Senior Project Guidelines

I. Introduction

A. General philosophy.

As stated in the Catalogue, the Senior Project "is not a mere report or semester paper, but a significant piece of independent study, research, or creative work." Indeed, a mandatory comprehensive senior research project is unusual among liberal arts colleges, and this experience distinguishes Allegheny graduates as they embark on professional careers.

More importantly, the successful completion of an independent research project is a milestone in personal development, with merit transcending the context of vocational utility. As with all crucibles of personal growth, the Senior Project evokes a spectrum of feelings over its course, from frustration and disappointment to excitement and acute curiosity. Letting one's efforts be driven by the latter—and not hindered by the former—is a large part of success.

The Senior Project is assessed with respect to: a) the work that is carried out, and b) how that work and its implications are communicated to others. Students are invested with full responsibility for the successful completion of the project, including literature research; documentation and interpretation of results; procurement, proper maintenance, and (in some cases) construction of equipment; troubleshooting; and the deft redirection of approaches not yielding desired results. This is a never-ending cycle requiring constant initiative.

Of course, the research advisor is an integral part of this cycle, but the student should not expect to wait upon the advisor to issue directives. Rather, the advisor should be viewed as an expert resource from whom guidance about specific research issues may be obtained. The advising relationship is a complex dynamic, however, and biochemistry faculty have differing styles, which reflect the diversity of approaches in the discipline. Students are therefore encouraged to be mindful of this when choosing their Senior Project advisor.

B. Goals and Behaviors.

The Biochemistry Program has defined specific goals for the Senior Project, which include:

- exposing the student to cutting-edge laboratory research at the interface between chemistry and biology
- beginning the development of the student's ability to ask interesting and well-defined scientific questions
- furthering the development of the student's ability to work independently
- engaging the student intellectually in a multidimensional biochemical investigation which utilizes fundamental principles in math, physics and chemistry.

Students who undertake such an endeavor should therefore exhibit the following observable behaviors:

- engaging productively and safely in independent research
- communicating scientific ideas in written and oral fashion, both formally and informally
- properly applying the relevant tools (literature, equipment, techniques, software) to the problem at hand.

II. Logistics

These guidelines represent normal practice in the Biochemistry Program. Any departure would have to be approved by the Biochemistry Program after the submission (in the semester prior to enrollment in the first semester of the Senior Project) of a formal request that provides justification for the biochemical nature of the project and for the reason the proposed first reader is the best person to supervise such a project.

A. Academic Credit. Biochemistry has a two-semester Senior Project. Students sign up for 2 hours in the fall (BCHEM 600), followed by 4 hours in the spring (BCHEM 610).

B. Scope of Project. The Senior Project must: a) exhibit scientific merit, b) contain a body of work appropriate for a senior-level research experience, and c) address a scientific problem, question or issue that lies at the interface between chemistry and biology. The exact scope of the project is defined collaboratively through discussion between the student and the research advisor.

C. The Research Advisor (First Reader). The process of assigning the research advisor depends upon which Junior Seminar the student takes (BIOL 580 or CHEM 584). In both cases, students submit a list of choices for an advisor, and assignments are made so as to match students with the most appropriate advisor while paying attention to overall workload in the respective departments. For students taking BIOL 580, an advisor from Biology in the Biochemistry Program is assigned during Biology's "spring sort" of rising seniors (a web-based form in which a student enters preferences for first and second readers). For students taking CHEM 584, an advisor from Chemistry in the Biochemistry Program is assigned as part of the Junior Seminar.

D. The Committee. In addition to the first reader, a student's committee must include one other member of the Biochemistry faculty (the second reader) in a different department from the first reader. These readers are assigned in the spring of a student's junior year. After consultation with the chairs of Biology and Chemistry (to try and balance readerships across faculty) and discussion at a program meeting, readerships are distributed across program faculty. Students are then informed of this additional reader. Students with a first reader in the Chemistry Department are assigned a third reader in the fall semester of their senior year. The Biochemistry program plays no part in this assignment.

III. Specific Guidelines

A. Scope. Anything presented as "Results" must be from research carried out by the student during the senior academic year. Work from summer research or previous independent study—or work by other students—may be included in the thesis, but must be presented as "Background" or "Previous Work" and must be cited accordingly. These results will not be considered for the purposes of grading.

