

Preface

Greetings from the authors! We're happy that you are examining the results of our efforts to assist you and your students. We believe you'll find the information below a valuable introduction to this laboratory manual.

Audience

This manual is designed for students at the college entry level and assumes that the student has no previous college biology or chemistry. The *Lab Manual's* terminology and classification conform to that of Starr and Taggart's *Biology: The Unity and Diversity of Life* and to Starr's *Biology: Concepts and Applications*, although you'll find that the exercises support virtually any biology text used in an introductory course.

Features of This Edition

Inquiry Experiments and the Methods of Science

We realize that the best way to learn science is by doing science. Thus, in this edition, you will find numerous **inquiry-oriented experiments**. Some are extensions of a preceding activity, while others stand alone. Each follows the cognitive techniques whose foundations are laid in the first exercise, "Scientific Method."

Throughout the manual, we place more emphasis on testing predictions generated from hypotheses. We strongly believe that all biology students—both majors and nonmajors—benefit by repeating the logical thought processes of science.

New and Updated Exercises

As always, we strive to provide students with exciting, relevant activities and experiments that allow them to explore some of the rapidly developing areas of biological knowledge. We have added an additional animal diversity exercise and re-ordered and re-grouped some of the microbe, plant and invertebrate phyla.

Updated Taxonomy

An attempt to provide accurate systematic information is like trying to hit a moving target. As new information floods in, our best understanding of taxonomy and systematic relationships sometimes seems to change daily. The taxonomy in our exercises is completely updated and reflects the most widely accepted information at the time of publication.

What's Important to Us

In preparing this lab manual, we paid particular attention to pedagogy, clarity of procedures and terminology, illustrations, and practicality of materials used.

Pedagogy

The exercises are written so the conscientious student can accomplish the objectives of each exercise with minimal input from an instructor. As suggested by the publisher, the procedure sections of the exercises are more detailed and step-by-step than in other manuals. Instructions follow a natural progression of thought so the instructor need not conduct every movement.

We attempted to make each portion of the exercise part of a continuous flow of thought. Thus, we do not wait until the post-lab questions to ask students to record conclusions when it is more appropriate to do so within the body of the procedure. Answers to in-lab questions are to be found in the *Instructor's Manual* as well as online.

Terms required to accomplish objectives are **boldface**. Scientific names and precautionary statements, or those needing emphasis, are *italic*.

The use of scientific names is deemphasized when it is not relevant to understanding the subject. However, these names generally do appear in parentheses because the labels on many prepared microscope slides bear only the scientific name.

Format

Each exercise includes:

1. Objectives: a list of desired outcomes.
2. Introduction: to stimulate student interest, indicate relevance, and provide background.
3. Materials: a list for each portion of the exercise so a student can quickly gather the necessary supplies. Materials are listed "Per student," "Per pair," "Per group," and "Per lab room."
4. Procedures: including safety notes, illustrations of apparatus, figures to be labeled, drawings to be made, tables to record data, graphs to draw, and questions that lead to conclusions. The procedures are listed in easy-to-follow numbered steps.
5. Pre-lab Questions: ten multiple-choice questions that the student should be able to answer after reading the exercise, but prior to entering the laboratory.
6. Post-lab Questions: questions that draw on knowledge gained from doing the exercise and that the student should be able to answer after finishing the exercise. These post-lab questions assess **recall** (preparing students for lab practical assessments), **understanding**, and **application**.

Practical Post-lab Questions

Virtually all courses use laboratory practical examinations. We explain to our students the difference between lecture-type questions, which they need to read and provide an answer based on the written word, and practical-type questions, for which a response depends on observation.

We believe the post-lab questions should draw on the knowledge gained by observation. Consequently, we've incorporated as many illustrations as possible into the post-lab questions. These illustrations typically are similar, but not identical, to those in the procedures. Thus, they assess the student's ability to use knowledge gained during the exercise in a new situation.

