

**HARVEY
MUDD
COLLEGE**

To: Senior Research Students '24

From: Professor Haushalter

Date: February 14, 2023

Subject: Senior Research Instructions and Dates

A chemistry major must satisfactorily complete 4 to 6 credit hours of Chemistry 151-152. A student electing the Joint Major in Chemistry and Biology must satisfactorily complete 6 credit hours of Chemistry 151-152 or Biology 193-194.

Please read the attached instructions and outline for Chemistry 151-152 and note especially the deadlines for the first semester report (December 1, 2023) and date of submission of the first draft of your thesis (April 5, 2024).

Retain this document for reference during the year. A copy of this document will be available at:

<https://www.hmc.edu/chemistry/research/>

Turn in the final page of this document, properly completed, to Kim Young (kyoung@g.hmc.edu) in the Chemistry department office in order to confirm your research mentor, by Monday, May 1, 2023.

If you choose to enroll in Biology 193-194, be sure to obtain the relevant guidelines concerning deadlines, reports, drafts, and final copies from the Biology Department.

OUTLINE OF CHEMISTRY 151-152 SENIOR RESEARCH

FALL 2023/SPRING 2024

Learning Objectives

After completing Chem 151 and 152, students will be able to:

- Demonstrate they can independently find and use information pertinent to their research efforts.
- Demonstrate an understanding of the relationship of their project to the current literature.
- Demonstrate an understanding of the broader impacts of their work on society.
- Design and execute an experiment or method to explore an important scientific question and test a hypothesis.
- Analyze experimental results, draw appropriate conclusions and suggest the next steps.
- Communicate findings in oral and written form.
- Master and apply an experimental or theoretical technique at a level beyond that presented in the core chemistry curriculum.

The courses that you have taken in chemistry and other fields provide you with most of the basic concepts and tools necessary to begin an independent research study. Such a study gives you an opportunity to review, transfer, and apply many of the things you have learned. It also provides a unique opportunity to learn a great deal about an area of chemistry of your choice — the kinds of problems that are current in the area and how those problems are approached. Perhaps of greatest importance, a research course gives you a chance to learn more about yourself, particularly how you function in a less structured academic endeavor and some ideas about the kind of chemistry that you like to do. If you have general questions concerning why or how research is conducted, please discuss these matters with members of the chemistry faculty.

1. The following is an outline that provides some advice, some guidelines, and some deadlines that are associated with the course. Senior research is an academic course. The lack of weekly “homework” does not mean that the course requires minimum effort. One unit of credit for research is equivalent to four hours per week spent on the project (laboratory, library, writing). If there is any key to success, it is a well-planned regular effort. Sporadic effort rarely leads to good over-all performance. Your research advisor will strongly encourage, perhaps demand, regular appearance in the laboratory. It is useful to maintain a log of the time that you actually spend working on your research problem. Remember, you need to plan your activities ahead of time to be effective in the laboratory.

2. The scheduling of your senior research time is not something to be left to chance. If you are planning on taking 3 units of research in the fall, your schedule should have 12 hours of time blocked out for these 3 units. Do not plan on “fitting your research in between your other classes.” Your overall experience (and your grade) will suffer if you do that. For example, one student might plan to have two 4-hour blocks for experimental work on Monday and Thursday afternoons, along with two 2-hour blocks for library work and spectral analysis on Tuesday and

Thursday mornings. Another student may be signing up for 2 units, and they have four 2-hours blocks set up for coding, job submission, and results analysis on Monday, Tuesday, Wednesday, and Thursday afternoons. Since this schedule is most certainly a function of what you are doing for research and whom you are working with for Chemistry 151-152, you need to consult with your faculty mentor before settling on a class schedule for each semester. Failure to do this may compromise your ability to complete Chemistry 151-152 in a satisfactory fashion.

3. In September, students in the course will be asked to present brief (ten minute) talks. In this talk you should define your research problem, suggest the method of attack on the problem, and suggest what results might be expected. (This talk should be based on discussions with your instructor and on your own literature review.)

