

Preface

Why write this lab manual? This project has been fueled by two observations. The first is that the content of many microbiology lab courses has increasingly lagged behind the principles and methods emphasized in lectures and textbooks. Second, some of these lab courses cling to the traditional method of exposing students to techniques as a progression of disconnected exercises. As a result, students learn many ways to characterize microorganisms, but not how to use these tools in an integrated way to solve problems in microbiology. These limitations can be found in the popular, commercial lab manuals and in many “in-house” manuals as well.

It is not hard to understand why laboratory courses in microbiology evolve slowly. First, there is often a lack of resources. Even small changes can result in the need for new equipment, large and small, and the cost can easily exceed the budget of many departments. These budgets are often prepared under the assumption that they will be stable from year to year, with little thought to the fact that a step up to more current content might require a one-time step-up in budget. Second, instructors often lack the time needed to test and then integrate new material into a lab course. In fact, there may be a disincentive for doing so: instructors are frequently evaluated by the “success” of their courses, meaning high enrollments and favorable student ratings, rather than by their content.

These problems can be less severe at well-endowed institutions offering teaching relief for course development and larger budgets. Many of these institutions produce their own lab manuals with up-to-date content. However, this content often reflects the interests and resources of the department and does not migrate well to other institutions, particularly small colleges.

We have tried to create a lab manual that offers a route to developing new content and pedagogy while remaining practical for the many undergraduate institutions that include a microbiology lab in the curriculum. We have sought to offer a course with the following characteristics.

1. The content conforms to the goals outlined in "Recommended Curriculum Guidelines for Undergraduate Microbiology Education" (American Society for Microbiology, 2012).
2. Work is arranged around solving real-world problems (a "Challenge"), with an emphasis on cooperative effort by the class.
3. Techniques are introduced as they are needed, so that students can recognize their usefulness in working toward the solution for each Challenge.
4. Background sections are included to ensure that students have the information needed to understand what they are doing and how it is related to broader concepts in microbiology.
5. The course is largely modular. Instructors can extract one or more Challenges and integrate these into their own course.
6. The modules are amenable to various modes of in-depth assessment, including individual formal lab reports and group oral presentations.
7. The manual has an Introduction that provides the foundation for the proper practice of microbiology by including:
 - a. A description of the scientific method
 - b. An introduction to experimental design
 - c. Instructions for keeping a proper notebook
 - d. Safety guidelines for BSL1 (biosafety level 1) teaching laboratories outlined by the American Society for Microbiology (ASM)
8. All the organisms for the course are BSL1, in accordance with ASM guidelines. Conditions for handling BSL2 strains are not required.
9. Much of the necessary equipment can be found in microbiology teaching laboratories or borrowed from other lab courses.
10. Questions, ranked according to Bloom's taxonomy, are provided for the lab sessions.
11. An accompanying *Handbook for the Instructor* covers in detail recipes, setup, and logistics.

Along the way it was also necessary to make some compromises:

1. The Challenges are based on situations found in the fields of medical microbiology and epidemiology. These areas engage students, many of whom are preparing for health-related careers, and they make up most of the content of many lab courses. Our emphasis is on problem-solving rather than on demonstrating the different areas of microbiology. The skills learned in the course, however, are broadly applicable to these other areas.
2. The steps to solving each challenge will differ somewhat from those used by professional medical microbiologists or epidemiologists. The differences

reflect the need to include certain fundamental techniques and to organize the work so that it fits within lab periods.

3. The work is based on a particular set of strains. These strains were selected to demonstrate different microbial characteristics while keeping the collection within a reasonable size. Where substitutions are possible, this is indicated in the *Handbook for the Instructor*. Many colleges and universities have large collections of BSL1 and BSL2 strains for teaching purposes. In some cases, these collections extend back decades and their provenance is incompletely or inaccurately recorded. We think it is safer and more convenient to work with a small number of BSL1 strains.

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