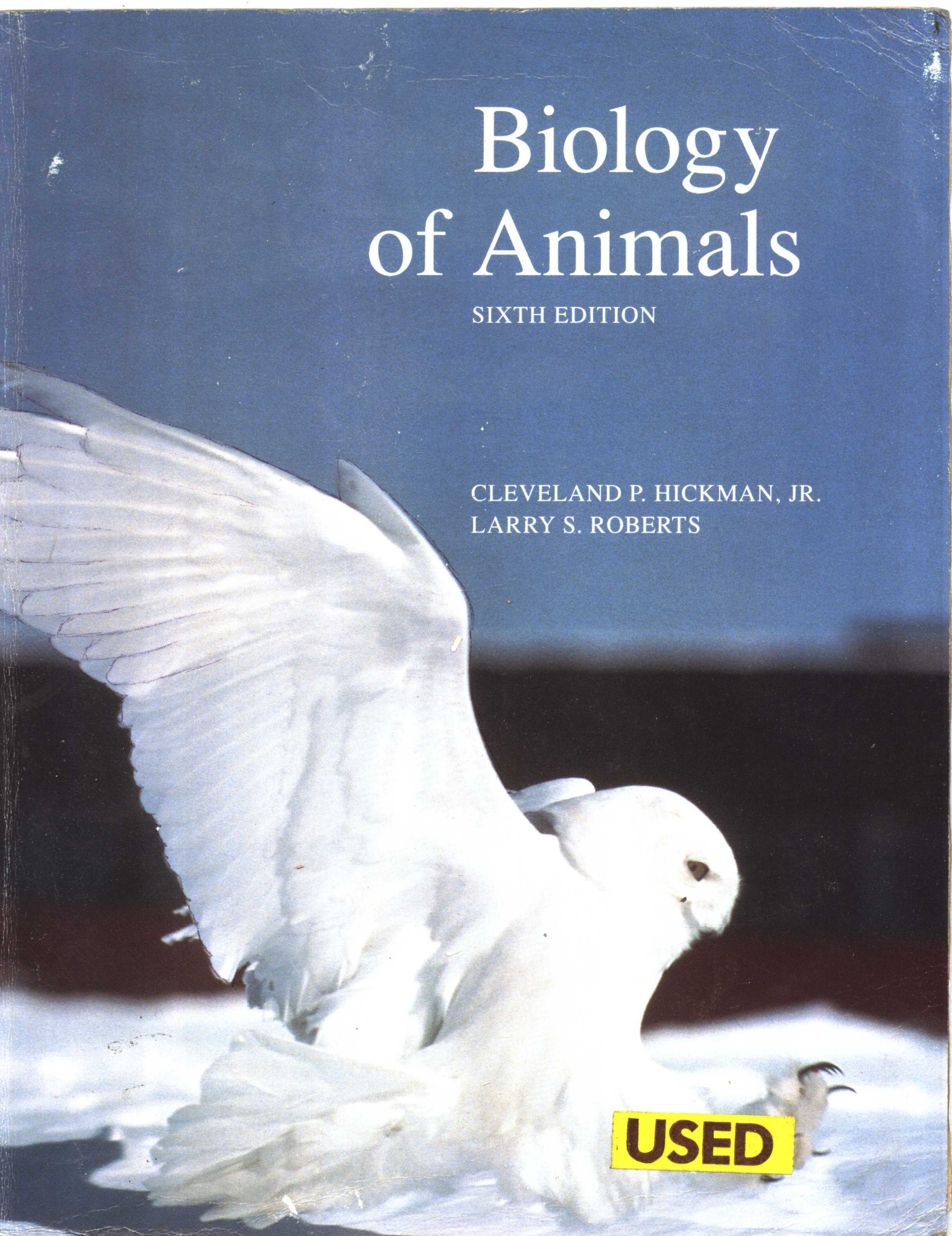
Biology of Animals

SIXTH EDITION

CLEVELAND P. HICKMAN, JR.
LARRY S. ROBERTS



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Preface

Biology of Animals is an introductory college text designed for a one semester course in general zoology. This sixth edition of *Biology of Animals* retains the overall organization and distinctive features of the fifth edition, which include emphasis on evolution, animal diversity and adaptations, and principles of zoological science. Also retained are several pedagogical features that have made previous editions easily accessible to students: opening prologues for each chapter that relate a theme or topic drawn from the chapter to engage student interest; chapter summaries and review questions to aid student comprehension and study; an accurate and visually appealing illustration program; in-text derivations of animal generic names; marginal notes that enhance and enlarge on text material; and an extensive glossary providing pronunciation, derivation, and definition of zoological terms.

New to This Edition

This sixth edition contains several important changes and improvements:

1. The section on the fast-moving field of molecular genetics in Chapter 3 has been revised extensively, including coverage of genetic engineering and genetics of cancer. We have added an explanation of the polymerase chain reaction (PCR). In the last few years the PCR has virtually exploded on the scene of molecular genetics and become one of its most widely used and powerful techniques.
2. The treatment of evolution (Chapter 4) has been revised to present Darwinism as five component theories of perpetual change, common descent, multiplication of species, gradualism, and natural selection. This restructured presentation, which reflects the current understanding that Darwinism is not a single, simple statement that is easily confirmed or refuted, prepares the student to dismiss the arguments of creationists who misconstrue scientific challenges to Darwinism as contradictions to the validity of organic evolution.
3. The chapter on reproduction and development was significantly reworked to include expanded explanations of parthenogenesis and hermaphroditism, genetic control of development, and the role of homeotic genes.
