DO YOU WANT TO DO RESEARCH?

A PRACTICAL GUIDE FOR THE STUDENT

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Independent or mentored research can be one of the most gratifying parts of a Biology major education; it can also be the worst if not done correctly. To succeed, a student must plan carefully and work diligently. The rewards will be worth the effort. Motivated students may get involved with a professor's research early in their academic career and are encouraged to look over faculty bios and contact professors about opportunities for research. Research can be done informally (not for academic credit) or for credit. There are a variety of ways to get credit – you should discuss the options with your advisor or your research supervisor. Many students complete a one-semester or a multi-semester research project to fulfill the "capstone" requirement for the BIO major, usually during their junior or senior year. A research capstone can be satisfied by an on-campus research experience (Bio 460) or an approved off-campus research opportunity (Bio 461). Note that there are other ways to fulfill the capstone requirement of the Biology major such as taking a designated capstone course, rather than completing a research project. ***This document is intended to guide students through the process of completing a Bio 460 or Bio 461 experience***.

RESEARCH ON CAMPUS: BIOLOGY 460 - HOW DO I DO IT?

1. The first and most important step is to **choose your research area and your research project advisor**. Every Biology 460 project is guided by a faculty member. *You must choose your faculty research project advisor as early as possible in the semester preceding that of the project.* The types of projects that each faculty member oversees and a brief list of Bio 460 projects that faculty have recently directed can be found in the document **Faculty Research Interests**. From your examination of this list and from other sources of information about each faculty member's interests (courses, readings, or from talking with other students and faculty), approach one or more of the faculty in the department and discuss the possibilities. ***Don't be shy: we expect you to come and talk to us!***

Once you have scouted the territory, make your decision. Directly ask the faculty member if they will serve as your research advisor. While all faculty members can accept 460 students, there are limits to the number of students that each faculty member can advise. If you start your search late, it is possible that the project advisor with whom you want to work will have a full load and cannot accept you. The faculty member may suggest that you do the project in another semester or work with another advisor. ***Don't take a refusal personally!***

2. Once you and your faculty project advisor have agreed to work together and have decided on an area of research, it is your responsibility to **learn about this area and to work on formulating a precise research project**. Your research project advisor may make suggestions about readings, library resources, and possible experiments. You should dive into the material immediately and regularly consult with your research advisor.

Students considering a particularly ambitious project that cannot reasonably be completed in a single semester should consider enrolling in Individualized Study - Tutorial (Bio 453) in the semester preceding the 460 research project or consider enrolling in Individualized Study – Research (Bio 463) in the semester following the 460 semester. Bio 453 and 463 are graded S/U and **do not count** toward the major requirements. Many students considering ambitious projects also work on it during the summer prior to formally completing their Bio 460.

3. Once you and your research advisor have clearly identified a project, **you should begin work on a prospectus**. The prospectus is a formal, typewritten document (double-spaced) which must contain the following:

Title page: A brief and informative project title, along with your name and that of the faculty research sponsor.

Introduction: A description of the main ideas behind your project. It should lay the groundwork for the reader and must include a short literature review, a summary of any preliminary research you may have already completed on the topic. Definitions of special terms unfamiliar to biologists outside of the proposed research discipline should be incorporated into the text.

Hypothesis *or* **Objectives**: A clear statement of the hypothesis you will test, questions to be addressed, *or* a statement of the objectives of the study. This should be based on the material presented in the introduction.

Research Design: Descriptions of how you will test your hypothesis, address your questions, and/or meet your objectives. The research design includes your laboratory and/or field procedures, the methods you will use to analyze your data (including statistical methods), and a time-line showing when you expect to finish each part of your project. In consultation with your faculty research sponsor, you must list the costs of any special supplies and equipment necessary for the project***. If appropriate/required, the student researcher must also apply for Senior Project funding from the Provost Office.***

References: A list of the references you cited in the Introduction and Research Design sections. At least five references relevant to your topic must be cited. Use the CSE author-year format.

Your prospectus will be read and must be approved by two faculty readers (your research project advisor plus another faculty member). In consultation with your research advisor, you should ask another Biology faculty to be your "second reader" (under special circumstances, your second reader may be a faculty member from another department); this faculty member will typically have expertise that enables them to judge and assist with certain aspects of your proposed project. Your two readers (project research advisor and the second reader) will review your prospectus and may make some useful suggestions and offer important ideas.

