

Laboratory Studies in *Integrated Principles of Zoology* offers students hands-on experience in learning about the diversity of life. It provides students the opportunity to become acquainted with the principal groups of animals and to recognize the unique anatomical features that characterize each group as well as the patterns that link animal groups to each other. Although this manual was written to accompany *Integrated Principles of Zoology*, it can easily be adapted for use with any other introductory zoology text and with a variety of course plans. Every effort has been made to provide clear instructions and enough background material to create interest and an understanding of the subject matter. Many illustrations complement the written word.

Distinctive Features in this Edition

Experimenting in Zoology. Project exercises accompany certain chapters, within sections entitled "Experimenting in Zoology." Two project exercises use molecular techniques to explore questions important to our understanding of zoology and evolution. Some of these exercises can be completed within a single laboratory period; others are followed for a longer period. In all project exercises the student follows experimental procedures, records and analyzes quantitative data, and draws conclusions from the results. Many instructors will want their students to gain additional experience by writing a laboratory report in which the student states the objectives, methods followed, results obtained, and conclusions that can be drawn from the results. The "Experimenting in Zoology" exercises are Effect of Temperature on the Locomotor Activity of *Stentor* (Exercise 7); Genetic Polymorphism in *Tetrahymena* (Exercise 7); Predator Functional Response: Feeding Rate in *Hydra* (Exercise 9); *Planaria* Regeneration Experiment (Exercise 10); Behavior of Medicinal Leeches, *Hirudo medicinalis* (Exercise 13); The Phototactic Behavior of *Daphnia* (Exercise 15); Agonistic Behavior in Paradise Fish, *Macropodus opercularis* (Exercise 19); Analysis of the Multiple Hemoglobin System in *Carassius auratus*, Common Goldfish (Exercise 19).

Exercises have been made more interactive, with questions placed throughout the text and with fill-in blanks provided for students to write down their responses and observations. This "active learning" approach involves students in the exercise and encourages them to think about the information as they read. Some questions may require students to consult their textbook for the answers. In some exercises, we have placed

questions within the figure legends, to be answered in the blanks provided when the student consults the figure.

To help students summarize, compare, and contrast organisms within and among phyla, a table has been provided (see Chief Characteristics of Animal Phyla, pp. xii-xiii). After each of the Exercises 8 to 23 has been completed, students should record developmental and morphological features of each group in the table. Instructors may ask students to draw comparisons among phyla for each feature in the table, or to consider the features of each phylum in relation to habitat or lifestyle.

An interactive exercise on how to make a cladogram forms the core study in Exercise 6, Introduction to Animal Classification. The exercise explains how to map characters onto trees and how to choose between different possible evolutionary pathways using the principle of parsimony. An additional interactive exercise on cladistics called "Taxonomic Classification and Phylogenetic Trees" is found in the Online Learning Center for *Integrated Principles of Zoology*. This exercise can also be used as a supplement to Exercise 6.

Up-to-Date Coverage. We have made several taxonomic updates that parallel the accompanying textbook, *Integrated Principles of Zoology*. Birds are now recognized as a clade within the class Reptilia. Birds and reptiles share several derived characters, including distinct skull and ankle characteristics and the presence of beta-keratin in the skin. This unites birds and non-avian reptiles as a monophyletic group. However, to apply Linnaean ranking for birds and reptiles we retain the traditional classification of class Aves and class Reptilia. All modern nonavian reptiles are now placed in the diapsid group. Turtles, formerly considered anapsids, are treated (controversially) as derived diapsids. Another change is inclusion of homopteran insects in the order Hemiptera; the order Homoptera is now obsolete.

Terminology. As with the previous edition, we have included the derivation of specialized biological terms and genera where first introduced. This will help students become familiar with the Latin and Greek roots from which technical terms are built. We repeatedly emphasize that the species is a binomial by spelling the complete species binomial in the classification breakdown for each representative species in the exercises.

Helpful Tools for the Student. There are many aids for the student in this laboratory manual. Throughout the exercises, working instructions are clearly set off from the descriptive material. Classifications, where appropriate, follow the text at the end of exercises. A revised cladogram showing the position of the group in the Eucarya and a "pie" diagram

showing the relative sizes of the classes in a phylum introduce each diversity exercise. Function is explained along with anatomy. Topic headings help the student mentally organize the material. Metric tables and definitions are placed on the inside front and back covers for convenient use. Much of the artwork was designed to assist the student with difficult dissections.

Directions for preparing the exercises in this manual are found in Appendix A. For each exercise we have listed the materials required, directions for preparing solutions, suggestions for maintaining and working with living materials, suggestions for demonstrations, and a listing of appropriate references, most of which are annotated. This information is convenient to the instructor as well as to students who may later wish to consult or implement an exercise.

New to this Edition

General

- Exercises are divided into "Core Study" and "Further Study" sections are divided to make them more manageable for students and instructors having labs of varying lengths. The "Core Study" makes the critical concepts of each topic accessible to students in short lab periods or when only a single lab is provided for each topic. The "Further Study" section of each exercise permits in-depth exploration of materials when time permits.
- In many exercises, labels for illustrations have been expanded to provide functional information for the identified structure. Where appropriate, transfer of text explanation to an illustration allows more effective understanding of structural and functional relationships.
- Introductory cladograms all revised for this edition, include shared derived characters and are presented in tree format.
- The classification of the protozoan groups was extensively revised for the 15th edition following new molecular phylogenies of some taxa, in particular the amebas. Phyla Foraminifera and Radiolaria are still in use, although some group members have been moved to other phyla. New phyla described here are Cercozoa, Centrohelida, and Amoebozoa, but readers familiar with protozoans will recognize many genera within these phyla. Common protozoans described in previous editions remain in the manual, albeit within new phylogenetic groups. Motile green algae, previously in phylum Chlorophyta, are now within Viridiplantae. The new name reflects the shared ancestry of green algae and land plants.

