

Integrated Principles of Zoology is a college text designed for an introductory course in zoology. This fourteenth edition, as with previous editions, describes the diversity of animal life and the fascinating adaptations that enable animals to inhabit so many ecological niches.

We retain in this revision the basic organization of the thirteenth edition and its distinctive features, especially emphasis on the principles of evolution and zoological science. Also retained are several pedagogical features that have made previous editions easily accessible to students: opening chapter dialogues drawn from the chapter's theme; chapter summaries and review questions to aid student comprehension and study; concise and visually appealing illustrations; in-text derivations of generic names; chapter notes and essays that enhance the text by offering interesting sidelights to the narrative; literature citations; and an extensive glossary providing pronunciation, derivation, and definition of terms used in the text.

NEW TO THE FOURTEENTH EDITION

The authors welcome to the fourteenth edition Susan Keen, who supervised this revision. Many improvements are the direct result of Susan's new perspectives and those of many zoology instructors who submitted reviews of the thirteenth edition. We revised all chapters to streamline the writing and to incorporate new discoveries and literature citations. Our largest formal revision is to include a cladogram of animal phyla on the inside front cover of the book, and to reorder chapter contents in Part Three (Diversity of Animal Life) to match the arrangement of phyla on the cladogram. Each chapter in Part Three begins with a small image of the zoological cladogram highlighting the phylum or phyla covered in the chapter, followed by an expanded cladogram of the contents of each major phylum. We place stronger emphasis on phylogenetic perspectives throughout the book. Material formerly presented separately as "biological contributions" and "characteristics" of phyla is consolidated in a boxed list of phylum "characteristics" for each chapter in Part Three. New photographs are added to illustrate animal diversity in many phyla.

Material new to the fourteenth edition expands and updates our coverage of eight major principles: (1) scientific process and the role of theory, (2) cellular systems and metabolism, (3) endosymbiotic theory of eukaryotic origins, (4) physiological and ecological systems, (5) populational processes and conservation, (6) evolutionary developmental biology, (7) phylogenetic tests of morphological homologies, and (8) taxonomy. Exciting new fossil discoveries and molecular phylogenies contribute important changes to the last three principles. The primary changes to each major principle are summarized here with references to the relevant chapters.

Scientific Process and the Role of Theory

Many changes throughout the book increase the integration of hypothetico-deductive methodology in discussing new discoveries and controversies. We begin in Chapter 1 with a more detailed explanation of the hypothetico-deductive method of science and the important contrast between the comparative method versus experimental biology as complementary means of testing hypotheses. The role of theory in science is illustrated explicitly using Darwin's theory of common descent in Chapter 6. Uses of Darwin's theory of common descent to test evolutionary hypotheses and to construct taxonomies get expanded treatment in Chapter 10, including a new conceptual distinction between classification and systematization and coverage of DNA barcoding in species identification.

Cellular Systems and Metabolism

We expand in Chapter 3 our coverage of the components of eukaryotic cells, the biological roles of subcellular structures, and specializations of cellular surfaces. Expanded molecular topics include pH (Chapter 2), prions as diseases of protein conformation (Chapter 2), lipid metabolism (Chapter 4), and accumulation of "junk" or "parasitic" DNA in animal genomes (Chapter 5). In Chapter 7, a new boxed essay reports the discovery of actively dividing germ cells in adult female mammals, and a revised boxed essay updates applications of cell biology to contraceptive medicine.

Endosymbiotic Theory of Eukaryotic Origins

The history of the endosymbiotic theory is presented in more detail, including the empirical testing of its original claims and its more recent expansion to cover a broader evolutionary domain (Chapter 2). Important molecular phylogenetic evidence for separate evolutionary origins of nuclear, mitochondrial, and chloroplast genomes is presented in the form of a new global "tree of life" relating prokaryotic and eukaryotic genomes (Chapter 10). The role of endosymbiosis in diversification of unicellular eukaryotes gets new coverage in Chapter 11, and evolutionary loss of mitochondria from some infectious unicellular eukaryotes is added to Chapter 2.