You, your project research advisor, and your second reader must meet to discuss and approve your complete prospectus by Friday of the 12th week of the semester (2nd week of November or April) preceding the semester in which you plan to do your project. For summer / fall projects, this would be the Spring semester. Approval of the prospectus may be conditional if the prospectus is incomplete or if the project is judged to be either too ambitious or too simple. After the necessary revisions, you will meet again to finalize approval of your prospectus. The approved final prospectus must be submitted to the Chair of the department by the end of 13th week of the semester**.** The form used by the Registrar for BIO 460 registration will be signed by the department chair ***only if the prospectus has been unconditionally approved by your two initial readers.***

Students planning to do research involving any vertebrate animals must complete and submit, in coordination with your faculty mentor, an "Institutional Animal Care and Use Committee" (IACUC) official protocol proposal, which details the proper care, experimental use and eventual disposition of their animal subjects. This form must be co-authored with your supervisor, and approved and signed by the department chair before submission to IACUC. IACUC's approval should be obtained by the end of the semester BEFORE research is to begin and it is a requirement for registration into Bio 460. Students must secure IACUC's approval of the experimental protocol BEFORE any research with vertebrate animals can begin.

Later in the process, there will also be a "third" reader which will be assigned to your research project by the Biology Department; this person typically has expertise very different from the focus of your project, and will help judge whether your final project paper is understandable by a broader audience.

4. **The actual implementation of the project will be governed by a contractual agreement with your project research advisor**. The formality of this contract is up to your project advisor. It is always the responsibility of the student to meet with the project advisor on a regular basis and to conduct the project at a pace that will lead to completion by the end of the semester. *As a rule, students have discovered that the time demands of a 460 project commonly exceed those of a regular course.* As such, you are strongly advised to commence the project at the earliest time possible after the approval of your prospectus and to plan a detailed work schedule!

5. **You will be assigned research space** in the department to do your work. You might be given a key to this area for which you must sign a receipt. If you fail to return the key to the Biology Administrative Assistant, facilities will charge you $55. It is your responsibility to safeguard this key and to keep your work area clean, orderly and secure at all times! ***In addition, you must complete the mandatory laboratory safety training provided by Gettysburg College at the beginning of every semester.***

6. During the last week of the semester, **you will give a brief (10-15 minutes) oral presentation to the department**. The precise date and location of the Bio 460 Symposium will be announced late in each semester. Your project advisor will help you prepare your presentation. You must **submit a Microsoft word file document with the final abstract of your project** to the Biology Administrative Assistant one week before the symposium. This abstract will be printed in a program booklet that will be distributed at the symposium and a compilation of all student abstracts will be made available to interested persons.

7. **The second and third readers (in addition to your project research advisor) will both read your final research paper.** You must submit a complete draft to your project research advisor and both readers by no later than 10 days before the last day of classes. The readers will make comments about the paper for you and for your project advisor, suggesting appropriate revisions as necessary. The final version of your research paper must be submitted by no later than the Wednesday of finals week.

This report must follow the standard format of a scientific paper in your field or the guidelines in Victoria McMillan's book, *Writing Papers in the Biological Sciences*.

8. **You will be graded A-F by your project research advisor**. Your final grade will be determined by your effort and execution, your final paper, and your symposium presentation. Although both readers will discuss with your project advisor a grade for your final paper and a grade for your symposium presentation, it is the responsibility of your project research advisor to determine and assign the final grade. Your project advisor will also evaluate the difficulty of the project you attempted, the quality of the data you obtained (independent of the quality of your data reporting), and your effort throughout the project. It is possible for a project with little useful or conclusive data to receive a good grade; it is also possible for a project with good data to receive a poor grade.

CAN I DO RESEARCH OFF CAMPUS?

Some students choose to do a research project off-campus. Most commonly, this is done if a student is enrolled for a semester at an approved off-campus program, such as the Duke University Marine Laboratory semester, the School for Field Studies, or the Semester-at-Sea program, or does summer research at a laboratory other than at Gettysburg College.

1. If a student performs off-campus research that is not formally credited as a research course, they may nonetheless receive Bio 461 credit. After the work is completed and the student has returned to Gettysburg College, they must secure a project advisor from the department. (It is preferable, but not always possible, that this be done before leaving campus.) The project advisor is normally that faculty member whose own specialty is nearest to that of the project. The student enrolls in Bio 461 with this faculty member as the instructor. Unlike Bio 460, Bio 461 is graded S/U. During the semester, the project advisor will work with the student in analyzing the data and writing the research paper. It is preferable (but not always possible) that students planning an off-campus project write a prospectus for approval before commencing the work.

