

BIO 493/4 Independent Research in Biology II

Background

Course description: Independent Research in Biology is an experience typically offered to students in their junior or senior years. Under the direct supervision of a faculty member, students engage in original research projects, generating new knowledge in the laboratory and/or the field. Given that it takes considerable time to fully develop a research project, a two-semester experience is suggested. During this time, students are expected to become engaged in literature review, experimental design, evaluation of protocols and hypotheses, and data acquisition and analysis. At the completion of the experience students are required to publicly present and defend their findings and to submit a manuscript, written in the format of a peer-reviewed journal article. Furthermore, students participating in Independent Research in Biology are encouraged to become involved in professional activities outside of The College. In any given year, approximately 5 to 10 students from the department present their original research at regional or national conferences, and many more are co-authors on published abstracts or manuscripts submitted to peer-reviewed journals.

How this course fits into the Biology Program: Independent Research in Biology is a rich, deeply engaging opportunity that, for many students, constitutes the ultimate learning experience within the major. Biology, as with any other scientific discipline, is based on experimentation, data acquisition and analysis. While most of the courses in the Biology Program offer laboratory components, and in fact, many provide students with the opportunity to engage in open-ended inquiry-based experimentation, Independent Research in Biology gives students a completely unique exposure to the discipline. Students involved in Independent Research are able to experience research science in a laboratory as it truly exists: they learn how to identify biologically relevant problems, determine the best experimental approach to address these issues, design and carry out experiments, collect and analyze data, and finally take their results and put them into the context of a larger biologic question or problem. In addition to developing these skills, students must learn to take responsibility for their experiments, to display initiative and creativity, and to work collaboratively and productively with a supervisor and their peers. These skills translate well beyond the major and prepare students for any science related career option that they may pursue after graduation. In sum, Independent Research in Biology is an incredibly valuable educational experience, and one that will have a long-lasting impact on the student's future.

Learning Goals

The ultimate goal of Independent Research in Biology is to provide students with a real-life exposure to original biological research. Students are expected to be actively engaged in the experience, on both practical and intellectual levels. As part of the learning experience, students will be involved in experimental design, data acquisition and analysis. Under the supervision of a faculty member, it is expected that students will gain independence in these processes, and will show an increasing ability to direct their day to day activities and in "trouble shooting" their own experiments. In addition to the learning goals associated with the actual hands-on work in the lab, students also have significant intellectual learning goals. These include understanding the theoretical relevance of the experimental problem and how their experiments fit into a larger biological context. To that end, students are expected to become adept at finding appropriate and relevant published studies, as well as critically reading and evaluating these works.

Student Assessment

In order to ensure that common standards for evaluating student performance are adopted by all faculty involved in Independent Research, detailed guidelines outlining performance goals and expectations have been developed and are shown below.

Performance Goals and Guidelines for Independent Research in Biology II:

Basic requirements:

- 1) attendance at laboratory meetings
- 2) maintenance of a laboratory notebook
- 3) attendance at all departmental seminars
- 4) presentation of a research poster to the department
- 5) submission of a final research paper written in a style suitable for a scientific journal

For students that complete a second semester of Independent Research in Biology II (BIO 493/4) and wish to use it as their capstone 'W' (writing intensive) course in the major, the following additional guidelines are provided.

The central learning goal for a Biology W course is to educate our students to write original research papers and grants. To that end, students will:

- 1) become well-versed in reading and interpreting original scientific literature.
- 2) understand how individual research papers fit into a larger scientific context and address relevant questions in a field.

In order for a student to complete the requirements for the course the student must produce a research paper based on laboratory research performed by the student that is suitable for publication in a scientific journal. A detailed description of the components of the research paper can be found at the end of the syllabus. The production of this paper requires substantial writing of a first draft (typically 15-20 pages), review of this draft by a faculty member, and final revision by the student. Students begin by writing the first draft based on extensive guidelines (see attached). This first draft is submitted and thoroughly reviewed by the professor. It is returned with substantial feedback so that students can write a second draft, building upon the comments received earlier. In total, students in either course produce more than 15 single spaced pages of finished scientific work. Original student research papers are expected to meet the following criteria:

- 1) clear and concise written exposition of the research question and its importance in the context of larger questions in the scientific discipline, supported by the primary scientific literature.
- 2) clear and concise explanation of the methods used in the study.
- 3) effective presentation and accurate analysis and interpretation of results.
- 4) effective revision based on faculty review.
- 5) thoughtful discussion of the results.

Students will be given a grade of IP until the project is completed. For the final grade, pluses and minuses may be given based upon the level of accomplishment within a grade level. A student that fails to meet the basic requirements and/or does not produce a research paper or poster will not pass.

Independent Research in Biology II: Performance Criteria

A Excellent Performance

- engages in persistent, hard work
- displays independent intellectual and technical involvement in work
- has an excellent grasp of technical and theoretical aspects of research
- makes project his or her own; makes creative contribution to design and analysis of experiments
- maintains an excellent lab notebook with up-to-date recording, tabulating, and analysis of data
- displays critical thinking in lab meetings
- final poster presentation and written research paper are of excellent to outstanding quality

B Good Performance

- engages in persistent, hard work
- exhibits ability to work independently and demonstrates technical independence
- delivers a very solid performance and completely reliable and reproducible experimental work
- gives competent presentations in lab meetings
- maintains a clear, organized lab notebook
- final poster presentation and written research paper are of good to very good quality

C Average performance

- engages in persistent, hard work
- performance in experimental work is fair to poor
- demonstrates an ability to work with limited supervision
- lab notebook displays evidence of confusion and is inadequately maintained
- participation in lab and lab meetings is of low quality
- final poster presentation and written research paper are of fair quality

D Poor Performance

- performance is inadequate or sloppy
- displays inability to work without direct supervision
- has an inadequate grasp of the technical aspects of the work
- does not maintain an organized research notebook
- poster and paper are unclear and poorly organized and presented