4. You will be required to submit a draft of the introduction to your thesis and an experimental progress report by 5 p.m., Friday, December 1, 2023. You should communicate early with your advisor if this report deadline conflicts with other deadlines you may have. Both the thesis introduction and progress report are important and useful. They provide you with a gauge of your progress and an opportunity to think seriously about the writing of a thesis. Keep in mind that time will be at a premium as the year draws to a close, and plan to work on both the thesis introduction and the experimental progress report throughout the semester. Ideally, a draft of an introduction to your thesis will include a clear statement of the objectives of your project, a rationale for why the project is of interest, a comprehensive survey of the literature (including properly cited references) to establish the background for the project and detail the scope of earlier and/or related investigations, and an outline of the approach to be used for experimentation and analysis. The experimental progress report should not only review progress to date but also outline the proposed investigations for the spring semester. The progress report may serve as a draft for the experimental section of your thesis with detailed descriptions of reagents, procedures, instrumentation, techniques, etc. Please note that both the draft thesis introduction and the experimental progress report are required. Enrollment in the second semester is contingent on submission of these items.

5. A single letter grade appears on the transcript for Chemistry 151-152 and is assigned after the completion of the spring semester. You will receive a grade of “N” at the end of the fall semester, which is a placeholder for the grade that will be inserted at the end of the spring semester. Your instructor will begin forming an assessment of your performance during the fall, so your performance during this period is important. The final grade will reflect such factors as: (1) your effort and progress on the project (particularly in light of the number of research units in which you are enrolled), (2) an evaluation of your department presentation to introduce the project, (3) an evaluation of your final presentation during Presentation Days, (4) the quality of your introduction draft and experimental progress report, submitted in December, and (5) the quality of your final thesis. If you have questions about your performance you should consult with your advisor. A strong performance in Chemistry 151-152 requires continued dedication to and active involvement in the research project throughout the entire academic year.

By the start of the Spring semester, your thesis adviser will provide you with an appraisal of your Fall research activities, including a letter grade that will reflect such factors as: (1) your effort and progress on the project (particularly in light of the number of research units in which you are enrolled), (2) an evaluation of your departmental presentation to introduce the project, and (3) the quality of your thesis introduction draft and experimental progress report. A strong performance in Chemistry 151-152 requires continued dedication to and active involvement in the

research project throughout the entire academic year. In addition, all aspects of the research investigation - experimentation, analysis, literature review, oral and written communication - are considered in awarding grades.

Project Summary

Your senior thesis should begin with a Project Summary that is no more than one-page long. The summary consists of an abstract, a statement on the intellectual merit of your work, and a statement on the broader impacts of the research. Audience: your peers (senior chemistry majors).

The Project Summary should answer the following questions:

- In what way did your senior thesis work advance knowledge and understanding within its own field or across different fields? (Intellectual Merit)
- How might your research benefit society or advance desired societal outcomes? (Broader Impacts)

There should be separate headings for the Intellectual Merit and the Broader Impacts sections. Make sure your name and class year appear at the top of the Project Summary.

Sample Format

Project Summary: (Insert Title of Your Thesis)
(Insert Your Name and Class Year)

Abstract

(Insert one paragraph abstract of the work)

Intellectual Merit

(Insert statement on the intellectual merit of the work)

Broader Impact

(Insert statement on the broader impact of the work)

6. The last day for experimental work for thesis presentation is Thursday, March 28, 2024. A draft of your thesis must be presented to your supervisor by Friday, April 5, 2024. Failure to meet this and the subsequent deadlines may prevent your graduation. (Note that You may continue to perform additional experimental work — after you have finished your thesis.)

7. You will be required to present a short (15 minute) seminar summarizing the nature of your research and your results. It is important that you plan this presentation carefully and rehearse your presentation at least once in the presence of your research supervisor. These presentations are **tentatively** scheduled for Monday, April 29, 2024. The actual date will be announced.

8. You will be required to provide **both** your thesis advisor and Ms. Young (kyoung@g.hmc.edu) with a high-quality (color, where necessary) electronic copy of your thesis in PDF format by 5 p.m., Friday, April 19, 2024.

