

Master of Chemical Sciences

Student Handbook

University of Pennsylvania



College of Liberal and Professional Studies
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Table of Contents

I.	Introduction.....	3
II.	Program Overview	4
III.	Curriculum	5
IV.	Program Policies	8
V.	Designing A Program and Course Registration.....	16
VI.	Capstone and Graduation Procedures	22
VII.	University Policies and Resources	25
VIII.	Appendices	
	A. MCS Curriculum.....	32
	B. MCS Forms.....	40
	C. Capstone Guidelines.....	42

I. Introduction

The purpose of this handbook is to provide students in the Master of Chemical Sciences (MCS) Program with information vital to the successful completion of the program. In this handbook students will find information on academic requirements, recommended courses, program and University policies, and resources both inside and outside of Penn. This handbook is designed to provide general information and does not supplant official University publications, University web pages, or regular meetings with academic advisors. Students need to plan to meet with their academic advisor at least once per term to discuss their progress and course selection. The MCS Associate Director is available for general, logistical, academic, and career advice. In addition, should students have questions that are not answered here or problems that they cannot resolve, they should consult their academic advisor or the MCS Associate Director immediately.

II. Program Overview

The Master of Chemical Sciences (MCS) at the University of Pennsylvania is a 10 Course Unit (CU) non-thesis graduate program designed to prepare students for various professions in chemistry-related industries.

The MCS is designed to give students a well-rounded, mechanistic foundation in a blend of chemistry topics. The curriculum is structured with a combination of core concentration and elective courses, which allow students to focus on topics best suited to their interests and goals. As a culminating exercise, students must complete an individual capstone project that demonstrates their ability to define a project, develop appropriate methods, complete research, and present results in a clear and concise manner. Many MCS students select a project that complements the profession they plan to pursue.

Students may study in the MCS program part-time or full-time and may take either day or evening courses pre-approved by the student's advisor and/or the MCS Associate Director. Part-time students are expected to complete their degree in no more than four years.

Relationship within the University

The MCS Program is housed in the School of Arts and Sciences (SAS), overseen by the SAS faculty, administered by the MCS Associate Director, and located in the Department of Chemistry. The program is offered through the College of Liberal and Professional Studies (LPS), which is part of the School of Arts & Sciences' (SAS) division of Professional and Liberal Education.

Students enrollment status (part-time or full-time) will determine for which Penn services they are eligible. Full-time students are enrolled in 3 or 4 courses or research courses per semester, while part-time students are enrolled in 1 or 2 courses per semester. Students are permitted to change their status from full- to part-time and vice versa at any point in their career without seeking prior permission. However, international students must be aware that they must maintain their full-time status to meet visa requirements.

III. Curriculum

Students are required to complete at least 10 CUs of graduate-level coursework for the MCS degree. There are two required courses for the MCS program:

- MCS 540 – *Pro-seminar* taught during fall semester of the 1st year, and
- MCS 699 – *Capstone*, which students register for following completion of their research.

MCS 540 – *Pro-seminar*

A required course during a student's first year, this class will review fundamental concepts regarding research design, the scientific method, searching scientific databases, ethical conduct, and professional scientific communication. Students will be required to give oral presentations and submit written assignments. This course will also acquaint students with issues, debates, and current opinions in the study of chemistry, which help them start defining their capstone project.

MCS 699 – *Capstone*

The research project, expected to span two to three terms with advisor approval, will culminate in a written scientific report, which will count as 1 CU towards the degree requirement.

Students also take 4-6 core courses in an area of concentration, which will allow them to acquire the skills necessary to master a sub-discipline and will help them prepare for their final capstone project. Ideally, each student builds on previous academic and professional experience when pursuing a concentration. The academic plan based on the chosen concentration is prepared in consultation with an academic advisor and the MCS Associate Director.

Areas of concentration in chemistry include:

- Biological
- Inorganic
- Organic
- Physical
- Materials
- Environmental Chemistry

Specific courses that fulfill each concentration are listed in Appendix A. Students also register for 2-4 electives in other concentrations in chemistry, physics, biology, or engineering with prior approval of the MCS Associate Director.

Students completing the Environmental Chemistry concentration will complete a minimum of 4-6 CUs in one of four major chemistry disciplines (biological, inorganic, organic, or physical) and then have two choices:

- Add a minimum of 2 CUs in environmental science (either Modeling (M) or Policy (P) as shown in appendix A) as an emphasis, or
- Add a minimum of 4 CUs in environmental science as a second concentration.

In both cases, students will design a capstone project that brings together the chemistry discipline and environmental science concentrations with emphasis on the chemistry aspect of the project. Students will be co-advised by faculty advisors from both the Chemistry and Environmental Science programs.

Students completing the Materials Chemistry concentration will complete a minimum of 2-4 CUs in one of four major chemistry disciplines (biological, inorganic, organic, or physical) and add a minimum of 2 CUs in materials science courses based on the capstone project topic as shown in appendix A. Students will design a capstone project that brings together the chemistry and materials science disciplines.

An optional *Independent Studies* course (MCS 599) provides opportunities to conduct laboratory research in the Department and learn specific analytical techniques appropriate for a future capstone project. The course may be repeated for credit with permission of the instructor, but only 1 CU may count toward the minimum 10 CUs required for the MCS degree.

Program of Study

Students should meet with their academic advisor and MCS Associate Director at least once a semester each semester prior to registering for courses. This is especially important during a student's first semester when an [Academic Planning Sheet](#) is completed. The MCS Associate Director is always available for general, logistical, academic, and career advice.

Below is a sample course schedule for a full-time student completing the MCS degree with an area of concentration in Physical Chemistry.

FALL	COURSE	CUs	SPRING	COURSE	CUs
CHEM 521	Statistical mechanics I	1	CHEM 522	Statistical mechanics II	1
CHEM 523	Quantum chemistry I	1	CHEM 524	Quantum chemistry II	1
MCS 540	Pro-seminar	1	MCS 599	Independent studies	1
SUMMER					
MCS 698	Capstone research	1			
FALL	COURSE	CUs	SPRING	COURSE	CUs
MCS 697	Work on capstone project	0.15	CHEM 525	Molecular spectroscopy	1
			CHEM 526	Chemical dynamics	1
			STAT 500	Applied regression and analysis of variance	1
			MCS 699	Capstone	1
Total CUs	11				

MCS 697 does not count towards the minimum 10 CUs required for the MCS degree.

Capstone Project

The capstone project lasts two to three terms and represents the culmination of an MCS student's graduate study. It reflects each student's concentration and the coursework that prepared him/her to undertake the proposed capstone project. It may also build upon the student's previous academic or professional experience. Under no circumstances will previous work experience exclude students from the capstone requirement. The capstone component may be a choice of a Penn laboratory research project, an off-campus laboratory research project, or a literature-based review project, but ALL

components will require an approved proposal prior to initiation and a completed scientific report (see guidelines in Appendix B).

Students will be guided and evaluated by a committee composed of a primary reader, a secondary reader and the Associate Director. The capstone proposal will be developed by the student in collaboration with the student's academic advisor, and either a secondary reader or an off-site project supervisor. Proposals for the capstone project are due at least 3 weeks prior to the start of the project, typically at the end of the spring semester. Approval from all committee members is required before the project can begin.

Most students are expected to start their capstones at the end of the first academic year in the summer and conclude at the end of the spring semester of the second year. For literature reviews, the time spent on the capstone will vary depending on the capstone proposal. Depending on the capstone option selected, students may begin working on the project as early as the spring semester of their first year in the program. The course grade for capstone credit will be assigned by the academic advisor, taking into consideration feedback received from the secondary reader or an off-site project supervisor (see Sections V and VI and Appendix C for additional details).

NOTE: If a student is currently working in the chemical industry, it is acceptable for them to complete their capstone project with their current employer; however, they must clearly demonstrate what new skills they will acquire through the experience.

INTERNSHIPS: Students who are interested in completing a summer or semester internship will have to include the internship as part of the capstone project. If the internship is not part of the capstone project, students will need to take a leave of absence from the program while completing the internship.

Time to Completion

MCS students may enroll on either a part-time or a full-time basis. Time to completion will vary depending on how many classes are taken each semester and whether summer classes are taken. Full-time students can complete the program in two years. Part-time students typically complete the degree in four years, taking one or two classes per semester. Students are expected to complete their degree in four years. Students needing additional time to complete their degree must petition the Faculty Advisory Committee for permission to continue beyond the four-year rule.

IV. Program Policies

Academic Standards

Students in the MCS program are expected to maintain the highest possible academic standards. To ensure that students are making satisfactory progress toward their degree, the academic advisor and MCS Associate Director every semester review student performance.

The MCS Faculty Advisory Committee has adopted the following requirements for MCS students to remain in Good Academic Standing as they progress toward their degree:

- All students will take a placement test in their chosen concentration prior to registering for fall semester courses during their first year in the program. An academic plan will be devised based on test results, admission status, and career goals using the [Academic Planning Sheet](#). In some cases, a student may be required to take one or more undergraduate courses to better prepare them for graduate-level coursework. Students must complete these undergraduate courses earning a satisfactory grade of B or higher in order to register for graduate courses. Students who do not meet these requirements will not be able to continue in the program.
- Students must take all courses that will count towards the degree requirements for a letter grade. Pass/Fail courses will not be counted toward the degree. The letter grade of “S” also does not count toward the degree.
- Students must maintain a cumulative 2.7 GPA in order to be in good standing and to graduate.
- Students must earn grades of B- or better in all graduate courses; however, one course with a grade of C+ may be counted toward graduation requirements.
- Students must make satisfactory progress with their capstone project as determined by the MCS Associate Director and their advisor (supervisor) to remain in good academic standing.
- When the same course is taken again to meet the academic requirements of the program, both courses and grades appear in the transcript, but only the first course’s CU contributes to the total number of CUs required for the program and only the grade for the first course is included in the cumulative GPA.
- MCS students are limited to one incomplete (I, GR, U, or NR) at a time. Students with two or more incompletes on their transcript will have their registration automatically blocked until they complete those courses.
- Students must follow all guidelines for ethical conduct, research, and publication – please review these resources:
 - [Penn’s Code of Academic Integrity](#)
 - [Penn Handbook for Students: Ethics and Original Research](#)
 - [Responsible Conduct of Research](#) (National Science Foundation)
 - [“On Being a Scientist”](#) (National Academy of Sciences)
- The [Pennbook](#) is a collection of policies that relate to student life at the University of Pennsylvania. These policies govern academic activities such as grading and exams, provide guidance on the use of campus resources, and explain expectations for membership in the university community. Students can refer to [Policy on Common Midterm Examinations](#) and [Rules Governing Final Examinations](#) for additional information.

Students must maintain regular contact with their academic advisor and MCS Associate Director. Academic advisors help students select courses appropriate for their area of concentration and facilitate

career development by helping students build connections on and off campus. Please refer to page 15 for more detailed information regarding academic advising and faculty advisor selection protocol.

Academic Warning

Students will be given an academic warning, delivered via e-mail, if they fail to meet the requirements of Good Academic Standing described above. Specifically, if they have:

- Received one grade of C+ or lower in any course (one course with a grade of C+ may be counted toward graduation requirements).
- Received a semester GPA lower than 2.7 for one semester.
- Unsatisfactory progress with the capstone project.

Students given an Academic Warning may continue in the program without formal review; however, it is recommended that they meet with the MCS Associate Director to discuss strategies to improve their academic performance.

Academic Probation

Students who fail the requirements for Good Academic Standing for multiple semesters or by significant margins as defined below will be placed on Academic Probation; specifically if they have received:

- More than one grade of B- or lower in any course. One course with a grade of C+ may be counted toward graduation requirements; others may have to be replaced or taken again.
- A cumulative GPA below 2.7 for more than one semester.
- Obtaining an incomplete the first semester enrolled in MCS 990
- Consistent unsatisfactory progress with the capstone project.

Students on Academic Probation will be placed on registration hold and required to meet with the MCS Associate Director and their advisor. They must develop a plan to remedy the conditions that placed them on academic probation, and the plan must be approved by the MCS Faculty Advisory Committee. Students will not be allowed to register for courses during their probation without an approved plan in place. Students remedying low GPAs will have an opportunity to register for courses; however, students with 2 or more incompletes will not be permitted to enroll in additional courses until their incompletes have been resolved and grades posted (see below). With the permission of the MCS Faculty Advisory Committee, students may take additional courses in order to increase their GPA or to fulfill requirements in courses where the student received a grade below a "B-".

Program dismissal

Students placed on Academic Probation will be reviewed once per semester thereafter by the MCS Faculty Advisory Committee. If, after a minimum of one semester on Academic Probation, the Committee decides that the student is unlikely to complete their degree program successfully, the student will be sent an academic dismissal letter via email and U.S. postal mail. Receiving two grades of C+ or below may lead to dismissal from the program.

Incompletes

MCS students are limited to one incomplete (I, GR, U, or NR) at a time. An incomplete grade indicates that a student has not completed all the work in a course and has done so with the instructor's permission. An instructor who chooses to grant an extension to a student who has not completed a course by the end of the term may grant either an Incomplete (I) or an Extended Incomplete (II). An Incomplete must be made up within the first four weeks of the start of the next term, and an Extended Incomplete must be made up by the end of the next term (including the summer term). In either case, if the Incomplete is not

made up by the deadline, it will become an F. An Incomplete is made up only when the official grade is received by the LPS Office and recorded by the Registrar's office on the student's official transcript. Once an Incomplete grade is converted to an F, the instructor may change the grade after the student has completed all required work.