4. Coverage of the animal phyla was thoroughly revised to emphasize the unifying architectural and functional theme of each group. The discussions of phylogenetic relationships were rewritten from a cladistic perspective, and cladograms are included to show the postulated relationships of different animal lineages as monophyletic groupings. Because cladistics is still not embraced by all teachers, we have presented cladograms as supplemental to the conventional Linnaean classification, which has been retained for each survey chapter.
5. The coverage of systematics (Chapter 14) has been rewritten and expanded to include a thorough explanation of cladistics, now widely used to deter-

mine the pattern of phylogenetic descent. This chapter and Chapter 4 were revised by Allan Larson of Washington University, who brings to this edition his comprehensive knowledge of evolutionary and systematic biology.
6. The art program has been extensively revised and broadened with many new color paintings by William C. Ober and Claire W. Garrison to exemplify concepts with greater accuracy and clarity.
7. Careful editing of all chapters has eliminated excessive detail while placing greater emphasis on basic concepts and on the role of experimentation in biology. Some of the numerous changes and updatings made throughout are cited below.

Organization and Coverage

The first five chapters (Part One) introduce the evolution of animal life. In Chapter 1 we explain the principles of science, provide a brief review of the chemistry of life (condensed for this edition by moving sections on basic chemistry to an appendix, leaving it available for review by those unfamiliar with these concepts), and trace the early evolution of life on earth from its primitive beginning some 3 billion years ago to the appearance of eukaryotes toward the end of the Precambrian. In Chapter 2, which moves to the organization of the eukaryotic cell, the discussions of mitosis and control of cell division have been updated. Chapter 3 focuses on the basic principles of heredity and molecular genetics. Chapter 4 (Organic Evolution) begins with an historical account of Charles Darwin's life and discoveries. The five components of Darwin's evolutionary theory are presented, together with important challenges and revisions to his theory and an assessment of its current scientific status. Explanations of microevolution and macroevolution follow, and the chapter ends with an illustrated essay on human evolution. The animal environment and the principles of ecology are the themes of the fifth chapter.

