



I. INTRODUCTION

A. General philosophy. As stated in the Academic Bulletin, 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.

Students are fully responsible 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 chemistry 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 Chemistry Department has defined specific goals for the Senior Project, which include:

- exposing the student to cutting-edge research techniques in chemistry
- 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 multi-dimensional chemical investigation

Students completing a Senior Project should therefore exhibit a variety of observable behaviors, which are detailed in the attached rubric.

C. Modification for the 2021-2022 academic year. The Senior Project for the 2021-2022 academic year has been modified to accommodate the flexibility that may be required during a global pandemic, while accounting for the lifting of prior restrictions during the previous academic year. The grant proposal format will be retained for the Fall 2021 semester, where preliminary data collected in the lab can support the hypotheses laid out in the proposal. The Spring 2022 semester will emphasize lab work that tests the hypotheses laid out in the grant proposal while accounting for reviewer comments made on the written document and during the end of Fall semester presentation.

Fall Semester

Grant writing skills are paramount to a successful career in research chemistry and vital to keeping the science funded. The goal of the project is to identify an unanswered question in the chemical sphere of knowledge and convince the reviewers (faculty advisor and committee members) that it is both a question worth answering and a question that the individual student is prepared to answer experimentally. It is important that you are able to demonstrate that the proposed project is feasible. To this end, grant writers include preliminary results to support their hypothesis and demonstrate their capability to complete the proposed project. Proposals submitted for the 2021-2022 senior comprehensive project must include preliminary results generated from work done in the lab.

II. LOGISTICS

A. Academic Credit. Chemistry has a two-semester Senior Project. Students sign up for 2 hours in the fall (CHEM 600), followed by 4 hours in the spring (CHEM 610). Students receive grades for both the fall and spring semester courses.

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) fall within the realm of at least one faculty

member's area of expertise. The exact scope of the project is defined collaboratively through discussion between the student and the research advisor.

C. Choice of Research Advisor. During the Junior Seminar, faculty members present research overviews of current projects, after which students submit three possible choices for a Senior Project advisor. Assignments are then decided by the department as a whole. Once assignments are made, students are encouraged to be in contact with their advisors as soon as possible.

D. The Senior Project Committee. Each Senior Project is evaluated by a three-member committee. The first reader is the student's research advisor; two additional readers are assigned to the student by the department. The written and oral presentations of the project should conform to the format and expectations of the first reader's subdiscipline; however, care must be taken so that the project is presented to an audience of non-specialists. All committee members have significant input in evaluating the project.

E. Biochemistry Majors & Joint Senior Projects. The goals, behaviors, appropriate topics, and meeting schedules of biochemistry majors, self-designed majors, and joint senior projects must conform to the department in which the primary research advisor is a member. Furthermore, the student is expected to abide by the guidelines of the specific group in which they are working.

Biochemistry majors wishing to complete a Senior Project in the Chemistry department must have completed the Chemistry Junior Seminar. The research advisor is assigned through the Junior Seminar, as described above. The second reader, who must be a Biochemistry faculty member outside the Chemistry department, is assigned by the Biochemistry program director. The third reader is assigned by the Chemistry department.

III. SPECIFIC GUIDELINES

A. Scope. Anything presented as "Preliminary 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 proposal, but must be presented as

"Background" or "Previous Work" and must be cited accordingly. These results will not be considered for the purposes of evaluating the progress of the project.

B. Audience. Students are reminded that their Senior Project board is composed of chemists, 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 (Proposal Prospectus). This document has many functions, and it should address three main topics. A prospectus, or pre-proposal is a shorter, condensed version of a proposal. The main goal of the document is to convince reviewers that you have a fundable idea worth expanding on in a larger proposal. Feedback from a prospectus is usually constructive and intended to help strengthen the proposal.

An 'Introduction and Background' section should present the reader with the general research question being addressed in the proposal. It should provide a selective but thorough review of the relevant previous work in the field and should hint at the student's comprehensive knowledge. In addition, it should show how the student's research question fits into this global picture. More importantly, it should naturally substantiate the motivation behind the proposed research (i.e., why is it interesting?).

The student should include an 'Assumptions and Justification' section. This section should provide an argument to support your research question, including evidence that the project is feasible and based in chemical principles. This section should anticipate and address potential conflicts with existing theory and literature. Any assertions or assumptions that the project builds on should be clearly identified. Where possible, verification of the assumptions should be provided either experimentally or from the literature. Assumption that will be tested during the Spring semester should be clearly explained. Any experimental supporting information (data, spectra, etc.) should be included and clearly labeled.