Students with two or more Incomplete grades are subject to registration hold and are required to meet with the MCS Associate Director to explain the circumstances of the Incompletes and develop a plan to resolve them. Students with two or more outstanding grades of Incomplete will not be allowed to register for courses; students with two or more outstanding grades of Incomplete who have already registered will be dropped from courses.

Academic Grievances

Evaluation of a student's performance in a course is the responsibility of the course instructor. Students must submit a written appeal to the instructor within the first two weeks of the academic semester immediately following the semester in which the grade was received in case of a dispute in a final grade in a course. The instructor must respond in writing to the student within two weeks of receiving the written appeal. If, after receiving the written response from the instructor, the student still believes that the grade has been unfairly assigned, the student must submit a written appeal to the MCS Faculty Advisory Committee. If the Committee believes the appeal demonstrates evidence of negligence or discriminatory behavior, a sub-committee will be formed to review the student's appeal and make a recommendation to the full Academic Committee. The School of Arts & Sciences and the Provost's Office have policies governing academic grievances. The [Penn Provost's information on Academic Grievances](#) and the [SAS policy for graduate students' grievances](#) contain additional information about the grievance procedure.

Enrollment Status

Inactive Status

Students who do not enroll in courses for four consecutive terms during the fourth term, including summer, will be inactive and will be automatically withdrawn from the program. Students who are withdrawn from the program will be required to apply for readmission to the program. Standard application fees will apply.

Leave of Absence

Students take time away from their studies for a wide variety of reasons including:

- Manage a medical concern
- Fulfill a family obligation
- Pursue career-related opportunities
- Complete military service
- Work on a political campaign
- Completing an internship that is not part of the capstone project

While interrupting their studies to take time away may seem intimidating, a leave is a means to the successful completion of a degree, not a barrier to graduating. More than three quarters of students who take a leave return to complete their degree within two years.

If students are considering a leave, they should take time to think carefully about their goals for their time away and for when they return. Speaking with an LPS program director is an important first step. Depending on their circumstances they may need to get advice from other sources as well. Students taking time away in order to manage a medical condition will discuss the leave with their healthcare provider. Their LPS program director will help them connect with other campus resources as they prepare to take a leave of absence, such as Student Financial Services, Housing, and International Student and Scholar Services.

Students typically take a leave for a full academic year. Individual circumstances may require more or less time; the length of the leave is determined by the school. It is recommended that students on leave remain in contact with their LPS program director and update them about changes in plans. The return from leave process supports students in a successful re-entry to academic life at Penn. When preparing to return, students must consult their LPS program director to complete the required forms and develop a plan that includes connection with appropriate resources.

Requesting a Leave of Absence:

- Students must meet with a program director to discuss a leave request.
- The student must submit a written request for leave of absence, detailing the reasons for the desired leave.
- The leave request will be evaluated by the Program. If the request is approved, the Program will stipulate conditions that must be met by the student before returning from leave.
- The student will be notified with the result of the leave request. The Program may deny any request for leave. In granting leaves, the decision of the Program is final.
- A student on leave may not be enrolled in Penn classes and will not receive credit for classes taken elsewhere during the leave unless special approval by the Program is given. Students on leave may not live in University-owned housing during the term of their leave. In addition, a student may not participate in and/or hold a leadership position in a registered University organization.
- Discontinuance of study without permission from the University does not constitute a leave of absence. Students who have requested a leave of absence for a given semester may still be dropped from the University rolls if their previous term's grades qualify them for this action.

Checklist: Leave of Absence, Drop or Withdrawal

Once a leave of absence or withdrawal has been approved, or they have been dropped, that action will be posted to their transcript. Their PennCard will be deactivated as soon as the leave, drop, or withdrawal has been processed.

Notifications

Be sure to notify all relevant offices of students' leave or drop. These offices may include the following, if applicable:

- [Student Registration and Financial Services](#)
- [Housing and Conference Services](#)
- [International Student and Scholar Services](#) (ISSS)
- [Student Telephone Services--](#)
- [Student Health Service](#)
- [Office of Student Conduct](#)

While Out

During the term of their leave or drop, students may call their program office if they have any questions. Please be aware of the conditions for return outlined in their leave or drop letter, since they will be required to fulfill them before they may re-enroll.

Applying to Return

Students must apply to return from leave or drop by the relevant deadline (for the fall semester, July 15; for the spring semester, November 15; for the summer, April 15). At that time they must fill out a request to return from leave or drop form and show that they have fulfilled all of the conditions for return as outlined in their original letter from their program. To begin this process, they must contact their program advisor.

Return from Leave of Absence

When a student wishes to return from a leave of absence, he or she must submit a request to return by the deadline (July 15 for the fall semester, November 15 for the spring semester and April 15 for the summer), or before the beginning of the relevant Advance Registration period, if the student wishes to advance register. This is done by contacting a program advisor and asking for the request to return from leave form. Any return request submitted to the program advisor later than the above-indicated deadlines may be denied. Timely submission of requests and documentation is a condition of all leaves. The standard length of an LPS leave of absence is one year. Students may request an early return from leave after one full semester on leave, but this request may be denied.

Provisional Admission

Some students seeking admission to the MCS are returning to school after a long absence or have undergraduate records that do not accurately reflect their academic ability. Those applicants may be accepted into the MCS provisionally. Applicants accepted as provisional admits must adhere to the following procedure:

- Full-time students must complete two required core graduate-level courses at Penn in the MCS program *and* the MCS 540 Pro-seminar.
- The student must receive a grade of "B-" or better in all courses and must receive a favorable recommendation from the instructors of core courses.
- If a student takes more than three courses in their first semester, they must receive a "B-" or better grade in all of the courses.
- Students may not receive an Incomplete (I, NR, GR) in any of these courses.

Students who meet these requirements will be fully admitted into the program. If after completing these core courses, students do not meet the academic requirements outlined above, they will not be able to continue in the MCS program.

Conditional Admission

Some students seeking admission to the MCS program may not have met all of the admission requirements that would have prepared them for successful completion of the graduate program. Such students may be admitted conditionally, and will have to satisfy the criteria for full admission into the program as described in their letter of admission. Students who satisfactorily complete the requirements will be fully admitted into the program. Students who do not meet the requirements and deadlines as described will not be able to continue in the program.

Deferred Enrollment

Students who are admitted to the MCS program may defer their matriculation for one year. Students who wish to defer must notify the MCS Associate Director in writing of their intentions as early as possible. It is not necessary for deferred students to reapply. However, students must inform the MCS Program if they enroll at any other institution prior to their matriculation at the University of Pennsylvania, and they must submit final official transcripts of any coursework completed prior to their enrollment at the University of Pennsylvania.

Transfer Credit

Students who enter the MCS program from Penn Chemistry, Non-Traditional Graduate Program, LPS Summer Program or the University's Post-Baccalaureate Undergraduate Studies may count up to 2 graduate-level courses towards their MCS degree. These Penn courses must be submitted to the MCS Faculty Advisory Committee or Admissions Committee for approval prior to the first semester of matriculation in the MCS program. Only courses appropriate to the student's degree program will be considered for approval.

Courses from other graduate programs or completed degrees are not eligible for transfer; however, students may request to waive a core MCS course if a graduate-level course of equivalent content has been taken at Penn. To request a waiver, a student must submit a request form, course description, and syllabus before the first semester of matriculation. The waiver request will be reviewed by the MCS Associate Director. If approved, the student takes an elective or equivalent course to replace the core course. Completion of 10 CUs at Penn are still required to complete the degree.

Courses taken outside of the University of Pennsylvania during a student's matriculation in the MCS are not eligible for a waiver or transfer.

Financial Aid

MCS students have limited eligibility for University-based fellowships, teaching and research assistantships, or scholarships; however, students can seek outside scholarship support (e.g., [National Science Foundation](#), [National Oceanic and Atmospheric Administration](#)). U.S. citizens or permanent residents are eligible to apply for loans through Penn's [Office of Student Financial Services](#). Full-time students (taking 3 or more courses in a semester) may be eligible for full loan support, and part-time students (taking 1-2 courses in a semester) may be eligible for partial loan support. International students are not eligible for loans through the University. The [Center for Undergraduate Research & Fellowships](#) is an information hub where Penn students can find information and support when considering applying for major grants and fellowships. Additional information can also be found in the [Grad Center page](#). MCS students might be eligible to Penn-based competitive funding opportunities:

- [GAPSA Fellowships and Student Travel Grants](#)
- Chisum & Marymount Graduate Fellowships
- Class of 1939 Graduate Fellowship
- Fontaine Fellowships

Research Support

The MCS program does not have funding to support costs incurred during the conduct of student research. Funding for completion of research for the capstone project must be provided by the on-campus academic

advisor and/or the off-campus organization sponsoring the student. Some off-campus location might offer a stipend for MCS students completing the capstone project at their institution.

Additional Policies

Sexual Harassment, Sexual Violence, Relationship Violence, and Stalking Policies

The University of Pennsylvania is committed to providing a safe and healthy environment, free of gender-based misconduct, to all members of our community and visitors to our community. As such, sexual assault, sexual violence, relationship violence, and stalking will not be tolerated. The University has established policies on behaviors that interfere with freedom of thought, discourse and speech, and the attainment of the highest quality of academic and educational pursuits and daily work. In order to ensure the creation of a climate where students are able to thrive and achieve their full potential, the University has developed a wide range of policies, including:

- [Sexual Harassment Policy](#),
- [Sexual Violence, Relationship Violence, and Stalking Policy](#),
- [Consensual Sexual Relationships Between Faculty and Students](#), and
- [Student Disciplinary Procedures for resolving complaints of sexual assault, sexual violence, relationship violence and stalking](#). General inquiries regarding these policies and procedures can be directed to the Office of the Provost, 1 College Hall, Room 122 Philadelphia PA 19104-6381; or (215) 898-7227 (Voice) or provost@upenn.edu (e-mail).

Policies on Mid-Terms and Final Examinations

The [Pennbook](#) is a collection of policies that relate to student life at the University of Pennsylvania. These policies govern academic activities such as grading and exams, provide guidance on the use of campus resources, and explain expectations for membership in the university community. Students can refer to the [Policy on Common Midterm Examinations](#) and [Rules Governing Final Examinations](#) for additional information.

Holidays

The University observes seven secular holidays. The University recognizes that there are several religious holidays that affect large numbers of University community members. In consideration of their significance for many students, no examinations may be given, and no assigned work may be required on these days. The University also recognizes that there are other holidays, both religious and secular, which are of importance to some individuals and groups on campus. Students who wish to observe such holidays must inform their instructors within the first two weeks of each semester of their intent to observe the holiday so that alternative arrangements convenient to both students and faculty can be made at the earliest opportunity. Please refer to the [Policy on secular and religious holidays](#) for more details. Questions or complaints regarding this policy are directed to the Office of the Provost, 1 College Hall, Room 122 Philadelphia PA 19104-6381; or (215) 898-7227 (Voice) or provost@upenn.edu (e-mail).

Confidentiality of Student Records

The University of Pennsylvania complies with Family Educational Rights and Privacy Act (FERPA). The [Confidentiality of Student Records Policy](#) describes the rights and responsibilities of students, faculty and staff regarding the confidentiality of student records. This policy pertains to personally identifiable information contained in education records. Questions or complaints regarding this policy are directed to the Office of the Provost, 1 College Hall, Room 122 Philadelphia PA 19104-6381; or (215) 898-7227 (Voice) or provost@upenn.edu (e-mail).

Non-Discrimination Statement

The University of Pennsylvania values diversity and seeks talented students, faculty and staff from diverse backgrounds. The University of Pennsylvania does not discriminate on the basis of race, color, sex, sexual orientation, gender identity, religion, creed, national or ethnic origin, citizenship status, age, disability, veteran status or any other legally protected class status in the administration of its admissions, financial aid, educational or athletic programs, or other University-administered programs or in its employment practices. Questions or complaints regarding this policy are directed to two different offices:

- [Office of Student Conduct](#)
- Executive Director of the Office of Affirmative Action and Equal Opportunity Programs, Sansom Place East, 3600 Chestnut Street, Suite 228, Philadelphia, PA 19104-6106; or (215) 898-6993 (Voice) or (215) 898-7803 (TDD). For additional information about Penn's [Equal Opportunity and Affirmative Action Policy](#)

V. Designing A Program and Course Registration

Student Advising

The MCS Associate Director will facilitate the selection and assignment of an academic advisor. Each student entering the MCS program will be assigned an academic advisor based on the concentration they have chosen. Academic advisors help students select courses appropriate for their area of concentration and facilitate career development by helping students build connections on and off campus. The academic advisor assigns the final grade for MCS 599 *Independent Studies*, MCS 698 *Capstone Research*, MCS 697 *Capstone Research*, MCS 699 *Capstone*, and MCS 990 *Capstone Continuation* with input from the research advisor. Selecting an academic advisor requires preparation. The recommended minimum preparation prior to students meeting potential research is as follows:

- Visit the Chemistry Department's website to learn about faculty members who could potentially serve as academic advisors based on similar research interests.
- Attend poster session offered New Student Orientation where Penn Chemistry faculty and graduate students present current research opportunities.
- Attend seminars and/or group meetings during fall semester (mid-September through mid-November) when a weekly evening seminar series will feature 15-20 minute presentations given by 2-3 current faculty members. These short seminars are excellent opportunities to learn about research being conducted in the Chemistry Department. Student attendance at these seminars is highly recommended, regardless of their area of concentration.
- Participate in webinars and presentations by representatives of off-campus locations. They will provide an overview of the institution and projects available. These will be offered during MCS 540 *Proseminar*.
- Watch videos of virtual poster sessions and/or scientific presentations of Penn faculty members and off-campus locations posted in the MCS Canvas Community.
- Read recent publications by the professor and their colleagues prior to meeting with them.