2. If a student enrolls in an off-campus individualized research course and successfully transfers the credit to Gettysburg College, he or she may petition the Biology Department to accept this course in lieu of Bio 460. This petition must be a formal, written request. The department may grant approval *only if the student convincingly demonstrates that the course was sufficiently similar to a Bio 460 experience at Gettysburg College*. To prepare for the symposium oral presentation (see below), the student is strongly advised to seek guidance from a member of the Biology faculty.

In either case, a written scientific research paper (to be read by the Biology project advisor) or an oral presentation during the Bio 460 symposium is required at the end of the first semester that the student returns to campus.

Some examples of recent projects done off-campus:

Zoe Yeoh (with Patricia Springer, University of California, Riverside, Center for Plant and Cell Biology, and Jennifer Powell). (2017) "LOF1 and interacting transcriptional factors in plant organ boundary development."

Katherine Kraft (with the Prostate Oncology Translational Research Team, Janssen Pharmaceutical Company, and Jennifer Powell). (2017) "Gene expression signatures during the development of drug resistance in castration resistant prostate cancer patients."

Brielle Barnard (with David Sweatt, primary investigator, University of Alabama, Dept. of Neurobiology, and Matt Kittelberger). (2014). "The effect of transcription factor 4 on cerebellar nodal signaling, a developmental pathway involved in left-right determination"

CAN I DO A 460 PROJECT IN ANOTHER DEPARTMENT?

Several faculty members at Gettysburg College, in science departments other than Biology, can advise Bio 460 projects. There are two ways for a student to do this and obtain Bio 460 credit.

1. A student may enroll in Bio 460 with a Biology faculty member as their formal project research advisor. The actual work, however, may be supervised by the faculty member in the other department, *e.g.,* Environmental Studies, Psychology, Health Sciences.

2. A student may enroll in a 460 course (or its equivalent) in another department under the exclusive direction of a faculty member in that department. In this case, as with a student who completes a course at another institution, the student may petition the department to accept this course in lieu of Bio 460. This petition must be a formal, written request. The department may grant approval *only if the student convincingly demonstrates that the course in the other department is sufficiently similar to a Bio 460 experience.*

In either of these cases, the oral presentation and the submission and approval of the final research paper to the Biology department is required at the end of the semester in which credit is given.

CAN I DO A SECOND 460 PROJECT?

Any student may choose to perform a second Individualized Research project. Since only one such project may count toward the Biology major, students should enroll in Biology 463 (graded S/U). In effect, a student chooses this project as an elective outside of the major. The second Individualized Study project may be an extension of the first under the direction of the same faculty member or it may involve a completely different topic under the direction of a different faculty member. In either case, the students are not obligated (but are highly encouraged) to present their work at the Bio 460 symposium at the end of the semester.

HOW ARE BIO 460 PROJECTS GRADED?

The faculty research advisor, in consultation with the two faculty readers, determines and records the grade that a student receives for his or her 460 project. To assist the faculty member in this task and to make research students aware of their responsibilities, a set of grading guidelines has been agreed to by the faculty of the Biology Department.

Grades for the Bio 460 project will be based on three criteria:

1. **Effort and execution, 40%**. In the short period of time that a 460 project lasts, a great deal of work must be accomplished. It is therefore essential that a student start early, work hard, and make frequent progress reports to the faculty project research advisor. The final grade, therefore, is based, in part, on the level of effort and on the degree of responsibility shown by the student. Since it is not uncommon for a project to generate only a small amount of good data in so short a time period, this category will reward the student who failed to complete the project as planned, but who worked hard, long, and creatively in the attempt.

2. **The final paper, 40%.** No research project is complete until it is "written up." The writing of a formal research paper is, therefore, a very important part of the final grade. The final paper will be judged on its formal style, on the completeness of the reporting of the relevant background literature, on the quality and clarity of the data reported, and on the completeness and aptness of the discussion of that data**. The faculty project research advisor will consider the input of both faculty readers in determining the grade**.

3. **The symposium presentation, 20%.** Scientists must frequently stand before their peers to present and defend their work. The presentation of research to the faculty and students of the Biology Department is an honor and a final opportunity to share an important accomplishment. This grade will be based on the preparation for and organization of the presentation, on the quality of the presentation itself, including its clarity and coherence, and on the quality of responses made to questions asked by the audience. **The faculty project research advisor will consider the input of both faculty readers in determining the grade**.