B. Audience. Students are reminded that their Senior Project board is composed of chemists and biologists, but not specialists. Information should be communicated in a way that is understandable to a general scientific audience and not heavily laden with discipline-specific jargon.

C. First Written Document (Progress Report: Chemistry; or Proposal: Biology).

1. Chemistry: This document has many functions, and it should address three main topics. An 'Introduction and Background' section should provide a selective but thorough review of previous work in the field and should hint at the student's comprehensive knowledge in both Chemistry and Biology. In addition, it should show how the student's research fits into this global picture. More importantly, it should naturally substantiate the motivation behind the proposed research (i.e., why is it interesting?) and highlight the ways in which the problem requires knowledge of both biology and chemistry. An 'Experimental Plan' section should outline in detail how the project is to be carried out, and it should include any references that validate the proposed work. This portion should also include any contingency plans—in other words, how might the project be modified if Plan A doesn't provide the desired outcome? Finally, the student is expected to produce results in the first semester, and these should be included in a 'Preliminary Results' section. All supporting information (data, spectra, etc.) should be included and clearly labeled. The report should also include a thorough 'Works Cited' section.
2. Biology: The research proposal is based on a current review of the primary literature relevant to your proposed research. This review should place the proposed research in context, and demonstrate a comprehensive knowledge of the chemical and biological principles necessary to understand that context. We expect the proposal to be well organized, with good syntax and grammar. The proposal should contain 1) an introduction to the topic that includes a literature review of background information relating to the chemistry and biology of the system or pathway, 2) a statement of the objectives and/or hypothesis(es) to be tested, 3) methods, including a detailed experimental design, 4) a budget, and 5) a timetable for completing the project. Your experimental design is expected to be complete, with appropriate controls and replications (if necessary), and statistical analyses (if appropriate) to be used. Methods should be explained in the detail appropriate for subdiscipline. An exhaustive treatment of methods will not compensate for a poor review and vice versa. The timetable should include a list of expectations for the work that you complete during the first semester.

   In addition, a final a progress report is due to the First Reader on the last day of the semester. The progress report should contain a description of the work done on the project during the first semester, including a summary of any relevant data collected, a discussion of problems and/or modifications of the proposed experimental design suggested by the preliminary experiments, and revised timetables, expectations, and "plan of action" for the spring semester.

D. First Oral Presentation (Chemistry) or Proposal meeting (Biology).

1. Chemistry: The student should prepare a ca. 20-minute presentation using PowerPoint giving a condensed background of the topic and focusing primarily on preliminary results. The talk should start from the premise that the committee has read the Progress Report (i.e., not simply rehash the written work), but it should still be cohesive and understandable on its own merit. Students may be interrupted during their presentations for points of clarification. Authors of hastily prepared or poorly organized presentations and/or theses may therefore expect more interruptions. At the conclusion of the formal presentation, students should be prepared for in-depth questions about any and all aspects of the project. These questions may include experimental design issues including, but not limited to, the logic used to determine reaction conditions and solution components, the choice and theory behind instrumentation used, interpretation of data, literature background, or basic chemistry and biology concepts related to the project.
2. Biology: The student will meet together with his/her committee members to evaluate and approve the proposal and agree upon a list of expectations for progress during the first semester. Students do not need to prepare a formal presentation with visual aids, but should be able to provide a brief overview (less than 5 minutes) of their project, if requested by the committee. The committee may ask questions to clarify the background, scope, or methods of the proposed work and to determine the student's preparation to undertake the project.

E. Final Written Document (Thesis). The final written work should address three areas with roughly equal attention: a) an introduction which should be relevant to the results presented and may look very different from the Progress Report or Proposal of the fall semester, depending upon the course of the research, b) results of the project and explicit experimental details about how they were obtained along with any supporting data, and c) interpretation of the results using both chemical and biological principles and a discussion of their significance within the field of Biochemistry. These are not meant to suggest particular headings in the thesis, but rather areas to be addressed. As authors of a scientific thesis, students are expected to interpret their data in a Biochemical context and fully document their results according to the accepted criteria of proof for their subdiscipline. Specific format will depend upon the particular subdiscipline.