The eight chapters of Part Two deal with animal form and function, animal behavior, and reproduction and development. We begin with the basic uniformity of organization of the animal body in Chapter 6 (including a new pictorial essay of tissue types) and follow with updated discussions of the integumentary, skeletal, and muscular systems. We have expanded the latter to include explanations of the distinction between fast and slow fibers and of the importance of tendons in energy storage. In Chapter 7 we emphasize the importance of homeostasis, which permeates all physiological thinking. This chapter includes discussions of some of the most accessible examples of homeostasis: osmotic regulation among animals in different habitats, the prominent role of the kidney in body fluid regulation, and temperature regulation. The explanation of kidney function was updated and somewhat condensed. In Chapter 8, dealing with the internal fluids, the discussions of immunity and circulation were almost completely rewritten and reillustrated for this edition. Chapter 9 is a comparative treatment of feeding mechanisms, digestion and the organization of the alimentary canal, and the nutritional requirements of animals. Chapters 10 and 11 cover nervous and endocrine coordination in detail. Topics that received comprehensive revisions for this edition were the autonomic nervous system and the mechanisms of hormone action. Chapter 11 now closes with a unified treatment of the reproductive hormones and the hormonal changes preceding birth.

We revised the opening section on animal behavior in Chapter 12 to distinguish between proximate and ultimate causation and to explain the different experimental approaches to animal behavior. The treatment of principles of classical ethology was condensed. In a new section entitled "The Control of Behavior" we explain why "instinct theory" has fallen out of fashion, and provide two clear examples of genetic transmission of specific innate behav-

iors: inheritance of hygienic behavior in honeybees, which shows simple Mendelian inheritance, and confused nesting behavior of hybrid lovebirds, an example of a more complex inheritance of intermediate behavior.

The 17 chapters of Parts Three and Four are a comprehensive, modern, and thoroughly researched coverage of the animal phyla. We emphasize the unifying architectural and functional theme of each group. The structure and function of representative forms are described, together with their ecological, behavioral, and evolutionary relationships. The drawing out of underlying themes and distinctive features of each group assists the student's approach to each chapter.

We begin the survey of the animal kingdom with an important chapter on the classification and phylogeny of animals (Chapter 12). We present a brief history of how animal diversity has been organized for systematic study, emphasizing the current use of Darwin's theory of common descent as the major principle underlying animal taxonomy. Continuing controversies between the schools of evolutionary taxonomy and phylogenetic systematics (cladistics) are presented, including a discussion of how these alternative taxonomic philosophies affect our study of evolution. Chapter 12 is an important preface to the organizational structure of the remainder of the book. It also emphasizes to the student that current issues in ecology, evolution, and conservation biology all depend upon our taxonomic system. The invertebrate chapters (Chapters 15 through 24) were thoroughly updated, and many new illustrations have been added, both artwork and photographs. The classifications in each chapter were positioned following other coverage of the particular group, in most cases immediately preceding the summary at the end of the chapter. The discussions of phylogenetic relationships were rewritten from a cladistic viewpoint, and cladograms have been presented where possible.

Other revisions of these chapters include the following: in Chapter 15, to make the concept of protozoa as Protista consistent; in Chapter 19, transferring the Priapulida to the pseudocoelomate grouping and incorporating the notion of nurse cells rather than cysts in the discussion of *Trichinella;* in Chapter 20, strengthening the concepts of head-foot and visceral mass in molluscs and the description of torsion, bivalve physiology, and adaptations for an active life in cephalopods; in Chapter 22, accepting the crustacean class Maxillopoda (containing the subclasses Ostracoda, Mystacocarida, Copepoda, Tantulocarida, Branchiura, and Cirripedia); in Chapter 23, describing the presence of the protocoel, mesocoel, and metacoel in the lophophorate phyla, and accepting the lophophorates as deuterostomes; and in Chapter 24, including the class Concentricycloidea in the phylum Echinodermata, and returning to the concept of subphyla Pelmatozoa and Eleutherozoa in the Echinodermata, in accordance with recent cladistic opinion.