Students will receive guidance from the MCS Associate Director who will facilitate the selection and assignment of an academic advisor. Students will submit the [Faculty Advisor on-line form](#) in Canvas Community the name of three faculty members to the MCS Associate Director no later than *the 2nd week of November*. Based on these names and availability of faculty members, an academic advisor will be assigned. The MCS Associate Director will guide the student through the initial course registration, program introduction, and define a Program of Study plan for their MCS career.

Students should meet with their academic advisor and/or MCS Associate Director at least once a semester to discuss their academic progress and choose courses for the following semester. The available worksheet Canvas Community can help define a student's Program of Study and coursework. Students will work with MCS Associate Director and their academic advisor to ensure that all degree requirements are fulfilled, and the worksheet is completed for graduation.

Full-time 1st year students will typically:

- Take 6 CUs of coursework during the academic year, including MCS 540 *Pro-seminar* fall semester
- In collaboration with the academic advisor and capstone supervisor, define a research project, draft and get approval of a proposal spring semester.

Full-time 2nd year students are expected to:

- Be registered in *Capstone Research* courses (MCS 697, MCS 698, MCS 990) while completing the capstone requirement
- Complete their research project, write their paper, and receive a grade for MCS 699 *Capstone*
- Make sure all requirements for graduation are met (see Section V below)

Course Registration Procedures

Course Selection

Appendix A provides a list of approved courses for the MCS program (please see updated revised lists of approved courses in Canvas). Additional chemistry and other types of courses offered at Penn are available online at the University's Course Register. The Course Timetable is available online and lists when courses are offered each semester. Students must receive approval from the MCS Associate Director to register in any course to ensure courses are acceptable for the program and will count towards the degree requirement.

Advance Registration

The course registration process involves two registration periods. Advance registration allows students to enter their requests for courses they wish to take. Students are encouraged to register during this period so that they have the best chance of getting into the courses they prefer. At the end of advance registration, all registration requests are processed, and students can then view in which courses they have actually been enrolled. Check the [LPS Academic Calendar](#) for the exact dates for advance registration.

Registration

The regular registration and add/drop period opens approximately three weeks after the advance registration request period has closed and students have been notified of their schedules. During the regular registration period, students will know immediately whether or not they will be able to enroll in the course they are requesting. The Associate Director will provide permits for students in courses after completing the academic advising sessions and [Academic Planning Sheet](#).

Some important information for students to remember when registering for courses:

- Check with their academic advisor and the MCS Associate Director to be sure the course for which they are registering fulfills a requirement for their degree.
- Consult their primary reader or research supervisor for courses relevant to their concentration and capstone project.
- Courses must be taken for a normal letter grade in order to count toward the MCS degree; "pass/fail" or "audit" are not acceptable options.
- Only courses numbered 400 and above may count toward the degree (the *first* set of three digits after the course subject is the course number (e.g., MCS 540 630).
- As a master's student, permission may be needed from the instructor to register for some graduate courses in other departments or schools. They will need approval from the MCS Associate Director prior to registering in these courses.
- Full-time students enroll in 3 or 4 courses or research courses; students are not permitted to enroll in more than 4 courses per semester.
- Part-time students enroll in 1 or 2 courses per semester.

Auditing Courses

MCS students may audit courses in the School of Arts and Sciences; however, they will be charged tuition and fees at the MCS tuition level. Audited courses will appear on the student's transcript, but no grade will be issued and the course will not count toward the 10 CUs needed to complete the program. Most courses are open to auditors on a space-available basis.

Registering for MCS and Non-MCS Courses and Permits

MCS students may register for graduate courses (numbered 400 or above) in other Penn departments and schools, if those courses are appropriate to the student's program. Students will first consult with their MCS Associate Director to determine if the course is appropriate to their program prior to registering.

Students in the MCS program require permission to register for courses outside the Department of Chemistry. In such cases, students will discuss it with the MCS Associate Director during an academic advising session. They may not be able to register until all students in the home department or school have had a chance to register. Permits will then be issued on a first-come, first-served basis. They can also consult the primary reader or research supervisor for courses relevant to the capstone project.

Students will receive permits for the courses approved by the Associate Director. Courses that require special permission from the department or instructor are indicated in the course timetable as "Permit Required". Students registering in research courses must complete on-line registration form in order to obtain a permit. Permits are obtained from the MCS Associate Director or department offering the course and entered electronically into the Student Record System (SRS). A permit is not a registration. Students must "claim" the permit by actually enrolling in the course through Penn InTouch. After both advance registration and regular registration are complete, the Registrar's Office removes unused permits from students' records.

Course Changes

MCS students are subject to LPS registration and drop/add deadlines, which may be different than deadlines for other schools and departments. Students must consult the current [LPS Course Guide](#) or the [LPS Academic Calendar](#) for deadlines to make registration changes and view financial obligations. Students are able to make changes in Penn InTouch. Adherence to LPS deadlines is strictly observed. Students who need to drop or withdraw from a course beyond the deadline must contact the MCS Associate Director. It may be necessary to provide documentation of the situation that necessitates the drop or withdrawal, particularly if the student is requesting a refund of tuition.

Adding a Course

Students may add a new course through the second week of the term – *but this is not recommended unless the student has been attending the course*. After that, it will not be possible to add a course. Students will use Penn InTouch to add courses during this time and follow the MCS process for enrolling courses.

Dropping a Course

Students may drop a course with no financial obligation until the published deadline in the current LPS Course Guide (approximately two weeks into the term). Students may also drop a course between the second and fourth weeks of the term, but in so doing they will incur a 50 percent financial obligation for the tuition and fees for the dropped course. **Absence from class does not constitute a drop, nor does notifying the instructor.** Students can officially drop a course through Penn InTouch through the second

week of the term. After the second week of the semester, students must contact the MCS Associate Director directly to drop a course. When making registration changes via Penn InTouch, it is always advisable to double check and make sure the changes have taken effect before logging-out. Students may also want to contact the MCS Associate Director to confirm that the dropped courses are no longer on their schedules. **Students who fail to drop a course officially may receive a grade of F and will be required to pay the full tuition rate.**

Changing Grade or Credit Status of a Course

All courses must be taken for a letter grade if they are to be counted toward the minimum CU requirement for graduation. However, students may register for courses that they do not want to count for their program on an audit or Pass/Fail basis. Before doing so, however, they must discuss this with the MCS Associate Director. Once they have done so, students may change their status in a course from credit to audit, from a letter grade to Pass/Fail, or from Pass/Fail to a letter grade until the deadline listed in the current LPS Academic Calendar for "Last day to change grade status in a course". No change is permissible after the published deadline. Auditors pay full tuition and fees.

Withdrawing from a Course

Students may withdraw from a course after the deadline to drop a course has passed (approximately four weeks into the term). To withdraw, students must see the MCS Associate Director, submit a [Withdrawal Form](#) outlining the reasons for the request, and obtain written approval from the instructor. Normally, permission is granted and a W (withdrawal) is recorded on the transcript.

After the published withdrawal deadline, students are permitted to withdraw only under extraordinary circumstances, which must be documented. Students who withdraw from a course have full financial obligation, except in documented cases of illness, military service, or other extraordinary circumstances, when they may petition for a 50 percent refund.

Note: Dropping a course is not the same as withdrawing from a course. Withdrawing from a course occurs after the drop deadline and carries with it full financial obligation. In addition, the student's transcript will have a "W" next to the title of the course. However, if a student drops a course during the normal Add/Drop period, no record of that course will appear on the transcript.

Independent Studies

Students interested in pursuing an individualized study project on campus or joining a faculty member's research team to learn specific laboratory skills can register for MCS 598 or MCS 599 *Independent Studies* only if they have not submitted a capstone proposal for approval. Students first communicate their interests to their advisor and the Associate Director of the MCS program prior to approaching a faculty member, most likely during an academic advising session. They will facilitate the process of identifying an appropriate faculty member for the student. Faculty members are not required to supervise an *Independent Studies* course. An additional laboratory fee is required for MCS 599. This course may be considered part-time or full-time depending on the numbers of hours per week committed to the class (20 hours/week or less will be considered part-time; at least 35 hours/week will be considered full-time). Students interested in exploring a literature review prior to submitting the capstone proposal can register in MCS 598 *Independent Studies Literature Review*. Students must first communicate their interests to their advisor and the Associate Director of the MCS program prior to registering in this course. MCS students may register for up to two *Independent Studies* courses during their academic career; however, only 1 CU for MCS 599 or 1 CU for MCS 598 will count toward the minimum 10 CUs required for graduation.

Students must complete the Online MCS 599 Registration Form <https://www.lps.upenn.edu/form/mcs-598-599>. The MCS Associate Director needs to approve it prior to registering for this class.

Capstone Research and Master's Continuation Registration

Students doing capstone research must be registered in a research course. Under no circumstances are students allowed to be working in a laboratory without being registered in a research course. Students must indicate how many hours a week they will be working on the capstone. That will determine if they will be enrolled full time (section 630) or part time (section 631). Students are considered full-time if they are working 35 hours/week in one of the following Capstone research courses:

- *Capstone Research (MCS 697)* (.15 CU) – May be taken for multiple course unit credit by students developing the research project for the capstone requirement but who will not be completing or presenting the final report. Advanced study and research in various branches of chemistry with the goal of advancing the capstone project. This course is taken by students who are not engaged in intensive preliminary research and have already completed MCS 698. This course does not count towards the 10 CUs minimum. Students must complete the online MCS 697 form <https://www.lps.upenn.edu/form/mcs-capstone-research>.
- *Capstone Research (MCS 698)* (1 CU) – For students initiating the research project for the capstone requirement but who will not be completing or presenting the final report. Only 1 CU will count towards the 10 CU minimum. Advanced study and research in various branches of chemistry with the goal of advancing the capstone project. This course is taken by students engaged in intensive preliminary research immediately after the capstone proposal have been approved. Students must first obtain approval of the capstone proposal and complete the online MCS 698 form <https://www.lps.upenn.edu/form/mcs-capstone-research>.
- *Capstone (MCS 699)* (1 CU) – Required course for students completing the research project and submitting the final report and presentations. Advanced study and research in various branches of chemistry with the goal of completing the capstone project. Student must complete the online MCS 699 form <https://www.lps.upenn.edu/form/mcs-capstone-research>.
- *Master's Continuation (MCS 990)* (.15 CU) – students enroll in this course if they fail to complete their Capstone in the term when they are enrolled in MCS 699. Student must complete the MCS 990 form <https://www.lps.upenn.edu/form/mcs-capstone-research>.

The cost of registration for *Capstone Research (MCS 697)*, and *Master's Continuation (MCS 990)* is less than the cost of a regular course and keeps the student status active (check with the MCS Associate Director for the current tuition rate). Students enrolled in *Master's Continuation* have access to the library and maintain their Penn e-mail accounts. Students are allowed to enroll in this course a maximum of two terms. Students not completing the program requirements after two semesters of *Master's Continuation* may be withdrawn from the program. Students who wish to extend *Master's Continuation* registration beyond two semesters must submit a revised timeline for the capstone completion and a justification for the requested approved by the Faculty Research Advisor at least one month prior to the last day of classes of the semester prior to request of the extension semester. The MCS Faculty Advisory Committee will review the petition and decide if it is granted and under what conditions.

In order to be evaluated and receive a grade for MCS 697 and 698, students must submit a preliminary progress report describing the progress of the research and signed by the advisor. To receive a grade for MCS 699 or 990, students are required to submit a final report, and give an oral and poster presentation.

Student Status

Students with visa, immigration restrictions, and/or loan requirements must be aware of their student status. If devoting a minimum of 35 hours/week, student's can be considered full-time if they are enrolled in:

- 3 or 4 courses in a single semester
- *Capstone Research* (MCS 697)
- *Capstone Research* (MCS 698)
- *Independent Studies* (MCS 599)
- *Capstone* (MCS 699)
- *Master's Continuation* (MCS 990)

If a student is enrolled in two or fewer courses in a single semester (other than those described above) or devoting less than 35 hours/week in the capstone, they are considered part-time. Students who meet the requirements of a full-time student are automatically enrolled in Penn's student health insurance coverage unless they show proof of coverage through another source. Students who are enrolled in less than 2 CUs per semester will become ineligible for federal student loans.

VI. Capstone and Graduation Procedures

Faculty Readers and Project Mentors

Students will be guided and evaluated by a committee composed of two faculty / expert academic readers and the Associate Director. They will help the student develop the capstone project proposal, approve both the proposal and the final scientific report, and will ultimately assign a grade for MCS 699. A more detailed description of the readers' roles and responsibilities is included in Appendix C. A graduation checklist is included in Appendix B.

Students are encouraged to identify their committee members as early as possible in their career. If they are having difficulty identifying faculty readers, the MCS Associate Director can recommend likely prospects among the faculty. However, it is the student's responsibility to contact the potential readers and discuss their project ideas in depth.

The proposal must be submitted to the committee members for final approval *prior to* the student beginning their research work, otherwise the work may not count towards the degree.

