PREFACE

This *Laboratory Manual* accompanies *Biology*, a general biology text which covers the entire field of general biology from an evolutionary perspective. This manual, like the text, introduces major concepts and gives examples from specific areas of biology. Each laboratory is referenced to the appropriate chapter in *Biology*, but the laboratories can easily be coordinated with other biology texts. All exercises have been tested for student interest, preparation time, estimated time of completion, and feasibility. Students work with living material during some part of almost all laboratories. The exercises can be performed easily in most laboratory settings, and instructors can be confident that they provide opportunities for their students to actively learn both laboratory skills and the scientific process. The estimated time for completion and special requirements are given in the Table of Contents and in the *Laboratory Resource Guide* to aid in advanced planning.

Several features in this *Laboratory Manual* allow adaptation to a variety of course orientations and designs. There are a sufficient number of laboratories to permit a choice of activities over the length of the course. Many activities may be performed as demonstrations rather than as student activities, thereby shortening the time required to cover a particular concept. The majority of exercises are designed to be easily performed by a number of laboratory sections in succession.

For instructors who wish to have their students write lab reports, appendix A provides students with a format to follow. The lab report is divided into sections: Introduction, Procedure, Results, and Discussion. There are instructions and examples for each section, and a report form is included. You may wish to begin this course by asking students to complete the report form for one particular exercise within a given laboratory and end the course by requiring a completely prepared laboratory report for the entire exercise, using the instructions and form simply as a guide. If students are particularly advanced, you may wish to add more sections to the outline, particularly later on. For example, a more lengthy discussion could also include alternative interpretations, identification of assumptions, and countering of possible criticism.

The other appendices are also helpful. Appendix B gives a review of the metric system; appendix C is a classification of organisms that is more complete than those portions found in the individual diversity laboratories. Practical Examination sheets are also provided.

NEW TO THIS EDITION

This laboratory manual has been widely accepted but none the less changes have been made that will even further enhance its appeal. Every laboratory was rewritten to achieve the goals listed here.

Page Layout. Every illustration and/or table is on the same page as its reference or on the facing page to its reference. No longer is it necessary to flip from page to page to find the illustration or table that goes with a particular portion of the text. This feature will make the laboratory manual much easier to use.

Self-contained Content. Each laboratory now contains all the information necessary to understand the concept and to answer the questions asked. This feature will reduce student frustration and increase learning.

Student Activities. There are many new student activities and the format has been changed for all of them. Headings are used which clearly indicate whether the activity is a microscopic observation, a dissection, or an experimental procedure. Sequentially numbered steps often guide students as they perform the activity. A color bar is used to signify a student activity.

Laboratory Review Questions. The laboratory review questions have been rewritten. They now offer an opportunity for students to use their writing and critical thinking skills. Suggested answers appear in the *Laboratory Resource Guide*.

Some instructors may choose to grade these answers as a measure of the student's understanding, and other instructors may choose to use these questions as a student self-test. If you use the Laboratory Review as a self-test you can copy the answers from the *Laboratory Resource Guide* and distribute them to students.

Scientific Method. All laboratories stress the scientific method and many opportunities are given for students to gain an appreciation of the scientific process. Some instructors prefer to begin the semester with a laboratory that explicitly explains the steps of this scientific method. These instructors should consider beginning the semester with laboratory 32 entitled Animal Behavior. This laboratory is based entirely on the garden snail, and therefore preparation is minimal and yet students will come away with a basic understanding of the scientific method. I particularly recommend this laboratory to teach the scientific method because it utilizes a living subject.

Laboratory Safety. Laboratory safety is of prime importance and the listing on page xiii will assist instructors in their efforts to make the laboratory experience a safe one.

New Laboratories

The following laboratories are new or have been significantly revised:

Laboratory 4 Enzymes now uses a variety of enzymes and substrates and does not require the use of any potentially harmful substances.

Laboratory 6 Cellular Respiration is a new laboratory requested by many adopters for some time.

Laboratory 7 Mitosis and Meiosis now includes simulation activities.

Laboratory 8 Mendelian Genetics contains exercises other than those requiring the use of fruit flies and the fruit fly experiments have been considerably shortened.

Laboratory 10 Molecular Genetics is a new laboratory designed to help instructors include biotechnology in the course syllabus. It also includes simulation activities.

Laboratory 14 Fungi is a new laboratory devoted exclusively to this kingdom.

Laboratory 19 Deuterostomes has a new section on comparative vertebrate anatomy.

Laboratory 21 Water Absorption and Transport in Plants now includes experimental student activities that will increase student interest.

Laboratory 22 Control of Growth and Development in Plants contains new experimental student activities that require minimal preparation.

Laboratory 23 Reproduction in Plants now asks students to key various fruits and contains an exercise on the effect of acid rain.

Laboratory 32 Animal Behavior stresses the scientific method and can be used as the first laboratory by those instructors who wish to begin the semester with such a laboratory.

Laboratory 34 Sampling Ecosystems now includes more explicit directions to guide instructors and students as they venture out of the laboratory setting.

Customized Editions

The thirty-five laboratories in this manual are now available as individual "lab separates," so instructors can custom-tailor the manual to their particular course needs.

Laboratory Resource Guide

The *Laboratory Resource Guide* is essential for instructors and laboratory assistants and is available free, to adopters of the *Laboratory Manual*, in bound form or as separates.

This edition's *Laboratory Resource Guide* was written by the author, who has taken great care to make the resource guide as comprehensive and as easy to use as possible. Each chapter includes these features:

Time Estimate, Special Requirements, and Notes. Time estimates inform instructors of how much time the laboratory is expected to take. Special requirements provide suggestions on how to manage this specific laboratory, and notes give other more general information.

Fifth Edition Changes. A list of changes tells instructors how the laboratory differs from the previous edition.

Materials and Preparations. This portion of the guide lists all the materials and gives instructions for preparations. There is a materials and preparations section for each major division of the laboratory so that instructors can easily tell what is needed for a particular group of experiments.

Answers to Exercise Questions. Suggested replies are listed for every question and table for the laboratory. The lab manual questions are in boldface type for better visibility and the answers are in italic.

Answers to Laboratory Review Questions. Suggested replies for the review questions appear at the end of the laboratory.