**Microbiology Superlab**

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 Microbiology Superlab is a semester long laboratory class for Biology majors. It is typically taken in the junior year. There are three superlabs and students must take one of the three to fulfill degree requirements. This course was one of the pilot courses for ABSL and it is the testing ground for the Feral Cat Research Project. Students learn about the community problem of homeless companion animals, specifically homeless cats, through short lectures, in class discussions and volunteering with a local nonprofit which conducts twice monthly sterilization clinics for homeless cats. At some of these clinics, under the supervision of a veterinarian, students collect stool samples from those cats whose caretakers have given us permission. These samples form the basis of the lab class. Over four years, we have collected samples from approximately 400 cats.

In the lab, students isolate total DNA from the samples and amplify the ribosomal RNA genes intergenic region using PCR and primers designed to anneal to bacterial *rrn* genes. The intergenic regions are cloned and, as a class, the sequences from the inserts of approximately 100-125 clones are determined. Each student chooses one clone and designs primers to specifically match the sequence of that clone’s insert. The primers are tested for cycling conditions and the minimum number of template molecules that the can amplify. At the end of the class, students use their primers to test a portion of the 400 cat samples for the presence/absence of their bacterium. A flow chart of the experiments is included.

Much of science is communication of ideas, experiments and data to other scientists and/or the general public. To teach this type of technical writing, students have weekly writing assignments, rather than a lab report requirement. These assignments are located at [http://fcrpmicrobiology.wikispaces.com/Superlab+IV](http://fcrpmicrobiology.wikispaces.com/Superlab%2BIV).The assignments include:

Week 1 Writing for a Lab Notebook, Experimental Protocols and Materials & Methods
Week 2 What information is found in each section of a scientific manuscript?
Week 3 Evaluating Scientific references
Week 4 Beginning writing of a manuscript - instructions to authors and the introduction
Week 5 Making figures and writing figure legends
Week 6 Writing Materials and Methods
Week 7 Learning about the bacteria that were identified
Week 8 Making slides
Week 9 Writing results
Week 10 Resubmit edited Introduction and Materials and Methods
Week 11 Writing discussions
Week 12 Writing abstracts

Students turn in a final manuscript that has each section edited at least once. For the service learning component, students can choose from several assignments, including researching and writing a short grant for our non-profit partner, or researching information for the public service website we are constructing. This website will include local public resources for homeless companion animals.

**LEARNING GOALS FOR THIS CLASS**

**Science**

1. Students learn how to set up an experiment without a cookbook in front of you.

2. Students learn how to develop an experimental protocol, including writing one and trouble shooting one.

3. Students learn how to interpret experimental results.

4. Students learn the importance of experimental controls and how to design them.

5. Students learn how to work independently in a lab.

6. Students begin to learn how independent research is conducted.

7. Students learn new scientific techniques, how to perform them and what kinds of information you can get out of them.

8. Students begin to learn what kinds of questions require what types of techniques.

9. Students begin learn how to develop experiments to answer a specific set of questions.

10. Students begin to learn how to think like a scientist.

**Technical Writing**

1. Students learn the difference between writing an experimental protocol, a lab notebook entry and a manuscript.

2. Students improve their ability to convey technical information in writing.

3. Students strengthen their understanding of the difference between technical and creative writing.

**Community Problems, Volunteerism and Science**

1. Students gain an understanding of when and how scientific information can be used to address community problems.

2. Students begin to learn how to convey scientific information so that the general public will listen to and comprehend what they are saying.

**Student Evaluation**

Students are evaluated in several different ways to assess different skill sets. The three major area of assessment are technical writing, laboratory skills and community assignment. The weekly writing assignments and manuscript are worth 40% of the final grade. The manuscript is submitted twice and both attempts are graded. Examination of lab notebooks (12.5%), a practical exam on lab techniques (10%), quizzes on experimental theory (12.5%) and attendance and quality of effort (15%) are assessed. The community service assignment is worth 10% of the final grade.

ABSL is assessed using pre- and post-tests on several different topics. The service learning impact is assessed using the validated Higher Education Pre/post tests developed by D. Díaz , A. Furco, & H. Yamada at the University of California at Berkeley in 1999. We have developed a self-reflection pre- and post-test to investigate perceived success in scientific collaborations and a scientific content test to determine if the course improves scientific literacy (manuscript writing, experimental design and trouble shooting, etc). The most difficult of these to develop is the content test as it is very course specific and must cover a wide enough range so that meaningful results can be obtained.

**Background and Context**

In collaboration with two colleagues at Duquesne, Dr. Becky Morrow and Dr. Lisa Ludvico, I developed the Application Based Service Learning pedagogy as a novel way to teach basic concepts in biology in a variety of different courses at different levels. The most extensive testing of ABSL has occurred in my microbiology superlab course, where some of the strengths of ABSL have been revealed. The microbiology lab course has been taught for 5 years using ABSL.

Part of the impetus to develop and test ABSL came from the realization that the microbiology lab course didn’t teach much about how scientists do science or focus on the skills needed to be a successful scientist. The labs were a collection of techniques, with a research project that lasted a few weeks at the end of the semester. If a technique didn’t work there was no time to repeat it. Students wrote lab reports and took traditional exams.

In developing the microbiology superlab, my experience in supervising undergraduates in my research lab was an important starting point. The most successful undergraduate research projects in the lab contained a limited number of techniques to be learned (usually no more than about 6) and the opportunity to do these techniques multiple times. This gives the students, who are new to a research lab setting, the time to learn how to do the technique and to learn how to trouble shoot it.

In microbiology superlab, I teach the students a technique and then they are responsible for writing out how to do it and repeating it whenever they need it during the semester. For the first five weeks of the semester, I am always present during the entire lab period and will answer any question, no matter how basic or how many times it is asked. During the next five weeks, students must give me a plausible answer to their question and I will tell them if their answer will work or give them a workable solution. During this time, I randomly leave the lab for 5-10 minute periods and leave the graduate teaching assistant in charge. This forces the students to begin to think about what they are doing and understand what to do if no one is standing over them and directing their every move. During the last five weeks of the semester, the students work more independently and with less supervision from me. Once the semester is finished, students who would like to continue can take research for credit in my lab. These students check all of the interesting experimental results found by the class to determine if they are reproducible

In developing the technical writing assignments, I was guided by what scientists routinely write, lab protocols, lab notebooks and edited manuscripts. In traditional lab reports, students usually write everything they did in lab in a long, unedited report. In many instances, these are written shortly before they are to be turned in. In reality, scientists write and then heavily and repeatedly edit their data into a concise and compact manuscript for a specific journal. The students mimic the process of manuscript preparation in the weekly writing assignments. The order of the weekly writing assignments allows the students to collect the information through out the semester and write their data into a manuscript. Each section of the manuscript is edited at least twice before the final manuscript is submitted. One advantage of the weekly arrangement is that the extensive grading and editing of each section is not overwhelming while still introducing students to the technical writing required in scientific careers.