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Department of Chemistry
301 Platt Boulevard | Claremont, CA 91711 | hmc.edu

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To: Senior Research Students ’26

From: Professor Kavassalis

Date: March 11, 2025

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. A student electing the Joint Major in Chemistry and Climate must satisfactorily complete 6 credit hours of Chemistry 151-152.

Please read the attached instructions and outline for Chemistry 151-152 and note especially the deadlines for the first semester report (*December 5, 2026*) and date of submission of the first draft of your thesis (*April 3, 2026*)

Retain this document for reference during the year. A copy of this document will be available at: https://www.hmc.edu/chemistry/research/

Complete the online thesis selection form by **April 9, 2025**

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.

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OUTLINE OF CHEMISTRY 151-152 SENIOR RESEARCH FALL 2025/SPRING 2026

Learning Objectives

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

- Design and execute an experiment to test a hypothesis or answer a specific question.
- 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 your work on society.
- Analyze experimental results, draw appropriate conclusions, and suggest next steps.
- Effectively communicate the findings of their work in oral, visual, and written form.
- Master and apply an experimental or theoretical technique at a level beyond that presented in the core chemistry curriculum.
- Produce a thesis describing an open question in the field of chemistry, its context, a method of addressing that question through experimental work, the results of the study, and pertinent conclusions.

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.

Responsibilities as the thesis student

- Spend eight (2 credits) or twelve (3 credits) hours a week in the lab (writing and lit review are part of this time too, and may not need to be done in “the lab,” but you will need to confirm with your advisor if outside “lab” work environments are appropriate).

- Life happens and the occasional (1-2 per semester) absence is unavoidable (illness, injury, family emergency). In those cases, be sure to let your advisor know when you will not attend lab or be late.
- Failure to comply with the safety policies of Harvey Mudd College, the Chemistry Department, and your lab may be grounds for failing Chem 151 and 152.
- Experimental work must be completed between the hours of 8 am and 5 pm, and no student is permitted to work in the lab alone. You must have a safety buddy within earshot of your lab in Jacobs/Keck (or elsewhere) at all times.
- You must become familiar with first aid resources and emergency protocols within the first two weeks of lab.
- Communicate with your advisor regularly and promptly.
- Make the most of your learning journey, discovering excitement in the process as you take ownership of your project!

Responsibilities of your advisor

Your advisor plays an integral part in guiding and assessing the thesis student. You should be able to expect your advisor to:

- Maintain regular contact: Your advisor should engage in regular communication with you, setting clear expectations for check-ins or meetings, project benchmarks, and be reasonably available for discussions or clarifications each week.
- Provide guidance: Your advisor should offer timely and pertinent advice and feedback on matters related to the project, including experimental design, laboratory techniques, analysis of data, interpretation of results, and thesis drafts.
- Keep track of your progress: Your advisor should supervise your progression towards your thesis goals and remind you of deadlines and agreed upon benchmarks.
- Safeguard student welfare: Your advisor has to ensure student well-being by enforcing safety measures, along with providing access to initial safety and resource training. Regular monitoring of safety compliance is vital in maintaining a hazard-free lab environment and we all have a part to play.
- Foster a conducive learning environment: Your advisor has the responsibility to ensure a safe and inclusive environment that is free from any form of harassment or discrimination.

Advice for planning your senior thesis

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.

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.

Assignments

1. Introductory talk

In September, students in the course will be asked to present brief (ten minute) talks. These talks serve as short summaries of your proposed work and provide the necessary contextual framework so that other chemists can understand the significance of your project. Your advisor should have a copy of the presentation to edit a few days prior (you must confirm in advance what "a few" looks like for your research group).

2. Fall draft of introduction and methods

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 5, 2025**. You should communicate early with your advisor if this report deadline conflicts with other deadlines you may have. *Enrollment in the second semester is contingent on submission of these items and earning a passing grade based on the enclosed rubric.*

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. Consider this draft the beginning of a conversation with your advisor. Although it will be only a draft version of the final document, a shadow grade will be assigned based on the laboratory work accomplished and the written document, keeping the learning outcomes in mind. 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.

In addition, your advisor *may* require a self-evaluation *and* a mentor evaluation to be completed with your draft. These evaluations will aid you in directing your efforts during the spring semester.

3. Spring drafts and final thesis document

The last day for experimental work for your thesis is **Friday, April 3, 2026**. You will have *three* opportunities to submit your thesis document. The first two are drafts, with the intention of building in time for editing and feedback from your advisor. A draft of your thesis must be presented to your supervisor by **Friday, April 10, 2026**. 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*. If the first draft is incomplete, you will not be able to take advantage of the process as intended. *Incomplete drafts are considered C-level work*. The section most often neglected by students is the Discussion of Results section, where you tie your work into the recent work of others in the field. You should compare, contrast, and draw meaning from your work taking relevant literature into account. *Your written document, in its final form, will constitute a significant portion of your final grade.* Consult the Formatting Tips/Style Guide and Project Summary Expectations for further details.

