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**BioSOLVE I and BioSOLVE II.**

**Description of Courses**

BioSOLVE (Biology Student Operated Laboratory Venture) is offered as a biology elective for juniors or seniors majoring in biology or chemistry. BioSOLVE is based on a business model where students collaborate as contractors with service-oriented individuals or institutions to perform specific, applied laboratory research services. In addition, students participate in community service associated with the organization or project to which BioSOLVE is contracted. BioSOLVE is organized as a two-semester course, where BioSOLVE I is analogous to the training period of a new employee in a research laboratory and BioSOLVE II mimics the continued work of the trained employee.

In BioSOLVE I, students participate in community service associated with the contracted work, study the role of biologists in providing solutions to community and global problems, study and experience the nature of scientific collaborations, learn the theory behind the relevant laboratory methods, develop proficiency in the laboratory techniques needed to perform the specific contracted work, and learn the skills of complete and accurate note-keeping, data processing, and scientific writing for scientific research. Some of the required community service occurs outside of scheduled class periods. Students also participate in the assessment of application-based service learning, as it pertains to BioSOLVE I. A grade of "B" or higher is required for enrollment in BioSOLVE II.

In BioSOLVE II, students continue to participate in community service associated with the contracted work, study the role of biologists in providing solutions to community and global problems, and study and experience the nature of scientific collaborations begun in BioSOLVE I. However, the major effort of BioSOLVE II is dedicated to performing the specific contracted laboratory research for which students were trained in BioSOLVE I, including the associated note-keeping, data processing, scientific writing and communication of data to collaborators. Some of the required community service occurs outside of scheduled class periods. Students also participate in the assessment of application-based service learning experienced in BioSOLVE II. Students who enroll in BioSOLVE II are also given the opportunity to register for additional credits of Directed Research to complete additional laboratory research under the supervision of the BioSOLVE instructor.

**BioSOLVE I Course Objectives**

Upon successful completion of the course, students will:

* Have performed community service related to an issue for which biological research data may contribute to a solution.
* Be able to explain the role of biologists and biological research in providing solutions to certain community and global problems.
* Be able to describe the nature of scientific collaborations, including advantages and challenges.
* Be able to explain the scientific theory behind the specific laboratory procedures used.
* Have demonstrated accurate, reproducible proficiency in the necessary laboratory techniques.
* Have generated novel research data.
* Have demonstrated competency in laboratory note keeping, processing of research data, and scientific writing.

**BioSOLVE I Course Content**

* Discussion of application-based service learning goals and participation in generating assessment data (completing surveys, interviews, etc.)
* The historical and modern-day roles of biological research in helping to solve community and global problems.
* The nature of the specific problem for which BioSOLVE is contracted to help solve: What is the issue? Why is it a problem? What has been/is being done by others to address the problem?
* The nature of the collaboration with the specific contractor: What community service will be provided? What is the value of this community service with regard to solving the problem? What biological research questions will be addressed? What specific laboratory methods will be used for the project? What are the needs (time-table, format, etc.) for communication of research data and interpreted results to the contracting organization?
* The biological principles needed to understand the biological research question and the laboratory methods being used for the project. This will integrate information from various sub-disciplines of biology, including review of material from introductory biology courses and introduction of selected new material from various upper-level biology courses.
* Performing the necessary laboratory research techniques (with the associated laboratory note-keeping) until accurate, reproducible results are consistently and reliably obtained.
* Interpret and record data.
* Generate scientific reports and communicate results with contracting organization.

**BioSOLVE II Course Objectives**

Upon successful completion of the course, students will be able to:

* Demonstrate completion of community service related to an issue for which biological research data may contribute to a solution.
* Explain their participation as biologists via biological research in providing solutions to certain community and global problems.
* Explain their experience with the advantages and challenges of scientific collaborations
* Demonstrate generation of accurate, reproducible novel scientific research data for the contracted project.
* Maintain an accurate and complete laboratory notebook.
* Interpret their experimental data and explain their conclusions using standard scientific criteria for written and oral communication.
* Prepare a manuscript for publication of research results.
* Prepare and deliver a formal presentation of research results at an appropriate venue.

**BioSOLVE II Course Content**

* Review application-based service learning goals and participate in generating assessment data (completing surveys, interviews, etc.)
* Review the nature of the specific problem for which BioSOLVE is contracted to help solve.
* Review the accomplishments of BioSOLVE I, both scientific and service-related.
* Complete community service related to the contracted work.
* Perform experimental laboratory research to generate novel data for the contracted project, using and expanding upon the techniques and skills learned in BioSOLVE I, including laboratory note-keeping and data interpretation.
* Generate scientific reports and communicate results with contracting organization.
* Prepare a manuscript of novel research (in format for scientific publication).
* Prepare and deliver oral or poster presentations of the novel research.