Capstone Project

It is expected that the development of the capstone project lasts two to three terms and represents the culmination of an MCS student's graduate study. Under no circumstances will previous work experience exclude students from the capstone requirement. The student's research project will focus on a topic they decide upon in consultation with their academic advisor. They will need to show a grasp of the theoretical underpinnings of the research they undertake and be able to justify the reasons for the research. The capstone may be a choice of a Penn laboratory research project, an off-campus laboratory research project, or a literature review or data management-based project, but ALL components will require an approved proposal prior to initiation, a complete scientific report, as well as oral and poster presentations. Posters will be put on display at the end of the academic year for faculty and students to view during a special event prior to graduation.

Most full-time students are expected to start at the end of the first academic year in the summer and conclude at the end of fall semester of the second year. Depending on the capstone option selected, students may begin working on the project as early as the spring semester of their first year in the program. For literature reviews, the time spent on the capstone will vary depending on the capstone proposal. Students enroll in *Capstone Research* courses (MCS 698 first then MCS 697) while they work on their project but are not completing or presenting the final report. Students register for *Capstone Research* (MCS 698) while engaged in intensive preliminary research, the semester they first start developing the capstone project. Students register for *Capstone Research* (MCS 697) while completing the capstone project but not engaged in intensive preliminary research. Students register for MCS 699 *Capstone* during the semester a final grade will be assigned. The course grade for capstone credit (MCS 699) will be assigned by the primary reader, taking into consideration feedback received from the secondary reader. Students who are interested in completing a summer or semester internship will have to include this work as part of the capstone project. If the internship is not part of the capstone project, students will need to take a leave of absence from the program while completing the internship.

Registering for the Capstone

Before a student begins the capstone project, a Capstone Project Proposal must be submitted to the MCS Associate Director. **This proposal must be approved by all committee members prior to the student beginning their research work.** Final capstones submitted without prior approval of subject matter and approved advisors, may not be accepted for completion of the degree requirements. Students register for MCS 699 *Capstone* during the term that they are finishing the research project, submitting the final report and presentations the semester, and receiving a final grade. Please refer to **Appendix C** for more information.

Writing the Capstone

The capstone may take one of two forms: a review paper based on a specific topic covered in the literature or a scientific report based on research completed. While it is not necessary that the work be publishable in a scholarly journal, this is strongly encouraged.

Capstone and Graduation Timetable

Please note the timeline for key degree deadlines below, and **allow plenty of time for review, feedback, and revisions** of proposals and final reports!

Activity	Dates
Copy of approved capstone proposal due in MCS office	Last day of classes in the term prior to the term the student intends to initiate the capstone project
Graduation application	Spring Term: Feb 1 Summer Term: Jun 1 (Feb 1 to participate in ceremony) Fall Term: Oct 1
Capstone project oral and poster presentation	No later than three weeks before the last day of classes
Capstone project report completed and approved	No later than one week after the last day of classes
Project supervisor evaluation	Submit signed form to MCS office no later than one week after the last day of classes

Forms

There are four forms, which need to be completed for the Capstone (all in Appendix C and in the MCS canvas community):

- [Capstone Project Proposal](#)
- Project Supervisor Evaluation
- Capstone Project Evaluation /MCS 699 course grade
- [Scholarly Commons Application](#) (to publish the student's work in Penn's online repository)

Graduation Procedures

Students who fail to complete their capstone project during the spring semester prior to graduation, must remain "active" in all subsequent terms in order to complete their MCS program and graduate. The final capstone paper is due to the committee members **at least two weeks prior to the end of term** (students must check with these individuals to see if they will need additional time for review and grading).

Students who have not submitted their final capstone paper and Certification of Completion of Capstone Project/Course Grade form within one week of the end of classes in the semester for which they intend to graduate will be registered automatically for *Master's Continuation* (MCS 990) in the subsequent term and for each and every term thereafter (including summer) until the completed and approved capstone is submitted to the MCS program. **Students are allowed to enroll in *Master's Continuation* (MCS 990) a maximum of two terms.** Student will be placed on academic probation if they need enroll in a second term of *Master's Continuation* (MCS 990) as it is an indication that they have not made significant progress in the capstone project. Students not completing the capstone requirements after two semesters of *Master's Continuation* may be withdrawn from the program.

Students must reapply online for graduation in the term during which they plan to complete the capstone. Thus, if a student does not complete the capstone in the semester in which they originally applied, they must re-apply for graduation in the next semester. The student's graduation date will be posted for the term in which they complete their capstone and receive a grade.

The [Graduation Application Form](#) will be completed online at the beginning of the term in which the student intends to complete the program and graduate. Specific deadlines to apply for graduation can be found on the web page where the Graduation Application Form is provided.

VII. University Policies and Resources

Enrollment Status

MCS students who are enrolled for three courses per term are considered full-time students and will be billed the full general fee. This fee covers access to many of the services described below. MCS students enrolled in one or two courses per term are considered part-time students. However, students enrolled in the *Capstone* (MCS 699), *Research* (MCS 698, MCS 697), *Independent Studies* (MCS 599 working at least 35 hours/week), or *Master's Continuation* (MCS 990) courses are considered full-time. Under no circumstances are students allowed to work in a laboratory without being registered in a research course. Students will register for these courses by completing an on-line form in the MCS Canvas Community.

Student Identification

Once a student is enrolled at Penn, a student ID number (Penn ID) will be issued, and this ID is used for registration and other transactions throughout the University. Students should never give out their social security number via email or fax. Once matriculated, the Penn ID number or the last four digits of the social security number will be sufficient for identification.

PennCard

The [PennCard](#) is the official University of Pennsylvania identification for students, faculty, and staff. The PennCard provides access to University facilities, services, cash convenience and more. To obtain this card, students will bring a valid form of photo ID (e.g., driver's license or passport) to the PennCard Center located upstairs in the Penn Bookstore on the corner of 36th and Walnut. Only active students registered for courses in the current or upcoming term may receive a PennCard, which must be carried at all times.

PennKey

A [PennKey](#) is required to authenticate, or verify, an individual's identity for many of Penn's networked computer systems and services. Authorized users need a PennKey and password to access such resources as Penn InTouch (course registration), Canvas (used in most classes), certain library resources, and public campus computers. A PennKey is also required to obtain a Penn email address. New students will receive either a letter, an email, or a link with information on how to create a PennKey and password within a few days of their admission to the MCS program.

Penn InTouch

[Penn InTouch](#) provides secure access via the Internet to a variety of information, including:

- Online registration and schedule planning tools
- Academic records and transcript orders
- Student billing and payment information
- Financial aid application status and awards
- Student loan application status, disbursements and loan history
- Student employment/work-study information and job listings
- Updating emergency contacts and address information
- Privacy settings for release of academic and financial information to parents and others

- Direct Deposit enrollment for student refunds and work-study payroll.

Email

All students enrolled at the University of Pennsylvania are eligible for a Penn email address free of charge. Even if the student plans to use a non-Penn email account, they must also establish a Penn address. The MCS Associate Director will send program information to the Penn address and also contact students with important information through this system. Course instructors will be given this address as well and will contact students in this way. Students may forward email from their Penn address to another account through Penn's webmail site but must remember that official communications will only be sent out to the Penn email. Instructions on how to create and use a Penn email account are available through [SAS Computing](#).

Academic Support Services

The [Weingarten Learning Resources Center](#), located at 3702 Spruce Street, Suite 300, provides professional consultation services for skills such as academic reading, writing, study strategies, and time management. This academic support is provided through a variety of services and programs including the very popular series of study skills workshops offered at the beginning of each fall and spring term for LPS students. Special workshop series is also offered for international students. For more information about the Weingarten Learning Resources Center, visit their website or call 215-573-9235.

Other [Academic Support Services](#) include:

- [Grad/Undergraduate Mentoring Program](#) – Provide guidance for an undergraduate student
- [Upward Bound](#), [FGLI](#) and [Veterans Upward Bound](#) – Academic and financial services for low-income and first-generation college students and veterans
- [Marks Family Writing Center](#) – For support with writing assignments

Room reservations

Students can reserve rooms in our building for any academic purpose (e.g., study session with a recitation or lab section, a group meeting, presentation practice session). There are some rooms that are under our department control, and some that are called “central pool” classrooms. The latter are controlled by the Registrar but are still available for our use.

- Department controlled rooms include:
 - Vagelos 2000, 3000, 4000
 - Faculty Conference Room
 - Lynch Lecture Hall
 - Nobel Laureate Hall

For these rooms, contact the Chemistry receptionist at the front desk to reserve them. Students may want to do this in person to ensure that the room they want is available for the day and time that they need it. The receptionist can always tell them which room is available, if their first choice is already reserved.

- Central pool classrooms include:
 - Classroom 109 (off the lobby)

- Classroom 119 (off the lobby)
- Classroom 514 (5th floor by elevators)
- Classroom B-13 (in the basement)

For the central pool classrooms, please keep in mind that during the regular school year, these rooms are heavily used for classes throughout the University, not just the Department. To reserve these rooms, students must request them online: [Penn ISC Classroom Technology Services](#).

Student Disabilities Services

The Office of Learning Resources includes the [Student Disabilities Services](#) (SDS), which provides comprehensive professional services and programs for students with disabilities to ensure equal academic opportunities and participation in University sponsored programs. Reasonable accommodation to a qualified student's known disability may be provided to assure equal access. Penn invites students with disabilities to identify themselves at any time during their course of study as enrolled students. Although the self-identification process is confidential and completely voluntary, it is required for those requesting accommodation. SDS may be contacted via their website, by phone at 215-573-9235, and by TDD at 215-746-6320.

Career Counseling

The University provides career counseling through the [Career Services](#) office for full-time MCS students or those finishing their final semester prior to graduation. A wide variety of resources are available online that can help students explore career development strategies, write effective cover letters and resumes, and hone their networking and interview skills. To make an appointment with a counselor, visit the Career Services website or contact the office at 215-898-7531. The Career Services office is located on the ground floor of the McNeil Building (3718 Locust Walk).

Student Health Information

The University provides outpatient medical care to students through its [Student Health Service](#) (SHS). The SHS offers an array of clinical services, including initial and follow-up treatment of acute medical illness and injury, management of chronic health problems, health screening and preventive care. All full-time students must carry coverage for care at SHS, either through payment of the Clinical Fee or through enrollment in the [Penn Student Insurance Plan](#) (PSIP). Full-time students who have private or employer-sponsored insurance do not have to purchase the student plan, but they must still pay the clinical fee for coverage at SHS. Coverage for the Student Health Service (either through the clinical fee or through enrollment in PSIP) is optional for part-time students.

In addition to providing medical care and preventive medicine services, SHS offers special workshops on stress reduction and smoking cessation, as well as travel information, immunizations, acupuncture, massage, and other services.

Immunization Requirements

Students enrolled in the MCS program are part of the University community and benefit from the University's efforts to provide a safe and healthy environment. All MCS students are required to comply

with [immunization requirements](#) upon first enrolling in credit courses. To comply, students must complete an [Immunization Worksheet](#). ***Students who are not in compliance with the University's immunization requirements will be placed on registration hold for the spring semester.***

Students are advised to call SHS at 215-746-3535 or consult their website for the most accurate and up-to-date information on student health requirements. The SHS office is located at 3535 Market St, Suite 100. They should be sure to bring their PennCard and insurance information whenever they go for medical care. For hours and other information refer to the Student Health website.

Student health insurance does not include dental insurance. The University of Pennsylvania has a dental school, which offers low-cost dental insurance to the University community.

Counseling and Psychological Services

[Counseling and Psychological Services](#) (CAPS) are for students of the University of Pennsylvania. All counseling services are free and confidential. Their office hours are 9am -5pm, Monday, Tuesday and Friday and 9am – 7pm Wednesday and Thursday. If students have an emergency that cannot wait until the next day, they should call the Hospital of the University of Pennsylvania (HUP) operator at 215-349-5490 and ask for the CAPS clinician on call. Please note that this HUP operator number is only for emergencies. To call regarding an appointment, a prescription or other non-urgent issues, please contact CAPS during regular office hours at 215-898-7021. CAPS is located at 3624 Market Street #1.

CAPS provides a variety of counseling services, including individual therapy, couples/family therapy, group therapy, crisis management, referral services, and outreach and prevention.

A variety of workshops throughout the year are also offered by CAPS, and topics have included:

- Stress Management
- Coping with Depression
- Crisis Intervention
- Body Image Issues
- Suicide Prevention
- Surviving Trauma
- Effective Communication Skills
- How to Help a Friend
- Secrets to Grad School Success
- Respecting Diversity
- Test Anxiety
- Grief and Loss Issues

All workshops are free of charge for members of the Penn community. Please check their website for details.

Student Financial Services

Student financial aid, including applications and disbursement of money, are handled through [Student Financial Services](#). Their offices are located in room 100 of the Franklin Building at 3451 Walnut Street. Call 215-898-1988 or visit their website for deadlines and other information.

Penn Bookstore

Located on the corner of 36th and Walnut Street, the [Penn Bookstore](#) carries textbooks and trade books as well as stationery, art supplies, school supplies, gifts, and other items. The [Computer Connection](#), within the Bookstore, also carries computers, software, and computer supplies at student rates. Visit the website or call 215-898-7595 for store hours and additional information.