Pro tip: Start with an outline. Use a well-organized outline as the foundation of your thesis. Leave placeholders for data, graphs, experimental details, key references, etc., as they come up throughout the year. Don't wait until you have finished your experiments to start the outline - write the outline early so you can fill in as you go. Giving yourself scaffolding will save you time and stress later.

For more advice, you might try reading Whiteside's "Writing a Paper" (2004, *Advanced Materials*).

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., Monday, April 27, 2026.** The final week should be devoted to polishing and practicing your final presentation.

4. Final Presentation

You will be required to present a short (12-15 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, May 5, 2025. The actual date will be announced. This is the final opportunity for you to share your amazing work. *Your faculty advisor must approve the presentation at least one week ahead of the presentation date* (this means you need a scheduled practice talk).

A-level work requires preparing for this practice presentation by:

- creating a best-effort, polished deck of slides
- practicing the presentation and timing of this best effort *before* coming to your advisor meeting practice talk
- checking the content for accuracy and concision *before* coming to your advisor meeting practice talk
- meeting with your advisor in preparation for your practice talk (this is where partial drafts are appropriate)

This will give your advisor and you time to discuss the content and timing of the presentation. It takes more effort that you may recognize to prepare an A-level presentation.

Pro tip: As you work during the year, keep an open presentation file where you insert placeholders for points you wish to include in the presentation. If you create figures that you like, insert them now with a note about what source files you used to generate them, so you can go back and find them easily later to edit for your presentation.

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Grading

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.

Attached is the Chemistry Department rubric for evaluating thesis work including laboratory and computational work as well as written and oral materials. Please review this rubric closely as you plan for your first semester and revisit the rubric before beginning spring semester.

While each advisor will weight the categories differently depending on the nature of the thesis project, all advisors will expect attention paid to each aspect of the below rubric. Your advisor may also provide additional expectations for what successful participation in their research group looks like, beyond what is written here.

Students should understand that A-level work requires above-and-beyond performance in the capstone experience and that failure to meet passing criteria in the rubric during the fall semester may prevent a student from enrolling in Chem 152, requiring an additional year of enrollment at the college.

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Statement on generative AI

In alignment with the goals and intended outcomes of this thesis course (including independent information sourcing, effective communication, and fundamentally, the production of an original thesis), the use of generative artificial intelligence (i.e. tools like ChatGPT) for producing text in your thesis is not allowed. It will count as an Honor Code Violation. The Harvey Mudd Capstone experience is an integral part of our curriculum, intended to cultivate critical thinking, demonstrate an ability to do original research and practice writing a substantial scientific document. AI that can create text automatically undermines these educational objectives.

All the text in your thesis must be solely your work, reflecting your unique perspective, arguments, and insights, which will be developed through your research. Text that is mechanically produced or derived using generative AI does not constitute your original work (academic journals are increasingly forbidding AI-generated text). However, recognizing that AI can have legitimate and powerful applications in other aspects of the research process, your research advisor may permit some specific uses for your particular thesis project. In instances where approval is given, you are required to offer full disclosure about the nature and extent of the AI usage.

Research, by nature, is a collaborative pursuit that thrives on knowledge exchange, teamwork, and shared resources. However, it is imperative to remember that while collaboration is central to many disciplines, your thesis will be a testament to your unique intellectual journey, delineated through writing that is solely yours.

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Grading Criteria Rubric

The below criteria are assessed in the Fall and Spring by your advisor

	Not passing	**D-Level Work**	**C-Level Work**	**B-Level Work**	**A-Level Work**
Attendance	Student largely fails to attend lab. Absences are not communicated to advisor.	Student regularly misses lab with only some communication .	Student misses lab occasionally but doesn't always communicate with the adviser.	Student occasionally misses lab. Absences are communicated to advisor.	Student fulfills all required lab hours. Rare absences are communicated to advisor well in advance.
Responsiveness and meetings	Advisor struggles to maintain communication throughout the year/semester.	Student communicates with advisor only after multiple attempts. Student misses > four meetings without advanced notice or emergency.	Communication needs improvement. Student often requires more than one attempt by the advisor. Student misses > two meetings without advanced notice or emergency.	Communication could be improved. Student occasionally requires more than one attempt. Student occasionally misses a meeting.	Student is in constant communication with the advisor and is proactive in notifying advisor of progress and challenges. Student does not miss or cancel meetings without advanced notice.