9. The draft introduction, experimental summary, and final thesis should be prepared as technical documents according to ACS guidelines. Consult *The ACS Style Guide*, 3rd edition (American Chemical Society, 2006, available electronically at [ACS style guide](#) for general guidelines on writing a scientific paper (Chapter 4), for the correct formatting for numerical references (Chapter 14), for guidance on the preparation of chemical structures (Chapter 17), figures (Chapter 15), and tables (Chapter 16), for conventions and usage of numbers and units (Chapter 11), and for other conventions in chemistry (Chapter 13).

The following details concerning the preparation of a thesis should be noted carefully.

- a. Drawings and figures may be included within the text and should have complete captions and be numbered sequentially.
- b. Drawings and/or figures taken from the literature are acceptable with proper attribution.
- c. Elaborate reaction schemes or kinetic pathways may appear on separate pages as figures.
- d. References should be numbered sequentially and presented at the end of the thesis. Consult the online ACS Style Guide for proper formatting ([ACS style guide](#)).
- e. The thesis should be organized as follows:
 - Title page (example attached - format)
 - Abstract - on separate page
 - Introduction
 - Experimental (if applicable)
 - Results/discussion
 - Conclusions and suggestions for future work
 - Acknowledgments
 - References
 - Appendices
- f. Remember, provide the chemistry department with a high-quality (color, where necessary) electronic copy of your thesis in PDF format.

Both good and poor examples of theses can be found on Sakai

Timetable: Senior Research

1. Tue., Sept. 5 & 12, 2023 Introduction to research problem, a 10-minute talk presented by student.
2. Fri., Dec. 1, 2023 First semester progress report due to thesis advisor.
3. Thurs., March 28, 2024 Last day for experimental work on thesis problem.
4. Fri., April 5, 2024 First draft of thesis given to advisor.
Returned to student with comments by Monday, April 8, 2024.
5. Fri., April 12, 2024 Revised draft of thesis given to advisor. Returned to student with comments by Monday, April 15, 2024.
6. Fri., April 19, 2024 Final electronic PDF theses are due by 5 p.m. to both your thesis adviser and Ms. Kim Young (kyoung@g.hmc.edu)
7. Mon, April 29, 2024 Research Presentation–Talk to be presented by student (12-minute talk will conclude with 3-minute Q&A).
8. Sun., May 12, 2024 Graduation!!

DEPARTMENTAL HONORS in chemistry are given to students showing outstanding professional promise as evidence by performance in research, active participation in courses and other departmental activities,* and interest above and beyond the requirements for graduation. Graduation with distinction is awarded by the College Faculty solely on attainment of a fixed GPA—see the HMC catalog.

* teaching assistant in laboratory and grader for chemistry courses; tutoring in chemistry (Academic Excellence); other activities

Characterization of Secondary Organic Aerosol Formed from Catechol and
Guaiacol in a Multiphase Cloud Simulation Chamber

by
Jake Weber

Harvey Mudd
College
Claremont, California

Dr. Lelia Hawkins, Research Director

April 19, 2024

Accepted by the Department of Chemistry in partial fulfillment of the
requirements
for the Bachelor of Science degree.

_____ Research Advisor

Chemistry 151-152 Enrollment Form for 2023/2024

Student Name: _____

Please complete either Section 1, Section 2, or Section 3.

1. I intend to enroll in Chemistry 151/152 and have discussed research opportunities with various faculty. I have selected the following individual to mentor my activities:

Faculty Member Name: _____

Department & Institution: _____

Student Signature: _____

Faculty Member Signature: _____

Research with a non-HMC Chemistry Faculty Member requires the approval of the Chemistry Chair: _____

2. I intend to enroll in Biology 193/194 and have selected the following individual to mentor my activities:

Faculty Member Name: _____

Department & Institution: _____

Student Signature: _____

Faculty Member Signature: _____

3. I intend to enroll in Engineering 112/113 and understand that I must be placed on a clinic team approved by the Chemistry Department to fulfill the requirement of Chemistry 151/152 in the event that there are no chemistry-related Clinic projects. I have discussed Chemistry 151/152 research opportunities with:

Faculty Member Name: _____

Department & Institution: _____

Student Signature: _____

Faculty Member Signature: _____

Please return this document to Kim Young (kyoung@g.hmc.edu)

Chemistry Department Office, Jacobs 1209,

by May 1, 2023