Computer Resources

[Information Systems and Computing](#) offers advice, training, consulting services and computer support to Penn students living on campus. The [Tech Center](#) serves as a distribution center for supported software to any person with a University affiliation and is located on the Ground Floor of Van Pelt Library. Students will need their PennCard for access to the building. The Tech Center is open Monday through Friday from 9am to 5pm in Room G-102 of the [Van Pelt Library](#), 3420 Walnut Street. During these hours, support is available in-person, as well as over the phone (215-898-9720) and through email (techcenter@upenn.edu). Students can also use the services of [Penn Chemistry Computing](#).

Libraries

The University of Pennsylvania has several [libraries](#). Van Pelt Library, the main University library, is located at 3420 Walnut Street (the entrance is on the College Green across from College Hall). There is a wealth of information and resources available through these libraries, including the [Weigle Information Commons](#) (WIC), which is located in the Van Pelt Library and offers training in various applications, like Excel and Photoshop. Through WIC, students can reserve study rooms, use the Digital Media Lab to print posters, and borrow equipment.

Recreation Facilities

MCS students have access to all of the [recreation facilities](#) available to the University community. For information regarding hours, fitness programs, locker rentals, etc. please visit their website.

Information for International Students

International students are responsible for maintaining their proper student visa status. They are responsible of complying with administrative and registration deadlines that might defer from the registrar and MCS. The office of [International Student and Scholar Services](#) (ISSS) is an important resource for all international students. Any questions about visas, international student tax issues, etc. should be directed to their ISSS advisors. They are located at 3701 Chestnut Street, Suite 1W and can be reached by calling 215-898-4661 or sending an email to iss@pobox.upenn.edu.

Federal regulations require that F-1 and J-1 international students register their presence at Penn. This process, known as the check-in procedure, has two steps: 1) completion of the New Student Arrival Information online form and 2) attendance at one of the Immigration Document Review and Presentation Sessions. Both steps must be completed after arrival in the United States but within 20 days of the program start date listed on Penn's I-20 or DS-2019. F-1 transfer students must complete the new student check-in process within 15 days of the program start date listed on Penn's I-20.

The [ISSS handbook](#), included in the Pennbook, has a lot of helpful information for international students new to Penn.

If students are planning to travel and would like a letter stating that they are a current student in good standing, please send an email to the graduate coordinator at chemgrad@sas.upenn.edu to request the letter.

International students with English as a second language are encouraged to use the resources available through the [English Language Programs](#) (ELP). They offer testing, consulting services, and cross-cultural training in addition to language instruction. The MCS Associate Director can refer international students to ELP on a case-by-case basis based on TOEFL scores and/or advising sessions. In some instances, it will be recommended that students complete an Oral Proficiency Interview (ACTFL OPI) administered by ELP staff and, based on the results, take English courses at the appropriate level. Students will be responsible of covering the cost associated with courses and testing.

Office of the Ombuds

The Office of the Ombuds assists individuals in finding solutions to problems that they may not be able to resolve through normal channels. The office is concerned with safeguarding individual rights and promoting better channels of communication throughout the University. It is independent of all administrative offices. The Ombuds is not an advocate for any one individual or group. He or she is an advocate for fairness, adherence to University regulations, due process, and personal responsibility.

The Ombuds does not have decision-making authority, but serves as an impartial mediator in helping to resolve disputes. The Office supplements, but does not replace, any existing grievance mechanisms or modes of redress. It can and does recommend changes in the existing rules and practices when necessary. The Office of the Ombuds may be reached at 215-898-8261.

Code of Academic Integrity

Inasmuch as the standing of an educational institution and the value of a degree from that institution are dependent upon the integrity of study and research carried on at that institution, the [Code of Academic Integrity](#) is drawn to make clear the policy of the University concerning academic honesty.

Students must follow all guidelines for ethical conduct, research, and publication – please review these resources:

- [Penn's Code of Academic Integrity](#)
- [Penn Handbook for Students: Ethics and Original Research](#)
- [Responsible Conduct of Research](#) (National Science Foundation)
- ["On Being a Scientist"](#) (National Academy of Sciences)

The [Pennbook](#) is a collection of policies that relate to student life at the University of Pennsylvania. These policies govern academic activities such as grading and exams, provide guidance on the use of campus resources, and explain expectations for membership in the university community. Students can refer to [Policy on Common Midterm Examinations](#) and [Rules Governing Final Examinations](#) for additional information.

Sexual Harassment, Sexual Violence, Relationship Violence, and Stalking Policies

The University of Pennsylvania is committed to providing a safe and healthy environment, free of gender-based misconduct, to all members of our community and visitors to our community. As such, sexual assault, sexual violence, relationship violence, and stalking will not be tolerated. The University has established policies on behaviors that interfere with freedom of thought, discourse and speech, and the attainment of the highest quality of academic and educational pursuits and daily work. In order to ensure the creation of a climate where students are able to thrive and achieve their full potential, the University has developed a wide range of policies, including:

- [Sexual Harassment Policy](#),
- [Sexual Violence, Relationship Violence, and Stalking Policy](#),
- [Consensual Sexual Relationships Between Faculty and Students](#), and
- [Student Disciplinary Procedures for resolving complaints of sexual assault, sexual violence, relationship violence and stalking](#). General inquiries regarding these policies and procedures can be directed to the Office of the Provost, 1 College Hall, Room 122 Philadelphia PA 19104-6381; or (215) 898-7227 (Voice) or provost@upenn.edu (e-mail).

Confidentiality of Student Records

The University of Pennsylvania complies with Family Educational Rights and Privacy Act (FERPA). The [Confidentiality of Student Records Policy](#) describes the rights and responsibilities of students, faculty and staff regarding the confidentiality of student records. This policy pertains to personally identifiable information contained in education records. Questions or complaints regarding this policy are be directed to the Office of the Provost, 1 College Hall, Room 122 Philadelphia PA 19104-6381; or (215) 898-7227 (Voice) or provost@upenn.edu (e-mail).

Nondiscriminatory Policy

The University of Pennsylvania values diversity and seeks talented students, faculty and staff from diverse backgrounds. The University of Pennsylvania does not discriminate on the basis of race, color, sex, sexual orientation, gender identity, religion, creed, national or ethnic origin, citizenship status, age, disability, veteran status or any other legally protected class status in the administration of its admissions, financial aid, educational or athletic programs, or other University-administered programs or in its employment practices. Questions or complaints regarding this policy are be directed to the Executive Director of the Office of Affirmative Action and Equal Opportunity Programs, Sansom Place East, 3600 Chestnut Street, Suite 228, Philadelphia, PA 19104-6106; or (215) 898-6993 (Voice) or (215) 898-7803 (TDD). For additional information about Penn's [Equal Opportunity and Affirmative Action Policy](#). Students can also find support and information in the [Office of Student Conduct](#).

Student Responsibility

While advisors, faculty, and staff will assist the student in every aspect of their graduate study, it is the responsibility of the student to ensure that all steps and necessary paperwork have been completed and submitted to the MCS Associate Director and/or LPS as appropriate. Grant proposals, awards, accepted publications and other records of achievement must also be submitted to the Associate Director of the MCS program.

Appendix A

MCS Curriculum

Academic Planning Worksheet

A minimum of 10 CUs must be completed at the University of Pennsylvania.

Pro-seminar 1 – 2 CUs

- MCS 540 (Pro-seminar I) (1 CU)
- MCS 541 (Pro-seminar II: Capstone Proposal Preparation) (0.5 CUs)
- MCS 542 (Pro-seminar III: Capstone Report Preparation) (0.5 CUs)

Capstone – 1-2 CUs

- MCS 697 (Research; does not count towards the 10 CUs, 0.15 CUs)
- MCS 698 (Research)
- MCS 699 (Capstone Seminar)
- MCS 990 (Master's Continuation; does not count towards the 10 CUs, 0.15 CUs)

Area of concentration – Students can select 4–6 CUs from each list

Biological (required)

- CHEM 451 (Biological Chemistry I)
- CHEM 452 (Biological Chemistry II)
- CHEM 555 (Macromolecular Crystallography: Methods/Applications)
- CHEM 557 (Mechanism of Biological Catalysis)

Biological (recommended, do not substitute required courses)

- CHEM 559 (Biomolecular Imaging)
- CHEM 567 (Bio-inorganic Chemistry)
- CHEM 580 (Biological Physics)

Inorganic

- CHEM 462 (Inorganic Chemistry II)
- CHEM 564 (Organometallics)
- CHEM 565 (Main Group Chemistry)
- CHEM 567 (Bio-inorganic Chemistry)

Organic

- CHEM 441 (Reactions, Mechanisms, and Stereoelectronic Effects)
- CHEM 443 (Modern Organic Synthesis)
- CHEM 451 (Biological Chemistry I) or CHEM 541 (Physical Organic Chemistry)
- CHEM 564 (Organometallics)

Physical

- CHEM 521 (Statistical Mechanics I)
- CHEM 522 (Statistical Mechanics II)
- CHEM 523 (Quantum Chemistry I)
- CHEM 524 (quantum Chemistry II)
- CHEM 525 (Molecular Spectroscopy)
- CHEM 526 (Chemical Dynamics)

Materials (Organic Track)

- CHEM 441 (Reactions, Mechanisms, and Stereoelectronic Effects)
- CHEM 443 (Modern Organic Synthesis)
- 2 materials courses

Materials (Inorganic Track)

- CHEM 462 (Inorganic Chemistry II)
- CHEM 565 (Main Group Chemistry)
- 2 materials courses

Materials (Biological Track)

- CHEM 451 (Biological Chemistry I)
- CHEM 555 or CHEM 557
- 2 materials courses

Electives for Environmental Science – 2-4 CUs

Modeling (M)

- ENVS 541 (Modeling Geographic Objects)
- GEOL 528 (Aqueous Geochemistry)
- ENVS 605 (Bioremediation)
- GEOL 618 (Fundamentals of Air Pollution)
- GEOL 656 (Fate and Transport of Pollutants)
- GEOL 663 (Geochemical Modeling)

Policy (P)

- ENVS 410 (Clean Water-Green Cities)
- ENVS 507 (Wetlands)
- ENVS 616 (Risk Assessment: Science & Policy Changes)
- ENVS 624 (U.S. Environmental Policy – Analysis of NEPA)

Additional Electives – 1-2 CUs minimum

- CHEM 7xx (This course if offered under different titles, is worth 0.5 - 1 CU, and students may register for it more than once.)
- MCS 598 (Independent Studies: Literature Review)
- MCS 599 (Independent Studies: Research Techniques)
- Other: _____

MCS 697 does not count towards the 10 CUs minimum requirement for the degree.

MCS COURSE LIST

NOTE: This is a comprehensive list of courses offered in the Department of Chemistry that may be taken to fulfill requirements of the MCS curriculum. The parentheses indicate which area(s) of concentration the course fulfills and when the course is typically offered. Not all courses are offered every year. Check current course listings for which courses are offered each semester.

Concentrations:

- Biological (B)
- Inorganic (I)
- Organic (O)
- Physical (Ph)
- Materials with Organic emphasis (MO)
- Materials with Inorganic emphasis (MI)
- Environmental Chemistry with modeling emphasis (M)
- Environmental Chemistry with Policy emphasis (P)

CHEM 441. Advanced Organic Chemistry: Reactions, Mechanisms, and Stereoelectronic Effects. (O, Fall)

Prerequisite(s): CHEM 242.

Study of important types of reactions and functional groups, with emphasis on synthetic usefulness, mechanisms, and stereoelectronic principles.

CHEM 443. Modern Organic Synthesis. (O, Fall) Prerequisite(s): CHEM 241 and 242.

Introduction to advanced organic synthesis. Study of important synthetic reactions including: oxidations, reductions, and methods for the formation of carbon-carbon bonds, with an emphasis in chemoselectivity, stereoselectivity and asymmetric synthesis. Survey of modern methods for the synthesis of small, medium and large ring systems. Analysis of modern synthetic strategies, with illustrative examples from total synthesis of natural and unnatural products.

CHEM 451. Biological Chemistry I. (B, O, Fall) Prerequisite(s): CHEM 242, 221 (may be concurrent), and 251 or permission of instructor. Structure, dynamics, and function of biological macromolecules. Properties of macromolecular assemblies, membranes and their compartments. (Formerly, CHEM 450-I).

CHEM 452. Biological Chemistry II. (B, Fall) Prerequisite(s): CHEM 242, 221, and 251 or permission of instructor.

Physical and chemical description of macromolecular information transfer. Gene organization, replication, recombination, regulation and expression. (Formerly, CHEM 450-II).

CHEM 462. Inorganic Chemistry II. (I, MI) Prerequisite(s): CHEM 261 or its equivalent and permission of instructor.

A detailed treatment of the theory and application of modern physical methods for the elucidation of structure and mechanism in inorganic and organometallic chemistry. An introduction to symmetry and group theory is followed by the application of these concepts to vibrational and electronic spectroscopy of inorganic complexes. Magnetic resonance is discussed in detail, including topics such as EPR, fourier transform methods, dynamic systems, and 2-dimensional NMR.

CHEM 521. Statistical Mechanics I. (Ph, Fall) Prerequisite(s): CHEM 222.

Principles of statistical mechanics with applications to systems of chemical interest.

CHEM 522. Statistical Mechanics II. (Ph, Spring) Prerequisite(s): CHEM 521.

A continuation of CHEM 521. The course will emphasize the statistical mechanical description of systems in condensed phases.

CHEM 523. Quantum Chemistry I. (Ph, Fall) Prerequisite(s): CHEM 222.

The principles of quantum theory and applications to atomic systems.

