

PREFACE

Designed to be used with all majors-level general biology textbooks, the lab topics included in this substantially revised lab manual are investigative, using both discovery-based and hypothesis-based modes of inquiry. Students experimentally investigate topics; use critical thinking skills to summarize, predict and test ideas; observe structure and diversity; and engage in hands-on learning. Students are often asked, "what evidence do you have that . . ." to encourage independent thinking. By emphasizing investigative, quantitative, and comparative approaches to the topics, the authors illustrate how the biological sciences are integrative, yet unique. As stated in its subtitle, the manual addresses the fundamental biological principles taught in introductory classes while emphasizing three evolutionary themes: form reflects function; unity despite diversity; and the adaptive processes of life. This manual is an excellent choice for colleges and universities that want their students to experience the breadth of modern biology.

For this edition, Warren Dolphin, Iowa State University Professor Emeritus of Genetics, Cell, and Developmental Biology, and David Vleck, Adjunct Associate Professor of Ecology, Evolution, and Organismal Biology at Iowa State, have teamed up to substantially revise the previous edition. Between them they have over 50 years of experience teaching introductory biology, including directing lab instructors in a year-long, multisection accompanying laboratory course. In this lab manual they share their experience with what works, where students have problems, and how specific lab discoveries relate to the greater field of biology as a whole.

Changes for the Tenth Edition

Based on our experience and the comments of reviewers, nearly every topic was substantially revised as follows:

- Many introductory background sections were rewritten to increase student interest and improve comprehension
- Procedures were updated for clarity and currentness
- New experiments were added to many topics
- New tables for data recording were added
- Guidelines for data analysis were clarified and expanded
- Both intermediate and terminal lab summaries were revised for many labs
- 18 new illustrations and 44 new photographs were added
- Increased emphasis on student inquiry, independent learning, and collaborative learning

Specific changes to lab topics include the following:

1. **Science: A Way of Knowing** was extensively rewritten. We added a new discovery-science activity using Venn diagrams analysis to help students identify patterns in data sets. We increased emphasis on student hypothesis creation and testing using binocular vision and dominant eye effects. We added a new section on how to write a lab report. Material on evaluating science literature and Internet sites was deleted.
2. **Using Microscopes and Observing Cells** is a new lab that combines Lab Topics 2 and 3 from the previous edition.
3. **Using Quantitative techniques** now appears earlier in the manual and was edited to improve clarity.
4. **Membranes, Diffusion, and Osmosis** was clarified and directions for dialysis tube experiment were rewritten.
5. **Visualizing Biological Molecules** text and art were edited to improve clarity.
6. **Determining the Properties of an Enzyme** was edited to improve clarity and more open-ended questions were added to promote critical thinking.
7. **Measuring Cellular Respiration** was substantially rewritten changing procedures and assays, creating new data tables, clarifying respiratory flexibility in yeasts, and emphasizing redox concepts in background section.
8. **Investigating Photosynthesis** was rewritten to reduce terminology, to better organize concepts, and to introduce more comparative studies of chloroplasts and aquatic plants.
9. **Mitosis and Chromosome Number** was substantially revised to change the chromosome staining procedure to the faster toluidine blue procedure and an inquiry-based goal of using chromosome number to identify an unknown plant species (of five recommended) was added.
10. **Modeling Meiosis and determining Cross-Over Frequency** directions were clarified and more thought-provoking questions added.
11. **Analyzing Fruit Fly Phenotypes and Genotypes** was edited for clarity.
12. **Isolating DNA and Transformation with Plasmids** was rewritten with an expanded background section, reordered transformation protocol that reduces

student confusion, a new table that stimulates critical thinking about experimental design, simplified directions to calculate transformation efficiency, and more critical thinking questions. Colorimetric test for DNA was dropped.

13. **Modeling Processes in Evolution** Investigation of Hardy-Weinberg Equilibrium was rewritten so that any of a three recommended programs that run on PC, Mac, or over the Internet could be used. Experiment on mutations in bacteria was dropped.

New interchapter on **Biological Diversity and Cladistics** was added to introduce students to the modern phylogenetic perspective on diversity.

14. **Investigating Bacterial Diversity** A cladogram of the domains of life was added. Directions for several procedures were revised for clarity.
15. **The First Eukaryotes** Based on the protist lab topic of the previous edition, this rewritten chapter now derives eukaryotes from prokaryotic ancestors and includes four new photos. Supergroup nomenclature is based on the 2013 recommendations of the Society for Eukaryotic Microbiology. Directions for observing several specimens were substantially revised.
16. **Ancestral and Derived Characteristics of Seedless Plants** was substantially revised. New introduction provides a cladistic analysis to derive plants from ancestral eukaryotes with two new figures. Section on stoneworts was revised with more emphasis on plant adaptations to land. More probing summary questions were added, descriptions clarified and number of boldface terms reduced.
17. **Derived Characteristics of Seed Plants** introduction was rewritten with a new cladogram deriving seed plants from seedless. Section on grass flowers was eliminated and number of boldfaced terms was reduced.
18. **Investigating Fungal Diversity and Symbiotic Relationships** received a new background section on evolutionary relationships with a cladogram. New diagrams of mycorrhizal fungi also added.
19. **From Basal to Bilateral Animals** Background section rewritten with cladogram showing relationships among ten animal phyla to be studied over next three labs. Sponge histology section rewritten. Planaria cross section anatomy and human fluke life cycle removed.
20. **Lophotrochozoa: Increased Complexity** New photos of bryozoan and squid. Introductions to annelids and mollusks rewritten. Earthworm cross section eliminated.
21. **Protostomia: Ecdysozoa** Retitled lab topic. Filarial worm and *Daphnia* observations eliminated.
22. **Deuterostomes and the Origins of Vertebrates** Material on echinoderm embryology added to distinguish deuterostomes from protostomes. Summary table of