Post-lab questions are identified by exercise section. This allows the instructor to easily assign or use only those questions relevant to portions of exercises performed by students. The questions also have been revised and are directly tied to the learning outcomes expected from each exercise.

Flexible Quiz Options

Each exercise has a set of pre-lab questions. We have found through nearly 80 combined years of experience that students left to their own initiative typically come to laboratory unprepared to do the exercise. Few read the exercise beforehand. One solution to this problem is to incorporate some sort of graded pre-exercise activity. At the same time, we recognize that grading a large number of lab papers each week can put an unreasonable burden on instructors. Consequently, we decided on a multiple-choice format, which is easy to grade but still accomplishes the pedagogical goal.

In our own courses, we have students take a pre-lab quiz consisting of the questions in their lab manual in scrambled order to discourage memorization. These scrambled quizzes are reproduced in our *Instructor's Manual*. Our quiz takes about five minutes of lab time and counts as a portion of the lab grade, thus rewarding students for preparation.

Other instructors have told us they use the pre-lab questions to assess learning after the exercise has been completed. We encourage you to be creative with the manual; do what you like best.

Lab Length and Exercise Options

We realize there is wide variation in the amount of time each instructor devotes to laboratory activities. To provide maximum flexibility for the instructor, the procedure portions of the exercises are divided by major headings, and the approximate time it takes to perform each portion indicated. Once the introduction has been studied, portions of the procedures can be deleted or conducted as demonstrations without sacrificing the pedagogy of the exercise as a whole.

It's our experience that if the lecture section covers the topic prior to the lab, students find the exercise much more relevant and understandable. We strive to create this situation in our courses, and thus no time is spent on a lecture-style introduction in the lab itself before the exercise begins. Therefore, we have two to three full hours for real scientific investigation and need to delete very little material to complete most exercises in the time allotted.

Illustrations

Perhaps our illustrations are more noticeable than anything else as you thumb through the manual. We continued our incorporation of a generous number of high-quality color illustrations, including everything a student needs visually to accomplish the objectives of each exercise. While there is no need for students to purchase supplemental publications, students may find the *Photoatlas for Biology*, ISBN 0-534-23556-5, to be a useful reference for this course and other biology courses.

Most illustrations of microscopic specimens are labeled to provide orientation and clarity. A few are unlabeled but are provided with leaders for students to attach labels. In other cases, more can be gained by requiring the student to do simple drawings. Space is included in the manual for these, with boxes for drawings of macroscopic specimens and circles for microscopic specimens.

We include a number of relevant figures from Starr and Taggart's *Biology: The Unity and Diversity of Life* and from Starr's *Biology: Concepts and Applications*. These illustrations further illuminate connections between lab exercise material and biological concepts.

Materials

Most of the equipment and supplies used in the exercises are readily available from biological and laboratory supply houses. Many others can be collected from nature or purchased in local supermarket, discount or office supply stores. (Our department budgets are not large!) We've attempted to keep instrumentation as simple and inexpensive as possible.

Anyone who lives in a temperate climate knows it may be necessary to adjust the sequence of the laboratory exercises to accommodate seasonal availability of certain materials. However, we provided alternatives, including the use of preserved specimens wherever possible, to avoid this problem.

Instructor's Manual

There is no need to worry, "Where can I get that?" or "How do I prepare this?" Our *Instructor's Manual* includes:

- Material and equipment lists for each exercise
- Procedures to prepare reagents, materials, and equipment
- Scheduling information for materials needing advance preparation
- Approximate quantities of materials needed
- Answers to in-text questions
- Answers for pre-lab questions
- Answers for post-lab questions
- Tear-out sheets of pre-lab questions, in scrambled order from those in the lab manual, for those who wish to duplicate them for quizzes
- Vendors and ordering information for supplies

And in the End . . .

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There are very few things in life that are perfect. We don't suppose that this lab manual is one of them. We hope your students will enjoy the exercises. We **know** they will learn from them. Perhaps you and they will find places where rephrasing will make the activity better. Please contact us with your opinions and any ideas you wish to share; encourage your students to do likewise.



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