CHEM 524. Quantum Chemistry II. (Ph, Spring) Prerequisite(s): CHEM 523.

Approximate methods in quantum theory and applications to molecular systems.

CHEM 525. Molecular Spectroscopy. (Ph, Fall)

A modern introduction to the theory of the interaction of radiation and matter and the practice of molecular spectroscopy. Conventional microwave, magnetic resonance, optical, photoelectron, double-resonance, and laser spectroscopic techniques will be included.

CHEM 526. Chemical Dynamics. (Ph, Spring)

Theoretical and experimental aspects of important rate processes in chemistry.

CHEM 541 (BMB 554) Physical Organic Chemistry. (O, MO) Prerequisite(s): CHEM 241 and 242; Chem 441 (Mechanisms) or the completion of its equivalent is strongly recommended (see instructor)

Chem 541 is a high level overview of classical physical organic chemistry. The course is divided into three parts. The first third will be an overview of organic bonding (basic molecular orbital theory, anomeric effect, Huckel molecular orbital theory, Woodward-Hoffmann rules), structure (bond lengths, bond angles, conformational analysis), and properties (electronegativity, nucleophilicity, electrophilicity, acidity, basicity). The second third will overview current computational methods including molecular mechanics, Hartree Fock, and density functional calculations. The focus will be on practical applications rather than the theory behind the calculations; students will be able to assess which calculations are most appropriate for a given task. Students will undertake energy minimizations, conformational searches, transition state calculations, and visualization of several molecular properties including orbitals and electrostatic fields. The last third of the course will survey thermodynamic and kinetic measurements used in understanding organic chemical reactions. Topics include Hammett analyses, kinetic measurements and interpretation, the Hammond postulate, Arrhenius theory, Eyring theory, and kinetic isotope effects. Articles discussing these techniques in delineating the organic reaction mechanisms for problems of current interest will be analyzed. The focus will be on experiments that can be accomplished with readily available analytical tools (NMR, IR, UV, GC, HPLC) and how simple physical organic analyses can be used to optimize reaction yields and selectivities.

CHEM 555. (BMB 554) Macromolecular Crystallography: Methods and Applications. (B, MO)

The first half of the course covers the principles and techniques of macro- molecular structure determination using X-ray crystallography. The second half of the course covers extracting biological information from X-ray crystal structures with special emphasis on using structures reported in the recent literature and presented by the students.

CHEM 557. Mechanisms of Biological Catalysis. (B) Prerequisite(s): One year of organic chemistry and a biochemistry course, or permission of instructor.

Reaction mechanisms in biological (enzymes, abzymes, ribozymes) and biomimetic systems with emphasis on principles of catalysis, role of coenzymes, kinetics, and allosteric control.

CHEM 559. (BMB 559) Biomolecular Imaging. (B, MO)

This course considers the noninvasive, quantitative, and repetitive imaging of targeted macromolecules and biological processes in living cells and organisms. Imaging advances have arisen from new technologies, probe chemistry, molecular biology, and genomic information. This course covers the physical principles underlying many of the latest techniques, and defines experimental parameters such as spatial and temporal resolution, gain, noise, and contrast. Applications to cellular and in vivo imaging are highlighted for confocal, two-photon, and force microscopies; single-molecule, CARS, and fluorescence correlation spectroscopy; FRET and fluorescence bleaching; mass spectroscopy; MRI, PET and SPECT. The role of molecular imaging agents comprised of proteins, organic or inorganic materials is widely discussed.

CHEM 564. Organometallics. (O, I)

This course is focused on molecular species that contain metal-carbon bonds, and the role of these compounds in catalytic processes and organic synthesis. Aspects of the synthesis, structure and reactivity of important classes of organometallic compounds such as metallo-alkyl, aryl, alkene, alkylidene and alkylidyne complexes are surveyed for the d and f block metals. Emphasis is placed on general patterns of reactivity and recurring themes for reaction mechanisms.

CHEM 565. Main Group Chemistry. (I, MI)

This course encompasses a comprehensive survey of the chemistry and properties of the p-block elements of the periodic table. Topics include syntheses, structures and reactivities of important compounds. In addition, alternative bonding theories which have been used to explain the unique properties of these compounds are critically examined.

CHEM 567. (BMB 567) Bio-inorganic Chemistry. (B, I, MI, MO)

The course covers selected topics in bioinorganic chemistry; special emphasis is placed on dioxygen chemistry and electron transfer processes. Course topics include: (i) oxygen uptake and utilization; (ii) diatomic oxygen transport; (iii) diatomic and monoatomic oxygen incorporation into substrates; (iv) metalloenzyme-catalyzed C-C bond formation; (v) the metallobiochemistry of DNA; (vi) metal-sulfide proteins; (vii) manganese-containing metalloproteins; (viii) Photosystem II: light-driven electron transfer and the biological water-splitting reaction; (ix) biological electron transfer; (x) electron transfer theory; (xi) mechanisms of energy storage and release; and (xii) long-distance electron transfer reactions.

CHEM 580 (PHYS 580) Biological Physics. (B) Prerequisite(s): Physics 150-151 or 170-171, Math 104-114 or Math 104-115. Recommended: concurrent Physics 230 or prior Physics 250, basic background in chemistry and biology.

ENVS 410. Clean Water-Green Cities (P, Fall) This course will provide an overview of the cross-disciplinary fields of civil engineering, environmental sciences, urban hydrology, landscape architecture, green building, public outreach and politics. Students will be expected to conduct field investigations, review scientific data and create indicator reports, working with stakeholders and presenting the results at an annual symposium. There is no metaphor like water itself to describe the cumulative effects of our practices, with every upstream action having an impact downstream. In our urban environment, too often we find degraded streams filled with trash, silt, weeds and dilapidated structures. The water may look clean, but is it? We blame others, but the condition of the creeks is directly related to how we manage our water resources and our land. In cities, these resources are often our homes, our streets and our communities. This course will define the current issues of the urban ecosystem and how we move toward managing this system in a sustainable manner. We will gain an understanding of the dynamic, reciprocal

relationship between practices in a watershed and its waterfront. Topics discussed include: drinking water quality and protection, green infrastructure, urban impacts of climate change, watershed monitoring, public education, creating strategies and more.

ENVS 541. Modeling Geographic Objects. (M, Fall) This course offers a broad and practical introduction to the acquisition, storage, retrieval, maintenance, use, and presentation of digital cartographic data with vector-oriented (i.e., drawing-based) geographic information systems (GIS) for a variety of environmental science, planning, and management applications. Previous experience in GIS is not required.

ENVS 507. Wetlands. (P, Fall) The course focuses on the natural history of different wetland types including climate, geology, and hydrology factors that influence wetland development. Associated soil, vegetation, and wildlife characteristics and key ecological processes will be covered as well. Lectures will be supplemented with weekend wetland trips, ranging from tidal salt marshes to non-tidal marshes, swamps, and glacial bogs in order to provide field experience in wetland identification, characterization, and functional assessment. Outside speakers will discuss issues in wetland seed bank ecology, federal regulation, and mitigation. Students will present a short paper on the ecology of a wetland animal and a longer-term paper on a selected wetland topic. Readings from the text, assorted journal papers, government technical documents, and book excerpts will provide a broad overview of the multifaceted field of wetland study.

ENVS 605. Bioremediation (M, Fall) This course is an introduction to current and developing techniques for analyzing environmental contamination and for remediation of damaged environments. Knowledge of these options is important for students interested in public/law applications and environmental/landscape design and as a starting point for those pursuing a more science-oriented understanding. The first portion of this course will address bioindicators-the use of living systems to assess environmental contamination. These include systems ranging from biochemical assays to monitoring of whole organisms or ecosystems, as well as techniques ranging from laboratory to field and satellite surveys. The second portion of the course will introduce technologies for bioremediation-the use of living systems to restore contaminated environments. The technologies scale from single-species systems to complex ecosystems such as constructed wetlands; case studies will be examined. Students will be expected to participate in field trips, as well as prepare a final paper examining a particular technology in detail.

ENVS 616. Risk Assessment: Science & Policy Challenges. (P, Fall) How do government policymakers make decisions about potential threats to human health and the environment in the face of scientific uncertainty? The course develops the concept of Risk Assessment from the publication of 1983 National Research Council (NRC) report commonly known as the "Red Book" which was used to rank the initial hazardous waste sites under the Superfund program. Using a variety of teaching tools, including lectures, panel discussions, and case studies, the course examines how public policy decisions regarding environmental risk are made and how effective those decisions are at reducing risks to affected populations. The course focuses on the complex interaction of science, economics, politics, laws, and regulations in dealing with environmental and public health risks. The course will begin with a review of the policy process and methods used in evaluating human health and environmental risks, including the traditional steps in the risk assessment process, including quantitative and qualitative aspects of hazard identification, dose-response assessment, exposure assessment, and risk characterization. The course will then focus on how scientific uncertainty, risk perceptions, socio-economic disparities, risk communication, and politics influence environmental risk-based decision-making. Issues such as special populations (e.g., children, elderly, immune-compromised, woman of pregnancy age, etc.) must be

considered when developing risk reduction strategies. The use of the “precautionary principle” will be discussed in the context of different types of environmental stressors (e.g., pesticides, chemicals, climate change, air pollution, water quality, and land use) and how this important controversial principle is applied differently in contrasting national and European risk management policies.

ENVS 624. U.S. Environmental Policy - Analysis of NEPA. (P, Fall) This course explores the history of the federal statute that is the National Environmental Policy Act (NEPA) and its implementation through the regulations of the Council on Environmental Quality. It describes the circumstances that trigger NEPA compliance and provides an overview of the environmental process, including the integration of social, environmental, and economic factors within the framework of existing laws, regulations, policies, and guidance for project decisions. It examines the components of the NEPA process, including purpose and need, scoping, alternatives development and analysis, impact analysis, public involvement, interagency coordination, mitigation, and documentation. The course will touch on practical processes that are involved in preparing and reviewing NEPA documents, cumulative effects assessments, and technical issues such as impacts on threatened or endangered species, wetlands, national historic preservation activities, environmental justice communities, etc. Case studies involving multiple governmental entities and nongovernmental stakeholders will be examined to highlight the essential steps and components needed to design, implement, and participate effectively in a collaborative NEPA process.

GEOL 528. Aqueous Geochemistry (M, Fall) Chemical composition and interactions of soils and soil water with applications to current problems.

GEOL 618. Fundamentals of Air Pollution (M, Spring) This course will cover various topics related to Air Quality. Initial lectures will cover the history of air pollution and composition of the atmosphere. We will then progress to discussion of atmospheric pollutants and sources of those pollutants. Additional topics will include: fate of atmospheric pollutants (transport and dispersion mechanisms), effects of air pollution (health and environmental effects), urban smog, acid rain, climate change, ozone depletion in the stratosphere, air quality criteria, and engineering controls.

GEOL 656. Fate and Transport of Pollutants (M, Spring) Pre-requisite: Aqueous Geochemistry (GEOL 528) or similar This course is designed to introduce the major concepts regarding geochemistry and geochemical modeling. The course introduces two United States Geological Survey (USGS) computer models, PHREEQC, a geochemical speciation model, and PHAST, a transport module which is coupled with PHREEQC output. These are highly respected, world-renowned models that are freeware via the USGS, complete with documentation. Once familiar with the models, the student can continue to work with them beyond the course experience.

GEOL 663. Geochemical Modeling (M, Spring) Pre-requisite: Aqueous Geochemistry (GEOL 528) or similar. This course is designed to introduce the major concepts regarding geochemistry and geochemical modeling. The course introduces two United States Geological Survey (USGS) computer models, PHREEQC, a geochemical speciation model, and PHAST, a transport module which is coupled with PHREEQC output. These are highly respected, world-renowned models that are free-ware via the USGS, complete with documentation. Once familiar with the models, the student can continue to work with them beyond the course experience.

PHREEQC is designed to perform a wide variety of aqueous geochemical calculations and can be used to simulate chemical reactions and transport processes in natural or polluted waters. PHREEQC is capable of modeling both equilibrium and kinetic reactions. Some of the simulations pursued during the course

include: Speciation of precipitation water; Iron speciation; Zinc sorption onto hydrous ferric oxide; Oxidation of organic carbon and the sequence of electron donors in natural waters; Benzene advective transport in groundwater; TCE transport and degradation.

MCS 540. Pro-seminar I. (ALL, Fall) Required course during 1st year will review the scientific method, research design, and professional scientific communication. Current opinions in the study of the chemistry and presentations by guest lecturers will add content to areas of concentration.

MCS 541. Pro-seminar II: Capstone Proposal Preparation. (ALL, 0.5 CUs, Spring) Highly recommended course during the semester prior to starting a Capstone project. Students will review the scientific communication, research design, prepare and submit original proposal for the capstone project. Current opinions in the study of the chemistry will add content to areas of concentration.

MCS 542. Pro-seminar III: Capstone Report Preparation. (ALL, 0.5 CUs, Spring) Highly recommended course while taking MCS 699. Students will prepare and submit the report using ACS style. This course will further develop their scientific writing skills and support students in the completion of their capstone.

MCS 598. Independent Studies: Literature Review. (ALL, 1 CU) Advanced study of literature and current research in various branches of chemistry with the goal of learning a new topic or research trends. Only one CU will count toward the minimum 10 CUs required for graduation.