Exercise 2

A new introductory paragraph discusses the importance of understanding the cell cycle and related processes. New interactive questions were added to the exercise.

Exercise 3

A new introductory paragraph emphasizes the importance of understanding gametogenesis and embryology.

Exercise 4

A new photograph of horseshoe crab blood was added together with a brief explanation of its importance to human medicine.

Exercise 5

This exercise on the ecological relationships of animals, formerly the final exercise in the manual, is now the opening exercise to Part Two on the Diversity of Animal Life. Exercise 5A introduces the scientific method with a study of population growth in cultures of flour beetles. This is a term-long project exercise for students working in groups of four. Exercise 5B is a fieldwork exercise on the ecology of a freshwater habitat. Animals collected from a suitable pond or stream habitat are returned to the laboratory for identification using the supplied dichotomous key. Instructions on how to use a taxonomic key were moved to this exercise from Exercise 6.

Exercise 6

The introduction to this exercise on animal classification was rewritten to explain the domains of life and the Opisthokonta in particular.

Exercise 7

The introduction was revised and the classification of the unicellular eukaryotes was updated.

Exercise 8

The section on sponge reproduction was condensed to contrast sexual and asexual reproduction in sponges. The art program was revised with replacement illustrations for Figures 8-4 and 8-6 and new art for Figure 8-5 that more clearly shows the flagellated chamber of demosponges and the incurrent and excurrent canals.

Exercise 9

The opening paragraph emphasizes the diploblastic adult body of radiates, a principal characteristic of the group. The term polymorphism is replaced with dimorphism, a term that better characterizes the polyp-medusa body forms displayed by Cnidaria.

Anatomical descriptions were condensed in several paragraphs to make the exercise more compatible with shortened laboratory periods.

The legend to Figure 9-6 was expanded to help students distinguish sexual and asexual stages in the life cycle of *Aurelia*.

The laboratory report was expanded to provide questions for *Aurelia* and *Metridium* as well as for *Hydra*.

Exercise 10

A new laboratory report has been added to provide questions for planarians, *Clonorchis*, *Schistosoma*, and tapeworms.

Exercise 12

To facilitate study, diagrams showing the dissection and anatomy of the freshwater clam are rearranged to appear on opposing pages.

Exercise 13

Annelid classification, as shown in the opening cladogram and detailed in the classification section, recently has been revised on the basis of molecular characters in addition to the presence or absence of parapodia and setae. This revision places all but the earliest annelids in two large clades, Sedentaria and Errantia.

The terminology for parapodium structure in Figure 13-1 has been simplified.

The laboratory report has been expanded to include questions for the clamworm and the earthworm.

Exercise 15

The description of serial homology has been rewritten to emphasize the significance of this important principle.

Exercise 17

Labels for rectal ceca and cardiac stomach in Figure 17-3 were expanded to include more functional information. Figure 16-7 was modified to show an enlarged pedicellaria.

A suggested list of characteristics was added to the comparative table of echinoderm characteristics in the laboratory report.

Exercise 18

New art for Figure 18-1 shows all five of the chordate hallmarks.

Classification of the subphylum Vertebrata was revised, placing the hagfishes and lampreys in separate superclasses.

Exercise 22

Figure 22-4 of the internal anatomy of a pigeon has been enlarged and revised.

Exercise 23

A new illustration (Figure 23-6) showing angular and rotational movements in vertebrates has been added.

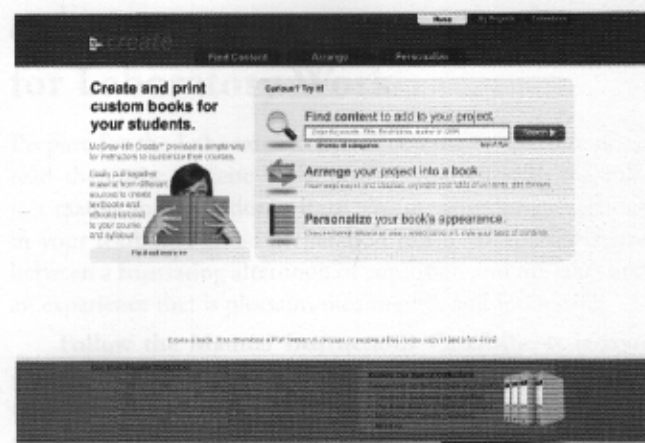
Supplements

Integrated Principles of Zoology Online Learning Center (www.mhhe.com/hickmanipz16e). The Online Learning Center for *Integrated Principles of Zoology* offers a wealth of teaching and learning tools for instructors and students. Instructors will find additional online laboratory exercises; illustrations, photographs, and tables from *Integrated Principles of Zoology*; and more! Students will find online activities such as cladistics exercises, chapter quizzes, key term flash cards, and web links.

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Although we make every effort to bring you an error-free manual, errors of many kinds inevitably find their way into a book of this scope and complexity. We will be grateful if readers who have comments or suggestions concerning content will send their remarks to Patrick Reidy patrick.reidy@mheducation.com.