Physiological and Ecological Systems

Numerous revisions address organismal physiology and its ecological consequences, beginning with the addition of "movement" as a general characteristic of life in Chapter 1. We add

new results on tracheal respiration in insects (Chapter 21), respiratory gas transport in terrestrial arthropods and in vertebrates (Chapter 31), and lung ventilation in vertebrates (Chapter 31). Also revised are the plans of vertebrate circulatory systems, coronary circulation, and excitation and control of the heart (Chapter 31). New material appears on regulation of food intake and of digestion (Chapter 32), digestive processes in the vertebrate small intestine (Chapter 32), and foregut fermentation in ruminant mammals (Chapter 28). Evolution of centralized nervous systems, chemoreception, mechanoreception and photoreception in invertebrates gets new coverage in Chapter 33, with expanded explanation of synapses and conduction of action potentials. Endocrinology of invertebrates is expanded, and vertebrate endocrinology is updated to include discussion of white adipose tissue as an endocrine organ, the pancreatic polypeptide (PP) hormone, and controversies regarding medicinal uses of anabolic steroids (Chapter 34). Invertebrate excretory systems, especially arthropod kidneys, get expanded coverage in Chapter 30. We cover regional endothermy in fishes (Chapter 24), and add new explanatory material on the importance of water and osmotic regulation, especially in marine fishes (Chapter 30). Revision of Chapter 35 updates our knowledge of susceptibility and resistance to disease, including acquired immune deficiency. We add a new section on cetacean echolocation (Chapter 28), greater explanation of frog mating systems (Chapter 25), and avian reproductive strategies, including extra-pair copulations (Chapter 27). We provide greater coverage of scientific controversies regarding bee communication, eusociality, and genetics of animal behavior (Chapter 36). Concepts of food chains and food webs are now distinguished, and quantitative data are added to illustrate them using ecological pyramids (Chapter 38).

Populational Processes and Conservation

Modes of speciation receive expanded coverage and explanation (Chapter 6), as do concepts of fitness and inclusive fitness (Chapter 6), and costs and benefits of sexual versus asexual reproduction (Chapter 7). Conservation of natural populations is updated, especially in fishes (Chapter 24), mammals (Chapter 36), and tuataras (Chapter 26). Historical biogeographic processes are illustrated with expanded coverage of explanations for Wallace's Line, the geographic contact between evolutionarily disparate faunas (Chapter 37).

Evolutionary Developmental Biology

This rapidly growing discipline gets updated coverage both in concept and application. New concepts of developmental modularity and evolvability join our general coverage of evolutionary biology in Chapter 6. We discuss in Chapter 8 new evidence that some sponges have two germ layers. Cnidarian development and life cycles get expanded coverage, and the diploblastic status of cnidarians and ctenophores is reconsidered in light of new phylogenetic results (Chapter 13). We provide

molecular-genetic interpretations of the diploblast-triploblast distinction (Chapter 13) and updated details of triploblastic development (Chapter 14). Insights from genomic and developmental studies offer new interpretations of metazoan origins (Chapter 12) and suggest that changes in the expression of a single gene underlie alternative developmental pathways of arthropod limbs (uniramous versus biramous; Chapter 19). Developmental differences among chaetognaths, protostomes, and deuterostomes are reevaluated in light of new phylogenetic evidence (Chapter 22). We restructure our general coverage of body plans (Chapter 9) and provide greater explanation of the complex development of gastropod torsion (Chapter 16).

Phylogenetic Tests of Morphological Homologies

New molecular phylogenies and fossil discoveries revise our interpretations of many homologies and reveal independent evolution of similar characters in different groups. In light of these issues, we expand our coverage of the concept of homoplasy in Chapter 10. Chapter 16 incorporates new evidence challenging homology of metamerism in annelids and molluscs and illustrating the scientific process in action. Evidence from *Hox* gene expression is used in Chapter 19 to homologize the cephalothorax of spiders with heads of other arthropods and to support phylogenetic evidence for multiple origins of uniramous limbs from biramous ones in phylum Arthropoda. Homology of diffuse epidermal nervous systems and tripartite coeloms of echinoderms and hemichordates and nonhomology of dorsal hollow nerve chords of hemichordates and chordates change our favored hypotheses for relationships among these groups (Chapter 22). Developmental comparisons demonstrate nonhomology of coelomic compartmentalization of lophophorates with that of echinoderms and hemichordates (Chapter 22). New data and interpretations revise inferred characteristics of the most recent chordate ancestor (Chapter 23), origin and diversification of amniotes and their adaptations for terrestrial life (Chapter 26), evolution of the mammalian middle ear (Chapter 28), and details of hominid morphological evolution (Chapter 28).