 **BioSOLVE and the Feral Cat Project**

BioSOLVE is structured to be flexible with regards to the community problem, collaborators and specific research project to which it is dedicated. For our initial problem, BioSOLVE has been working on the Feral Cat Project in collaboration with Nancy Trun and her Microbiology Superlab students at Duquesne University. The BioSOLVE research involves performing PCR (using specific bacterial primers developed by the Duquesne students) to screen DNA extracted from large numbers of feral cat fecal samples to determine the prevalence and distribution of various bacteria in feral cats. BioSOLVE course content specific to the Feral Cat Project has included the following:

* Lectures and literature searches to learn about feral cats: problems and solutions.
* Volunteering at feral cat spay/neuter clinics and for a feline adoption organization.
* Preparing and distributing an informational brochure and giving an oral presentation about homeless cats (problems, solutions, resources for assistance and opportunities to help) at the college's annual Animal Blessing event and for the college's Community Service Club.
* Meeting with collaborators from Duquesne Microbiology Superlab as well as community partners.
* Guest lectures regarding work done by Superlab students.
* Lectures for background information in microbiology, pathogenic microbiology and molecular biology relevant to the Feral Cat Project.
* Lectures on the theoretical basis of relevant lab techniques such as DNA extraction, cloning, PCR and gel electrophoresis.
* Developing proficiency in basic lab skills, such as sterile technique, laboratory safety, use of an analytical balance, calculating molarity, making dilutions, making and sterilizing reagents, trouble-shooting protocols and equipment.
* Developing proficiency in PCR, gel electrophoresis, photodocumentation, annotation and storage of research data electronically and in hard-copy.
* Submitting a manuscript of each semester's research to the Duquesne collaborators.

**Assessment**

* Content exams in BioSOLVE I: Lecture exams on microbiology, pathogenic microbiology and molecular biology, history and nature of scientific collaborations, and the feral cat issues. Lab theory and practical exams on techniques covered in the course.
* To assess content retention, I gave the same BioSOLVE I content exams at the end of BioSOLVE II. As a control for content retention, I re-administered a final exam from another upper-level biology course that the students took at the same time they took BioSOLVE I.
* Scientific laboratory notebooks and final course manuscripts and oral presentations, were graded on scientific content and professional style/delivery.
* Participation grades for service activities and collaborative laboratory and written work included self and peer evaluation, as well as faculty observation.
* Service-Learning Survey (Diaz, Furco, Yamada, UC Berkeley, 1999) was given pre- and post-BioSOLVE I and post-BioSOLVE II. Assesses students' attitudes about community service and service-learning.
* Self-reflective test given pre- and post-BioSOLVE I and post-BioSOLVE II. Test was developed by collaborator and writing instructor Susan Seibel. Assesses students' opinions of their own traits and behaviors and how they contributed to or hindered success in the course.
* ABSL Survey was given pre- and post-BioSOLVE I and post-BioSOLVE II. This test was developed in collaboration with Susan Seibel to assess the synergistic influence of combining service learning with novel research in a structured course. The survey asks questions about the students' interest in and commitment to biology laboratory work when it is/is not dedicated to novel research and when it is/is not applied to solving a community problem. Similarly, it assesses the students' interest in and commitment to doing community service when it is/is not directly related to course work and/or novel research.
* BioSOLVE course evaluation was given post-BioSOLVE II, but asked students to reflect on the entire BioSOLVE experience. This evaluation assesses students' opinions about the research and service components and the courses, overall, and was based on the evaluation used by collaborator Nancy Trun in her Duquesne University Microbiology Superlab course.

**Background and Context**

Included in La Roche College’s mission are commitments to providing students with skills and knowledge necessary for employment or further education in their chosen fields, training students to be ethical and compassionate citizens of the world, and a long-standing tradition of community service. BioSOLVE is consistent with these three aspects of La Roche College's mission. The Department of Biology, like the other sciences at La Roche College is dedicated solely to undergraduate education. Facilities, funding, and faculty responsibilities are focused on classroom teaching, providing only limited opportunities for students to engage in research. Our biology professors typically teach 15-25 contact hours per week with 4-7 different courses each semester. We do not have our own individual research programs, research laboratories or budgets for laboratory work outside of lab classes. Supervision of individual student research is not included in the required teaching load and is only minimally compensated. Thus, it has been very difficult to provide individual students with a meaningful research experience. However, we believe that undergraduate research is an essential part of training our graduates for employment or advanced education. My motivation for developing the BioSOLVE courses was to establish a high-quality program of real life biological research, in a manner that is appropriate and manageable for a small, undergraduate, non-research institution, while supporting the mission of our college. BioSOLVE has created a cohort of student researchers working collaboratively on a continuing research project that generates a pool of meaningful, interpretable, useful data. Since research is done within structured courses, the work is included as part of the instructor's teaching load. BioSOLVE has given our undergraduates more advanced research opportunities with potential for publication and/or presentation at professional conferences within the financial, space and mission constraints of La Roche College. BioSOLVE also offers a unique educational experience that directly ties scientific research to community service and La Roche’s mission to graduate ethical and compassionate citizens of the world.

**Support**

Development, implementation and two years' assessment of BioSOLVE was funded as a subcontract to La Roche College on a CCLI grant from the National Science Foundation to Duquesne University.

Direct and indirect support for BioSOLVE came from La Roche College as follows:

* Renovations to create our first biology laboratory dedicated solely to student research
* Permission to offer BioSOLVE courses in spite of low-enrollment (compared to traditional biology courses)
* Reimbursement of travel expenses to present this pedagogy in a microbiology education symposium at the 2010 General Meeting of the American Society for Microbiology
* Capital expenditures for additional laboratory equipment
* Enhanced marketing of biology programs by the VP of Academic Affairs and the college's offices of Institutional Relations and Admissions