In particular the background discussion in the introduction, and the interpretation of the data needs to convince the reader that the student has worked to synthesize their knowledge of biology and chemistry to address the problem at hand. The following are examples of discussions that would indicate an acceptable level of synthesis. This is not an exhaustive list and is meant for the purpose of illustration only.

- Consider a Chemistry project that is designed to measure a property of or prepare a compound. The compound in question should have some demonstrable biological relevance for the project to be considered "biochemical". The introduction should include a discussion of the biological implications of the compound to living organisms in more than a superficial way. Thus some exposition of the metabolic pathways involved or mechanisms of action that the compound has in a living system need to be addressed. Finally the interpretation of the data should highlight

the ways in which the data can be used to further understand the biological implications of the compound of interest.

- Consider a Biology project that is designed to elucidate some aspect of genetic or cellular function by exploring the effect of some mutation or compound on the RNA or protein levels produced by some known biological pathway. Students should take care to include a discussion of what is known about the chemistry of the pathway in question including chemical structures, important chemical interactions and reaction mechanisms where applicable. This discussion at the molecular level should permeate the introduction and background as well as the interpretation of the data obtained.

F. Second Oral Presentations

1. Chemistry: The same guidelines apply as for the first oral presentation, except the focus is almost entirely on results and discussion. If addressed at all, only enough introductory material should be included to contextualize the rest of the talk. Where appropriate, results should be supported with spectra or other instrumental data. The talk should conclude with an indication of what future work might be carried out.
2. Biology: There are two aspects to the Biology oral presentation of the final project. The first is a committee meeting to defend the final written document. This meeting is much like the first proposal defense meeting except that the committee will focus questioning on the entirety of the project and seek to ascertain the level at which the student understands and can interpret the results obtained. The second aspect of the Biology related oral presentation is a formal scientific talk at the Biology Department Senior Project Symposium. Students will be assigned to one of several concurrent sessions in which they will present a ca. 15-minute scientific talk on their project. Several Biology department faculty will be present and will grade the presentation based on the Biology department oral presentation rubric.

G. Assessment. The Senior Project is assessed over three broad categories. 1) the written communication of the project; 2) the oral communication of the project; and 3) the development of the student as a scientist.

1. Chemistry: In both semesters, the senior project is graded on the form and content of the written work (ca. 20%), the organization, thoroughness, and response to questions in the oral presentation (ca. 20%), and on the quality of the work carried out and the competency of the student (ca. 60%). Immediately after the oral presentation, the committee meets in private to determine a recommended grade. The research advisor then meets with the student, at which point the student is told if the project has received a passing or failing grade, but is not told the actual letter grade (this is provided by the Registrar when grades are released). Grades recommended by the committee are reviewed by the entire department after all oral exams have been completed. At this time final grades are assigned to each Senior Project. In addition, grades may be withheld until the student properly attends to his/her laboratory space, including properly storing all samples, disposing of waste, and cleaning equipment and uploads a copy of the final thesis to DSpace.

2. Biology: The first semester grade is based on the quality of the research proposal (30%) and the extent and quality of the progress made on the project as shown primarily in the written progress report, as well as attendance and quality of participation in Senior Seminar (70%). The second semester grade is broken into four parts: 1) the quality of the written project (33%); 2) the quality of the oral defense with the committee (17%); 3) the quality of the oral symposium presentation (17%); and 4) the level of scientific scholarship displayed during the research as evidenced by intellectual curiosity, persistence, flexibility, and participation in the Senior Seminar (33%). The student will receive a written critique from the senior project committee of their efforts including the earned grade after 1) submitting the corrected and bound thesis, 2) giving a symposium presentation, and 3) cleaning their workspace and returning all materials used during the project.

H. Rewrites and revisions.

1. Chemistry: In extreme cases, students may be asked by the committee to submit a rewritten thesis after the oral presentation in order to receive a passing grade. Without the express instruction of the committee, however, rewritten theses submitted after the deadline may be accepted for archival value (DSpace), but will not be considered for the purposes of grading. In other words, an incomplete thesis cannot be 'made up' after the fact.
2. Biology: Immediately following the senior project oral defense, the committee will tell the student whether or not any revisions are required in the written manuscript. However, revised theses will not be considered for the purposes of grading. When these corrections have been made to the satisfaction of the committee, the student must submit a bound (or electronic) copy to their First Reader and upload the finished document to DSpace for archival purposes.