Taxonomy

New molecular-phylogenetic and fossil data reject some familiar taxa and suggest new ones. We discuss evidence for a sister-group relationship of choanoflagellates and metazoans in Chapter 12. Chapter 14 discusses new phylogenetic results that underlie recognition of phylum Acoelomorpha and a revised phylogenetic hypothesis for nemertine worms. Acanthocephalans now appear to descend from a rotiferan ancestor (Chapter 15). Clade Clitellata (oligochaetes and leeches), pogonophorans, and vestimentiferans descend from polychaete annelids according to new phylogenetic data, making polychaetes paraphyletic (Chapter 17). Chapter 18 presents new evidence for clade Panarthropoda (Onychophora, Tardigrada, and Arthropoda). Chapters 19 and 21 present evidence supporting

recognition of clade Pancrustacea (crustaceans and hexapods) and rejection of arthropod subphylum Uniramia. Chapter 20 includes new evidence that hexapods derive from a crustacean ancestor, and Pentastomida is subsumed in Crustacea. Entognatha and Insecta form separate clades within subphylum Hexapoda (Chapter 21). We update recognition of insect orders in Chapter 21. We introduce in Chapter 22 clade Ambulacraria (Echinodermata and Hemichordata), which is likely the sister group of chordates (Chapter 23). The fossil genus *Haikouella* gets increased coverage and illustration as the likely sister taxon to craniates (Chapter 23). Changes to fish taxonomy include using the clade name Petromyzontida for lampreys and removing bichirs from chondrosteans (Chapter 24). Early tetrapod evolution is extensively revised with reference to new fossil discoveries, including the genus *Tiktaalik* (Chapter 25). We replace the traditional use of "Reptilia" with one including the traditional reptiles, birds, and all descendants of their most recent common ancestor (Chapter 26). Phylogenetic results place turtles in the clade Diapsida (Chapter 26), contrary to earlier hypotheses. Amphisbaenians are now included within lizards according to their phylogenetic position, and the section on relationships of snakes to lizards is expanded (Chapter 26). Chapter 27 includes fairly extensive revisions of avian taxonomy based upon phylogenetic results from DNA sequence data.

TEACHING AND LEARNING AIDS

To help students in **vocabulary development**, key words are boldfaced and derivations of technical and zoological terms are provided, along with generic names of animals where they first appear in the text. In this way students gradually become familiar with the more common roots that form many technical terms. An extensive **glossary** provides pronunciation, derivation, and definition of each term. Many new terms were added to the glossary or rewritten for this edition.

A distinctive feature of this text is a **prologue** for each chapter that highlights a theme or fact relating to the chapter. Some prologues present biological, particularly evolutionary, principles; those in Part Three on animal diversity illuminate distinguishing characteristics of the group presented in the chapter.

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

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

Again, William C. Ober and Claire W. Garrison have strengthened the art program for this text with many new full-color paintings that replace older art, or that illustrate new material. Bill's artistic skills, knowledge of biology, and experience gained from an earlier career as a practicing physician have enriched this text through ten 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 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

For Students

Online Learning Center

The **Online Learning Center** for *Integrated Principles of Zoology* is a great place to review chapter material and to enhance your study routine. Visit www.mhhe.com/hickmanipz14e for access to the following online study tools:

- Chapter quizzing
- Key term flash cards
- Web links
- And more!

For Instructors

Online Learning Center

The *Integrated Principles of Zoology* **Online Learning Center** (www.mhhe.com/hickmanipz14e) offers a wealth of teaching and learning aids for instructors and students. Instructors will appreciate:

- A password-protected Instructor's Manual
- Access to the new online **Presentation Center** including illustrations, photographs, and tables from the text
- PowerPoint lecture outlines
- Links to professional resources
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Instructor's Manual

This helpful ancillary provides chapter outlines, lecture enrichment suggestions, lesson plans, a list of changes from the previous edition, and source materials.

Test Bank

A computerized test bank utilizing testing software to create customized exams is available with this text. The user-friendly software allows instructors to search for questions by topic or format, edit existing questions or add new ones, and scramble questions to create multiple versions of the same test. Word files of the test bank questions are provided for those instructors who prefer to work outside the test-generator software.

Course Management Systems

Online content is available for a variety of course management systems including BlackBoard and WebCT.

Laboratory Studies in Integrated Principles of Zoology by Cleveland Hickman, Jr., and Lee B. Kats

Now in its fourteenth edition, this lab manual was written to accompany *Integrated Principles of Zoology*, and can be easily adapted to fit a variety of course plans.

Biology Digitized Video Clips

McGraw-Hill is pleased to offer digitized biology video clips on DVD! Licensed from some of the highest-quality science video producers in the world, these brief segments range from about five seconds to just under three minutes in length and cover all areas of general biology from cells to ecosystems. Engaging and informative, McGraw-Hill's digitized biology videos will help capture students' interest while illustrating key biological concepts and processes. Includes video clips on mitosis, Darwin's finches, cichlid mouth brooding, sponge reproduction, and much more!

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Although we make every effort to bring to you an error-free text, errors of many kinds inevitably find their way into a textbook of this scope and complexity. We will be grateful to readers who have comments or suggestions concerning content to send their remarks to Debra Henricks, Developmental Editor at debra_henricks@mcgraw-hill.com.

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