MCS 599. Independent Studies: Research Techniques. (ALL, 1 CU) May be considered part-time or full-time depending on the numbers of hours per week committed to the class (20 hours/week or less will be considered part-time; at least 35 hours/week will be considered full-time). Advanced study and research in various branches of chemistry with the goal of developing a special skill or learning new techniques. (Requires additional laboratory fees.) Only one CU will count toward the minimum 10 CUs required for graduation.

MCS 697. Research for Capstone. (ALL) (.15 CU) May be taken for multiple course unit credit by students developing the research project for the capstone requirement but who will not be completing or presenting the final report. Advanced study and research in various branches of chemistry with the goal of advancing the capstone project. This course is taken by students who are *not* engaged in intensive preliminary research. This course does not count towards the 10 CUs minimum.

MCS 698. Research for Capstone. (ALL) (1 CU) May be taken for multiple course unit credit for students initiating the research project for the capstone requirement but who will not be completing or presenting the final report. Advanced study and research in various branches of chemistry with the goal of advancing the capstone project. This course is taken by students engaged in intensive preliminary research. Only 1 CU will count towards the 10 CU minimum.

MCS 699. Capstone. (ALL) (1 CU) Required course for students completing the research project, and submitting the final report and presentations. Advanced study and research in various branches of chemistry with the goal of finishing the capstone project.

MCS 990. Master's Continuation. (ALL) (.15 CU) Students enroll in this course if they fail to complete their Capstone in the term when they are enrolled in MCS 699.

Appendix B

MASTER OF CHEMICAL SCIENCES FORMS

I.	Graduation Checklist.....	41
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Graduation Checklist

Student name: _____ Date: _____

Penn Email: _____

Semester: _____

Project _____ Title: _____

Project Type: on-campus research off-campus research review paper

Project Supervisor: _____

Secondary Reader: _____

Academic Advisor: _____

Forms

There are four forms, which need to be completed for the Capstone (all in Appendix C and in the MCS canvas community):

- [Capstone Project Proposal](#) Approval date: _____
- Graduation Application Form Completion date: _____
- Survey Completion date: _____
- Oral Presentation (defense) Completion date: _____
- Final Report – electronic Submission date: _____
- Final Report – hard copy Submission date: _____
- Poster – electronic Submission date: _____
- Poster – presentation Submission date: _____
- Certification of Completion of Capstone Project/Course Grade form Date: _____

- Project Supervisor Evaluation Submission date: _____
- Capstone Project Evaluation /MCS 699 course grade Date: _____
- [Scholarly Commons Application](#) and permission (to publish the student’s work in Penn’s online repository) Date to be submitted: _____

Student Signature: _____ Date: _____

Approval MCS Associate Director: _____ Date: _____

Appendix C

MASTER OF CHEMICAL SCIENCES CAPSTONE GUIDELINES

Table of Contents

I.	Capstone Overview	43
II.	Timeline	45
III.	Developing A Proposal	46
IV.	Writing A Final Report.....	50
V.	Guidelines for Oral Presentation	61
VI.	Guidelines for Poster Presentation.....	62
VII.	Capstone Evaluation Tools	
	a. Speaker Evaluation Form.....	62
	b. Poster Evaluation Form.....	63
	c. Project Supervisor’s Evaluation Form.....	64
	d. MCS 699 Capstone Project Evaluation Form.....	67

I. Capstone Overview

This guide will provide students with information vital to the successful completion of the capstone project for the Master in Chemical Sciences (MCS) program. They will find procedures, timelines, and resources relevant to their project. They must discuss their ideas with their faculty advisor and project supervisor when they first begin to develop their capstone project. The MCS Associate Director is always available to guide them with respect to project requirements.

Choosing a Topic

Typically, a capstone project last two to three terms and represents the culmination of students MCS graduate study. The capstone may consist of a Penn laboratory research project, an off-campus laboratory research project, or a literature review or educational project. Under no circumstances will previous work experience exclude a student from the capstone requirement. If they are currently working in the chemical industry, they might be able to complete their capstone project through their employer; however, they must clearly demonstrate what new skills they will acquire through the experience. Their research project will focus on a topic that they decide upon in consultation with their academic advisor and project supervisor. They will need to demonstrate a grasp of the theoretical underpinnings of the research they undertake, be able to justify the reasons for the research, and identify key learning outcomes they plan to achieve through the work.

The capstone topic is typically directly related to their area of concentration and professional goals. Topic ideas may come from:

- A guest speaker in the Department of Chemistry
- An article read
- Chemistry faculty research
- An academic advisor
- Professional experience a student would like to develop further
- Projects available in research laboratories

The capstone project will help students develop new skills that will advance their career.

Students who are interested in completing a summer or semester internship will have to include this work as part of the capstone project. If the internship is not part of the capstone project, students will need to take a leave of absence from the program while completing the internship.

Identifying Capstone Mentors

Regardless of their project's design, students will need to secure two advisors or "readers" who will help them develop their project proposal and/or help them organize and edit their final report. They will become members of their committee. The third committee member will be the MCS Associate Director. Readers can include the following individuals:

- Their academic advisor
- Another Penn faculty member
- Their off-campus project supervisor
- A professor from a local university, an adjunct faculty member, or a lecturer academically engaged in their capstone topic

Students' primary reader or project supervisor must be an expert in the research field; the secondary reader need not be. Students are encouraged to identify the faculty advisor and readers as soon as possible. If they are having difficulty identifying these individuals, the MCS Associate Director can recommend likely prospects from among the Department of Chemistry faculty. However, it is their responsibility to contact these individuals and discuss their project ideas in depth.

- *If students are planning to conduct research on the Penn campus, their academic advisor is expected to serve as their project supervisor. If they would like to work with another faculty member instead, they can serve as their project supervisor (and their academic advisor can serve as the secondary reader).*
- *If students are planning to work off-campus, their project supervisor will be on-site and work in collaboration with their academic advisor to ensure their goals are met.*
- *If students plan to complete a literature review or educational project on campus, their academic advisor is expected to provide guidance for their project.*

Capstone Mentors' Responsibilities

Title	Possible Roles	Responsibilities
Academic advisor	Project supervisor	Help guide development of and approve proposal; supervise throughout the project; edit and evaluate final report; assign grade for MCS 699
	Secondary reader	Help guide development of and approve proposal; advise throughout the project; edit and evaluate final report; assign grade for MCS 699 with feedback from supervisor
Penn faculty member	Project supervisor	Help guide development of and approve proposal; supervise throughout the project; edit final report; provide feedback to academic advisor regarding performance
	Secondary reader	If possible, help guide development of and approve proposal; edit final report
Off-campus researcher	Project supervisor	Help guide development of and approve proposal; supervise throughout the project; edit final report; provide feedback to academic advisor regarding performance
Local professor or lecturer	Secondary reader	If possible, help guide development of and approve proposal; edit final report

II. Timeline

Students are expected to start their project during the summer following completion of their first academic year of study. Depending on the capstone option selected, they may begin work on their project as early as spring semester during their first year in the program. **Regardless of when they start, remember that they need to have their proposal approved *PRIOR* to starting their work in order to receive credit for their capstone experience.**

It is recommended that one-third of the way through their project students check-in with their academic advisor to ensure that their research is on-track as outlined in their proposal. If any revisions need to be made because of unexpected events affecting progress, they should be made as soon as possible. These are typically documented in the progress report submitted at the end of each term.

The final products of their capstone research will be a scientific report, oral and poster presentations. Students will work closely with their committee members. In addition to the scientific report, they will be expected to present their work via an oral presentation and create a poster detailing their work. These posters will be displayed at the end of the academic year for faculty and students to view during a research symposium prior to graduation.

The course grade for capstone credit (MCS 699) will be assigned by students' academic advisor, taking into consideration feedback of their committee members, as well as their final report, oral presentation and poster. If they register for MCS 699 during the semester they expect to receive a grade for completing their capstone project and report. Students need to be enrolled during their capstone project for international visa or program requirements during the terms they are not receiving the final grade need to register for MCS 698 or 697 *Research*. Students will submit progress reports of their work in order to obtain a grade in MCS 698 and MCS 697.

Semester	Activity
Late fall – year 1	Start developing ideas for capstone project; discuss with academic advisor
Spring – year 1	Draft and receive approval of proposal <i>prior to</i> initiating research
Summer – fall	Work on capstone project; register for MCS 698 or MCS 697
Spring – year 2	Register for MCS 699; finish writing capstone report; create poster
Late spring – year 2	Give oral presentation and present poster; graduate*

* If students are unable to finish their capstone report and receive a grade for MCS 699 prior to graduation, but they expect to complete these requirements prior to the start of fall semester, they can still participate in the graduation ceremony, although they will not receive their diploma at this time.

If students have completed all course work for the degree but have not completed their capstone report, they will be automatically enrolled in the *Master's Continuation* course (MCS 990) for one additional semester or until the report is complete and a grade has been assigned. This will ensure that they will continue to have access to the library and their Penn e-mail accounts. Students are allowed to enroll in this course a maximum of two terms. Students not completing the program requirements after two semesters of *Master's Continuation* may be withdrawn from the program and might results in academic dismissal. Students extending *Master's Continuation* registration beyond two semesters, they must receive permission from the MCS Associate Director and MCS Faculty Advisory Committee.

III. Developing A Proposal

As stated earlier, students' capstone may consist of Penn laboratory research, off-campus laboratory research, or a literature review or educational project. Their capstone proposal will be developed in collaboration with their academic advisor and project supervisor (for off-campus projects). They must submit a proposal for approval by their academic advisor, a project supervisor (for off-campus projects), and the MCS Associate Director **at least 3 weeks prior to** the anticipated start date of their capstone project. A template and guidelines for writing an effective proposal are included below. If their project will be conducted in a research laboratory located off-campus, they may be required to sign a non-disclosure agreement, and this must be included as an appendix to their capstone proposal.

Funding to conduct student's capstone research is not provided by the MCS program; it is their responsibility to ensure that adequate resources are available for the work proposed. Students will work with their project supervisor to make sure research costs will be covered.

Students who are interested in completing a summer or semester internship will have to include this work as part of the capstone project. If the internship is not part of the capstone project, students will need to take a leave of absence from the program while completing the internship.

Guidelines for Capstone Proposals

The following items must be included in the capstone proposal:

1. **Project cover sheet** (next page)
2. **Project Description**
 - a) **Work Site:** Include a brief summary describing the company and their goals, complete work address, phone and e-mail contact details for supervisor(s), and any compensation/reimbursement provided. If working at Penn, please include campus address and details.
 - b) **Position Title and Overview:** Include a 1-2 sentence description of students' key responsibilities.
 - c) **Project Description:** Describe in detail what they will be doing and how they will be doing it. If they will be conducting research, this section must contain details about the overall project including a description of the problem, project rationale, objectives, methodology or experimental design, and overall expected outcomes. More detailed information can be attached in the appendices. The body of the Project Description should focus on **their** activities. Proposals of literature reviews should provide an overview of topics to be discussed and the rationale.
 - d) **Timeline:** List specific start and end dates, number of work hours/week, and total number of months students will spend on this project.
 - e) **Learning Outcomes:** Explain what new skills and/or knowledge students will be acquiring through this experience and how it will move them forward along their career path.

- f) **Evaluation Criteria:** How will students project supervisor evaluate their performance? Identify project-specific parameters to be assessed in addition to those listed in the project evaluation form.
- g) **References:** This is a listing of all references used in the order that they are referenced in the text. Page numbers in the bibliography continue the pagination of the text; do not number the bibliography separately. MCS project reports follow ACS style citation.
- h) **Appendices** (including current resume or CV, and additional project details)

Guidelines for Capstone Proposals (off campus location)

The following items must be included in the capstone proposal:

1. **Project cover sheet** (next page)
2. **Project Description**
 - a) **Work Site:** Include a brief summary describing the company and their goals, complete work address, phone and e-mail contact details for supervisor(s), and any compensation/reimbursement provided. Students must also specify if they are working in a project with confidential information. If they are working in collaboration with Penn faculty member, it must be specified what part of the work they will be completing at which location and how the confidentiality issues are being taken care of.
 - b) **Position Title and Overview:** Include a 1-2 sentence description of students' key responsibilities.
 - c) **Project Description:** Describe (in detail) what students will be doing and how they will be doing it. If they will be conducting research, this section must contain details about the overall project including a description of the problem, project rationale, objectives, methodology or experimental design, and outcomes. More detailed information can be attached in the appendices. The body of the Project Description must focus on *their* activities. If they are working in a project that contains confidential information, they must make a disclaimer. They should also explain the extent of sharing they are allowed to disclose. Their proposal should demonstrate that they have knowledge of the background information, rationale, goals and expected outcomes must be explicit. The experimental design should provide enough information to demonstrate that they have knowledge of the project, and all of the members of their committee can easily follow it.