As with the invertebrate chapters, cladograms have been added to the six chordate chapters (Chapters 25 through 30) to show the inferred branching events in each group's history and the origin of some of the principal shared derived characters. The traditional phylogenetic trees have been retained but redrawn to agree with cladistic analysis as closely as possible. Much of the text on ancestry and relationships has been rewritten. Some of the more significant text revisions in these chapters were protochordate biology (Chapter 25); evolution and classification of bony fishes (Chapter 26); tetrapod origin and evolution and paedomorphosis in salamanders (Chapter 27); origin, adaptive radiation, and classification of amniotes (Chapter 28); *Archaeopteryx* and origin of modern birds (Chapter 29); and mammalian evolution, feeding specializations in mammals, and reproductive cycles in mammals (Chapter 30). The chordate, fish, and amphibian chapters especially benefited from new artwork prepared by artists Bill Ober and Claire Garrison.

Teaching and Learning Aids

Vocabulary Development

Key words are boldfaced, and the derivations of generic names of animals are given where they first appear in the text. In addition, the derivations of many technical and zoological terms are provided in the text; in this way students gradually become familiarized with the more common roots that recur in many technical terms. An extensive glossary of more than 1000 terms provides pronunciation, derivation, and definition of each term. More than ninety new terms were added to the glossary for this edition.

Chapter Prologues

A distinctive feature of this text is an opening essay set off in a panel at the beginning of each chapter. Each essay draws out some theme or topic relating to the subject of the chapter. Some present biological, particularly evolutionary, principles; others (especially those in the survey sections) illuminate distinguishing characteristics of the group treated in the chapter. Each is intended to present an important concept drawn from the chapter in an interesting manner that will facilitate learning by students, as well as engage their interest and pique their curiosity.

Marginal Notes

Marginal notes, which appear throughout the book, augment the text material and offer interesting sidelights without interrupting the narrative. We prepared several new marginal notes for this edition and revised many of the existing notes.

For Review

Each chapter ends with a concise summary, a list of review questions, and annotated selected references. The review questions enable the student to self-test retention and understanding of the more important chapter material.

Art Program

The appearance and usefulness of this edition have been further enhanced with many new full color paintings by William C. Ober and Claire W. Garrison. Bill's artistic skills, knowledge of biology, and experience gained from an earlier career as a practicing physician have enriched this text through five of its editions. Claire practiced pediatric and obstetric nursing before turning to scientific illustration as a full-time career. Texts illustrated by Bill and Claire have received national recognition and have won awards from the Association of Medical Illustrators, American Institute of Graphic Arts, Chicago Book Clinic, Printing Industries of America, and Bookbuilders West. They are also recipients of the Art Directors Award.

Supplements

Instructor's Resource Guide and Test Bank

The Resource Guide has been broadly revised and expanded for this edition. The guide provides a chapter outline, test bank, commentary and lesson plan, resource references listing, and a listing of films and videotapes for each chapter. We trust this will be of particular value to first-time users of the text, although experienced teachers may also find much of value.

Laboratory Manual

The laboratory manual by Cleveland P. Hickman, Jr., and Frances M. Hickman, *Laboratory Studies in Integrated Zoology,* now in its eighth edition, has been extensively rewritten and reillustrated. It was designed to accompany a year-long course in zoology but can be adapted conveniently for semester or term courses by judicious selection of exercises. The popular wall chart, "Chief Taxonomic Subdivisions and Organ Systems of Animals," has been redesigned for this edition.

Computerized Test Bank

For the first time ever with this edition, the test questions contained in the *Instructor's Resource Guide* are available as a computerized test generation system for IBM and Macintosh computers. Using this system, instructors can create tests and quizzes quickly and easily. Instructors can sort questions by type or level of difficulty, and can also add their own questions to the bank of questions provided.

Transparency Acetates

A set of full color transparency acetates of important textual illustrations is available with this edition of *Biology of Animals.* Labeling is clear, dark, and bold for easy reading.

Animal Diversity Slides

A set of animal diversity slides, photographed by the authors and Bill Ober on their various excursions, are offered in this unique textbook supplement. Both invertebrates and vertebrates are represented. Descriptions, including specific names of each animal and a brief overview of the animal's ecology and/or behavior, accompany the slides.

Acknowledgments

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Cleveland P. Hickman, Jr.
Larry S. Roberts

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