Finally, a 'General Research Plan' section should outline how the project is to be carried out, and it should include any references that support the

proposed work. This requires an understanding of the strengths and limitations of the techniques proposed. Proposed research should only include techniques and instrumentation available at Allegheny College. Any experiments already completed or that are planned for the Spring semester should be clearly identified and outlined. 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?

The report should also include a thorough 'Works Cited' section. Plagiarism can be difficult to identify by oneself in grant proposals and literature reviews. Students are encouraged to consult their advisor if they are at all unsure about what constitutes plagiarism or have questions about academic integrity.

D. First Oral Presentation. The student should prepare a ca. 20-minute PowerPoint presentation giving a condensed background of the topic and focusing primarily on the project justification. The talk should start from the premise that the committee has read the Prospectus (*i.e.*, not simply rehash the written work), but it should still be cohesive and understandable on its own merit. The committee will serve as Reviewers of the proposal prospectus and provide constructive feedback on the likelihood of success. Reviewer comments should be considered and addressed in the final Spring semester written document.

Students may be interrupted during their presentations for points of clarification. Authors of hastily prepared or poorly organized presentations and/or prospectus may 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, which may include experimental design issues, interpretation of data, literature background, or basic chemistry concepts related to 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 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 and discussion of their significance. 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 within the context of their field of study and fully document their results according to the accepted criteria of proof for their subdiscipline. Specific format will depend upon the particular subdiscipline.

F. Final Oral Presentation. 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.

IV. EXECUTION OF THE PROJECT

A. Meetings. Research advisors' styles vary from more directive to more "hands-off", reflecting the diversity of environments within the discipline. Students are encouraged to consider this aspect in their choice of advisor. In all cases, however, responsibility for successful completion of the Senior Project lies with the student.

Some advisors have required weekly group meetings. The format of these meetings varies, but can include opportunities for students to engage the rest of the group in their project and/or to review literature that is relevant to the entire group. These meetings might also provide an opportunity for students to speak both formally and informally and to show adequate intellectual engagement with their chosen field of study. In contrast, some advisors have no formal meetings with students. Some advisors schedule weekly meetings with students one-on-one and some schedule one-on-one meetings only as the need arises. There are no formal meetings with second and third readers.

B. Calendar & Deadlines

1. First Oral Presentation. Students present progress to date and summarize their plan for the spring semester. They also defend their written proposal prospectus (see below). Presentations are scheduled beginning the Monday after Thanksgiving.

2. Written Proposal Prospectus. Students submit a well-written report providing motivation for the project and placing the project in the context of other work in the field. Students must submit an electronic copy of the prospectus (in PDF format) to their Chemistry Senior Project Canvas site by 4:00 pm on the Friday prior to Thanksgiving week. It is the student's responsibility to verify that the file has been properly transferred to the Drop Box folder. *Not submitting the Progress Report on time will result in a failing grade for the first semester of the Senior Project.*

3. Final Oral Presentation. Students present and interpret the results of their research project and explain the significance of their work. They also defend their final grant proposal (see below). Presentations are scheduled for the last two full weeks of classes.

4. Thesis. Students must submit an electronic copy of the thesis (in PDF format) to their Chemistry Senior Project Canvas site by 4:00 pm on the Friday three weeks before finals begin. The file must contain all necessary experimental documentation (e.g., spectra, crystallographic data, etc.) to support the conclusions drawn. Please consult with your research advisor for guidance. It is the student's responsibility to verify that the file has been properly transferred to Canvas. *Not submitting the thesis on time will result in a failing grade for the Senior Project.*

The file must also be uploaded to [DSpace](#) before grades are released. Advisors may request revisions to the thesis (e.g., for accuracy or clarity) before uploading to DSpace; however, the revised document will not be regraded.

5. Rescheduling an oral exam. Times for an oral exam may be changed only under extenuating circumstances. Any change of time must be approved by the entire committee. It is the student's responsibility to arrange the new meeting time and reserve the room.

C. Assessment

The Senior Project grade is dependent upon three broad categories (investment, expertise, and communication), and an acceptable threshold must be achieved in all categories for a passing grade. Please consult the rubric for further guidance.

Immediately after each oral exam, 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. At this point, however, a letter grade has not been assigned. Committee recommendations are reviewed by the entire department after all oral exams have been completed. At this time final grades are assigned to each Senior Project.

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. The release of Senior Project grade is also contingent upon uploading the thesis document to [DSpace](#).

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