Oral presentations	Student does not give oral presentations and make up presentation is not an appropriate accommodation.	Advisor determines that student is not ready for oral presentation(s) Make up presentation arrangements can be made.	Oral presentations are not sufficiently rehearsed, somewhat unclear, or include some incorrect content.	Oral presentations have been practiced in advance with the advisor. Oral presentations are clear and correct.	Practice presentations include complete and polished slides. Presentation has been practiced in advance of presenting to the advisor. The presentation is clear, concise, and correct.
Intellectual Ownership and Independence	Student completes almost no experiments or methods suggested by the advisor.	Student fails to complete multiple experiments or methods suggested by the advisor.	Student completes most experiments or methods suggested by advisor.	Student completes experiments or methods suggested by advisor and occasionally contributes a suggestion.	Student demonstrates intellectual ownership of the project by *routinely* contributing ideas, solutions, and/or suggesting new experiments or methods.

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Familiarity with Background Literature	Student exhibits no understanding or familiarity with literature provided or found elsewhere.	Student shows limited understanding of literature provided or found elsewhere.	Student is partially familiar with literature provided by the advisor. Has not undertaken independent lit. review.	Student is familiar with literature provided by the advisor.	Student is familiar with literature provided by the advisor and seeks out references beyond those suggested by the advisor.
Experimental Skill, Safety, and Care in Design and Execution	Shows poor understanding of experimental procedures and neglects safety guidelines. Experimental design and execution are poorly thought out, inconsistent, or unsafe, evidencing little comprehension of scientific methods.	Demonstrates limited understanding of experimental procedures. Safety guidelines are occasionally overlooked. Experiments demonstrate a lack of consistency, precision or appropriate scientific methods.	Has basic understanding of experimental procedures and mostly observes safety guidelines. Experimental design and execution show some inconsistencies or lack of thoroughness.	Shows a good understanding of experimental procedures and safety guidelines are largely met. Design and execution of experiments reflect competence and care, but minor lapses or errors may occasionally occur.	Demonstrates thorough understanding of experimental procedures, ensuring safety guidelines are met consistently. Design and execution of experiments, whether in lab, field or computational settings, indicate a high degree of rigor, precision, creativity and adherence to scientific methods.

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Citations	Familiarity with or use of citations in written work and oral presentations is virtually non-existent	Citations are incomplete, improperly formatted, or missing entirely in written work and oral presentations.	Citations are mostly complete and correctly formatted, but may have minor errors in written work and oral presentations.	Citations are primarily correct.	Number, variety, and selection of references in written work and oral presentations indicate the student has a high level of understanding.
Data Management and Lab Notebook Maintenance	Lab notebook shows no evidence of being maintained or used in a coherent manner. Digital files and data management are largely neglected, indicating an inability or failure to properly document and store experimental results.	Lab notebook is incomplete and/or unintelligible. Digital files and data are inconsistently organized or stored, complicating data navigation and the reproduction of experimental results.	Lab notebook is mostly complete but lacks some details or clarity. Digital files and data show some organization and storage efforts, but inconsistencies could pose challenges for data navigation and reproduction of results.	Lab notebook is complete. Most digital files and data are organized and stored adequately. There might be minor difficulties for a new student to reproduce experimental results or navigate the data structure.	Lab notebook is clear and complete. Digital files and data are well-organized and stored securely. A new student could use the lab notebook to reproduce experimental results and easily navigate the data structure.

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Important Dates

1. Tue., Sept. 16 & 23, 2025	Introduction to research problem, a ~10-minute talk presented by student. *(NOTE: these dates may move before the start of the semester while seminar is being scheduled - you will know well in advance when you are presenting)*
2. Fri., Oct. 10, 2025	Thesis motivation draft due to advisor (*optional, by advisor*)
3. Fri., Dec. 5, 2025	Thesis introduction and first semester progress report due to thesis advisor.
4. Fri., Feb. 27, 2026	Revised motivation, introduction and methods due to advisor (*optional, by advisor*)
5. Fri., April 3, 2026	Last day for experimental work on thesis problem (in conversation with advisor).
6. Fri., April 10, 2026	First draft of thesis given to advisor. Discuss with your advisor your group's schedule for feedback.
7. Fri., April 17, 2026	Revised draft of thesis given to advisor.
8. Mon., April 27, 2026	Final electronic PDF theses are due by 5 p.m. to both your thesis adviser and Ms. Kim Young (kyoung@g.hmc.edu)
9. Mon, May 4, 2026	Research Presentation–Talk to be presented by student (12-minute talk will conclude with 3-minute Q&A).
10. Sun., May 17, 2026	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

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Formatting Tips/Style Guide

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

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Project Summary Expectations

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)

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Example Cover Page:

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, 2023

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

_____ Research Advisor