deuterostome characteristics was added for students to complete based on their observations.

23. **Investigating Plant Cells and Tissues** Introduction was rewritten and shortened. Coverage of plant cells was reorganized to eliminate redundancies. Tissues observations were simplified.
24. **Vascular Plant Functional Anatomy** Anatomical section rewritten and simplified. Three integrated experiments added to explore the transpiration-cohesion-tension theory.
25. **Flowering Plant Reproduction, Development and Dispersal** New section added on role of gametophytes. Fertilization coverage expanded. Section on fruits expanded. Observations based on film moved to end. Summary questions revised. Hormone material moved to following lab.
26. **Research Project: Chemical Signals in Plant Development** A new completely investigative lab in which students design their own experiment to test the effects of the environment and plant hormones on seedling development of one or more species of plants. It emphasizes collaborative learning about independent investigation and the method of science.
27. **Investigating Digestive, Renal, and Reproductive Systems** Integration of the preceding interchapter of previous edition provides a better match to how students use manual. Hydra digestion removed. Bold-faced terms and terminology reduced. Large tables removed. Material on thymus and thyroid moved from later chapter to simplify dissection logistics.
28. **Investigating Circulatory Systems** Materials reordered to improve logistics in lab. Redundancies removed and excess figures reduced. Goldfish experiment now replaced by video exercise. Lab summary revised to be more informative.
29. **Investigating Gas Exchange Systems** New figures added on gills structure and mammalian respiratory tree. Alveolar structure investigation rewritten and discussion of respiratory volumes clarified with new activity on the effects of posture on ventilation. Tables removed and replaced with critical thinking and questions.
30. **Muscle and Skeletal Systems** Muscle histology section revised to emphasize what could be observed and a new summary table added to encourage students to articulate their observations. The material on naming pig muscles was moved to the end of the muscle section, and listed as optional. Material on hydrostatic skeletons was removed. The text list of major skeletal bones (about $\frac{3}{4}$ page) was removed, and replaced by short paragraphs of text that include additional functional information and fewer bold-faced terms. The skeletal system student investigation was rewritten with open-ended questions to promote discovery learning.
31. **Investigating Nervous and Sensory Systems** Instructions for viewing spinal nerves and the sympathetic trunks and sympathetic ganglia were expanded and

clarified. Table 31.1 was expanded to encourage student written summaries to reinforce learning from the preceding section. An experimental demonstration of the blind spot has been added. At reviewer's suggestion, material on ear anatomy and hearing has been removed.

32. **Estimating Population Size and Growth** was rewritten with an expanded background section, mark-recapture and quadrat analyses were simplified, and a new activity on dispersion with new figures was added.

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 Gerald Gates, *University of Redlands*
 Jim R. Goetze, *Laredo Community College*
 Becky Green-Marroquin, *Los Angeles Valley College*
 Ida Greidanus, *Passaic County Community College*
 Dana Brown Haine, *Central Piedmont Community College*
 Cynthia M. Handler, *University of Delaware*
 Chad Heins, *Bethany Lutheran College*
 Sidney S. Herman, *Lehigh University*
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 James R. Jacob, *Tompkins Cortland Community College*

Paul Jarrell, *Pasadena City College*
 Marcy Kelly, *Pace University*
 Margaret Krawiec, *Lehigh University*
 Peter A. Lauzetta, *Kingsborough Community College (CUNY)*
 Raymond Lewis, *Wheaton College*
 Lewis Lutton, *Mercyhurst College*
 Charles Lycan, *Tarrant County Junior College*
 Lee Anne Martinez, *University of Southern Colorado*
 Thomas Mertens, *Ball State University*
 Jamee Nixon, *Northwest Nazarene University*
 Karel Rogers, *Adams State College*
 Stephen G. Saupe, *St. Johns University (Minnesota)*
 Mary Schmall, *McDaniel College*
 Nancy Segsworth, *Capilano College (British Columbia)*
 Mindy Skarda, *Southwestern Community College*
 Gary A. Smith, *Tarrant County Junior College*
 Stacy Smith, *Lexington Community College*
 Trenton Smith, *Simpson University*
 Timothy A. Stabler, *Indiana University Northwest*
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 Kiran Misra, *Edinboro University*
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