Examples:

 - If students are synthesizing/modeling molecules and cannot provide a specific name or structure, label the molecules with a generic name, give an overall description of the molecule and what types of modifications they will be making in their research (in general terms)
 - If students are completing physical or characterization studies of specific molecules and cannot provide a specific name or structure, label the molecules with a generic

name, give an overall description of the molecule and emphasize their proposal in the studies that they are making and what do they expect to obtain

- d) **Timeline:** List specific start and end dates, number of work hours/week, and total number of months students will spend on this project.
- e) **Learning Outcomes:** Explain what new skills and/or knowledge students will be acquiring through this experience and how it will move them forward along their career path.
- f) **Evaluation Criteria:** How will students project supervisor evaluate their performance? Identify project-specific parameters to be assessed in addition to those listed in the project evaluation form.
- g) **References:** This is a listing of all references used in the order that they are referenced in the text. Page numbers in the bibliography continue the pagination of the text; do not number the bibliography separately. MCS project reports follow ACS style citation.
- Include all authors and do not use *et al*
 - Include the title of the paper
 - Example of citation format for peer reviewed publications:
 - Sarper, A.; Ayten, A.; Eser, I.; Ozbudak, O.; Demircan, A. Tracheal Stenosis after Tracheostomy or Intubation: Review with Special Regard to Cause and Management. *Texas Hear. Inst. J.* **2005**, *32* (2), 154–158.
 - Cataneo, D. C.; Ximenes, A. M. G.; Cataneo, A. J. M. Mitomycin C in the Endoscopic Treatment of Tracheal Stenosis: A Prospective Cohort Study. *J. Bras. Pneumol.* **2018**, *44* (6), 486–490. <https://doi.org/10.1590/s1806-37562017000000423>.
 - Example of citation format for websites:
 - PubChem Compound Summary for CID 5743, Dexamethasone <https://pubchem.ncbi.nlm.nih.gov/compound/Dexamethasone#section=Mechanism-of-Action> (accessed Jul 31, 2021)
- h) **Appendices** (including current resume or CV, and additional project details such as lab protocols)

A copy of the capstone proposal, its appendices, and signed cover sheet must be submitted to students' academic advisor, their project supervisor, and the MCS Associate Director for approval **at least 3 weeks before the start of the project and/or the end of semester preceding initiation of the project. The document must follow ACS style. For additional information about format guidelines, please visit:**

http://pubs.acs.org/paragonplus/submission/jacsat/jacsat_authguide.pdf

[ACS style guide](#)

Master of Chemical Sciences Capstone Project Proposal Cover Sheet

Name: _____ Penn ID: _____

Phone: _____ Email: _____

Date Submitted: _____

Project Period (mark all that apply): summer 20__ fall 20__ spring 20__

Area of Concentration: _____

Number of CUs Completed: _____

Project Title: _____

Project Type: on-campus research off-campus research review paper

Project Supervisor: _____

Academic Advisor: _____

Off-Campus Location (if applicable): _____

Project Start and End Dates: _____

Site Supervisor Phone: _____ Email: _____

I have read the Capstone Proposal and agree to serve as a mentor for this project.

Project Supervisor/Academic Advisor (circle): _____
Printed name

Signature: _____ Date: _____

Academic Advisor/Secondary Reader (circle): _____
Printed name

Signature: _____ Date: _____

MCS Associate Director:

Signature: _____ Date: _____

IV. Writing A Final Report

Work with students project supervisor and committee members to develop an outline for a final report, based on the guidelines provided below. The Weingarten Learning Resources Center, located at 3702 Spruce Street, Suite 300, provides professional consultation services in skills such as academic reading and writing through a variety of services and programs including the very popular series of study skills workshops offered at the beginning of each fall and spring term for LPS students. A special workshop series is also offered for international students. For more information about the [Weingarten Learning Resources Center](#), visit their web site or call 215-573-9235. The MCS canvas community contains modules that will help students organize their time and provide best practices for technical writing. Key materials are also discussed in MCS 540, therefore make sure they save the materials distributed in class.

There is also a wealth of information and resources available through the University of Pennsylvania libraries, [Van Pelt Library](#), the main University library, located at 3420 Walnut Street (the entrance is on the College Green across from College Hall). The [Weigle Information Commons](#), which is located in the Van Pelt Library, offers training in various applications, like Excel.

Students project mentors and the MCS Associate Director provide feedback on their final report prior to final submission. A final draft, that contains both the content and correct formatting, must be approved by all committee members one week prior to presenting their capstone. Once a final document is approved, students submit their report to Penn's online repository, the [Scholarly Commons](#), for publication.

Guidelines for Capstone Final Report – Research Project

The Capstone Report must be written using these general guidelines, if a research project was completed. Bound as well as electronic copies of a student's report are submitted to their academic advisor and the MSC Associate Director. It must follow [ACS style guide](#).

Sections will be organized as listed below:

1. Pretext Pages
 - a) Abstract Page
 - b) Title Page
 - c) Approval Page
 - d) Acknowledgements (optional)
 - e) Table of Contents
 - f) List of Figures
 - g) List of Tables
 - h) List of Appendices
2. Scientific Report
 - a) Introduction
 - b) Materials and Methods
 - c) Results
 - d) Discussion
 - e) Summary or Conclusion
3. References

4. Appendices
5. Fly Leaf (blank page)

Number of Copies

Submit one digital copy and one bound official copy of students Capstone Report to the MCS Associate Director as well as their academic advisor.

Paper, Font and Spacing

The Capstone Report must be printed on standard size, white, 8½ x 11-inch paper. Use single line spacing throughout and print on only one side of the paper. Use regular, unadorned print (e.g., New Times Roman or Arial) 10-12 point size for text. Document must follow ACS style (citations, tables, schemes, figures, equations, etc.). For additional information about format guidelines, please visit: [ACS style guide](#)

Margins

Every page of the internship report must be kept within a minimum margin of 1½ inches (for binding purposes) on the left side of the page; 1 inch at the right side, top and bottom of the page.

Pagination

All pages except the title page must be numbered. This includes full-page photographs, charts and graphs, the bibliography, and appendices. For the pretext pages, use small Roman numerals (ii, iii, etc.). Page i is the abstract page, but the page number is not printed on this page. The first item on the Table of Contents list must be the Abstract. This will be followed by the title page, the approval page and any dedication or acknowledgment section students may wish to include. This is numbered in the small Roman series, with the page numbers displayed. Titles for pretext pages must be centered. The remainder of the Capstone Report is numbered with Arabic numerals (1, 2, etc.).

The page numbers that are displayed must be centered at the bottom of each page.

Writing Pretext Pages

- Abstract, Title and Approval Pages (see format below)
- Abstract
Describe where students project was conducted (name of company, department, location, type of business). Summarize their research project goals, activities, and accomplishments, highlighting key knowledge or skills gained. How did this Capstone Project benefit them, and how did it benefit the company? The abstract is limited to 350 words in length. It should be 1.0 line-spaced (spacing - 0 before or after) using only one side of the paper.
- Acknowledgments
If a student wishes, they may include a page with a brief note of dedication or acknowledgment of help received from particular individuals.
- Table of Contents
Capstone Reports are expected to have a Table of Contents for the convenience of the reader. If figures or tables are scattered throughout the text, a separate List of Figures or List of Tables must be included after the Table of Contents.

Writing the Scientific Report

Use Arabic numerals (1, 2, etc.) to number these pages. Start with the first page of the introduction as page 1 and end with the last page of students final report; either References or Appendices.

The format for the scientific report must include:

- **Introduction**

The introduction is a concise statement of the problem and an outline of the scope, aim, and nature of student's project. A review of the literature pertinent to the subject must be included and used to provide context for the Capstone Paper. Students must state the rationale, goals, and experimental design in this section. Clearly distinguish their new methods from experimental techniques/pathways used from the literature.

- **Materials and Methods**

The purpose of the Materials and Methods section is to recount, in a concise manner, the materials and methods used to approach the project. It should include sufficient information so that the study could be repeated. Care should be exercised not to include superfluous information. Also, be sure to avoid including results and/or conclusions. It should include a general consideration (instrumentation, reagents, etc.) and experimental methods. For some areas of research, it might make more sense to include this section after the Results and Discussion. This must be approved by all committee members before students start writing the first draft of the report.

- **Results and Discussion**

The results reflect the findings of students' investigation only, not the findings of other researchers in the area. This is a summarized form of extensive data that may appear in the figures, tables and/or appendices. The discussion provides an analysis of the data acquired. They may draw comparisons with findings of other researchers in the field or even speculate to some degree and, if appropriate, suggest additional research (future work). Clearly distinguish their findings from literature comparison.

- **Summary or Conclusion and Future Work**

The conclusion is a final brief statement, which draws together the objectives and findings of the entire research project.

- **References**

This is a listing of all references used in the order that they are referenced in the text. Page numbers in the bibliography continue the pagination of the text; do not number the bibliography separately. MCS project reports must follow the ACS style citation and formatting.

- Include all authors and do not use *et al*
- Include the title of the paper
- Example of citation format for peer reviewed publications:
 - Sarper, A.; Ayten, A.; Eser, I.; Ozbudak, O.; Demircan, A. Tracheal Stenosis after Tracheostomy or Intubation: Review with Special Regard to Cause and Management. *Texas Hear. Inst. J.* **2005**, *32* (2), 154–158.
 - Cataneo, D. C.; Ximenes, A. M. G.; Cataneo, A. J. M. Mitomycin C in the Endoscopic Treatment of Tracheal Stenosis: A Prospective Cohort Study. *J. Bras. Pneumol.* **2018**, *44* (6), 486–490. <https://doi.org/10.1590/s1806-37562017000000423>.
- Example of citation format for websites:
 - PubChem Compound Summary for CID 5743, Dexamethasone <https://pubchem.ncbi.nlm.nih.gov/compound/Dexamethasone#section=Mechanism-of-Action> (accessed Jul 31, 2021)

i) **Appendices** (including current resume or CV, and additional project details such as lab protocols)

Guidelines for Capstone Final Report – Literature Review

The literature review must demonstrate that students have read, and have a good grasp of, the main published work concerning a particular topic or question in their field. The review will be guided by their research objective or by the issue or thesis they are arguing and will provide the framework for further work. Guidelines were taken from <http://library.bcu.ac.uk/learner/writingguides/1.04.htm>.

It is very important to note that their review should not be simply a description of what others have published in the form of a set of summaries, but must take the form of a critical discussion, showing insight and an awareness of differing arguments, theories, and approaches. It should be a synthesis and analysis of the relevant published work, linked at all times to their own purpose and rationale.

The literature review should:

- compare and contrast different authors' views on an issue
- group authors who draw similar conclusions
- criticize aspects of methodology
- note areas in which authors are in disagreement
- highlight exemplary studies
- highlight gaps in research
- conclude by summarizing what the literature says

The purposes of the review are:

- to define and limit the problem students are working on
- to avoid unnecessary duplication
- to evaluate promising research methods
- to relate their findings to previous knowledge and suggest further research

A good literature review, therefore, is critical of what has been written, identifies areas of controversy, raises questions and identifies areas which need further research.

Selection of sources is critical, and here are some questions to ensure students do a thorough overview:

- Have they indicated the purpose of the review?
- Are the parameters of the review reasonable?
- Why did they include some of the literature and exclude others?
- Which years did they exclude?
- Have they emphasized recent developments?
- Have they focused on primary sources with only selective use of secondary sources?
- Is the literature they have selected relevant?
- Is their bibliographic data complete?

A literature review is not necessarily divided into distinct sections like a research manuscript (e.g., methods, results), so students will have to give careful thought into the construction of their review paper. Have they organized their material according to issues? Is there logic in the way they organized the material? Does the amount of detail included on an issue relate to its importance? Have they been sufficiently critical of design and methodological issues? Have they indicated when results were conflicting or inconclusive and discussed possible reasons? Finally, has their summary of the current literature contributed to the reader's understanding of the problems?

Structure of the Literature Review

The Capstone Report should be written using these general guidelines, if a literature review project was completed. Bound as well as electronic copies of their report must be submitted to their academic advisor and the MSC Associate Director. It must follow [ACS style guide](#).

Sections must be organized as listed below:

1. Pretext Pages (follow above guidelines)
 - i) Abstract Page
 - j) Title Page
 - k) Approval Page
 - l) Acknowledgements (optional)
 - m) Table of Contents
 - n) List of Figures
 - o) List of Tables
 - p) List of Appendices
6. Literature Review (see below)
7. References (see page 52 for some formatting guidelines)
8. Appendices
9. Fly Leaf (blank page)

The overall structure of a students' review will depend largely on their own thesis or research area. What they will need to do is to group together and compare and contrast the varying opinions of different writers on certain topics. What they must not do is just describe what one writer says, and then go on to give a general overview of another writer, and then another, and so on. Their structure should be dictated instead by topic areas, controversial issues or by questions to which there are varying approaches and theories. Within each of these sections, they would then discuss what the different literature argues, remembering to link this to their own purpose. Document must follow ACS style guide (citations, tables, schemes, figures, equations, etc.). For additional information about format guidelines, please visit: [ACS style guide](#).

Linking words are important. If they are grouping together writers with similar opinions, they would use words or phrases such as "similarly", "in addition", "also", and "again". More importantly, if there is disagreement, they need to indicate clearly that they are aware of this by the use of linkers such as "however", "on the other hand", "conversely", or "nevertheless".

At the end of the review, students must include a summary of what the literature implies, which again links to their hypothesis or main question.

AN ABSTRACT OF THE CAPSTONE REPORT OF

Student Name for the degree of Master of Chemical Sciences

Title: Underlined Title here

Project conducted at: Company Name and complete mailing address

Supervisor: Supervisor's or Research Advisor Name and Title

Dates of Project: *start (approval of proposal) and end dates (presentation date)*

Abstract approved:

*Printed Name, Academic Advisor**

Begin text here, using the same spacing, font style and font size as within the body of the text in their document.

**Include academic advisor's middle initial unless there is none. Do not include his/her title. Co-academic advisors may share the same signature line; put both names below the line.*

*Quantum Mechanics and the Electronic Structure of Atoms and
Molecules*

by
Linus Pauling

A CAPSTONE REPORT

submitted to the

University of Pennsylvania

in partial fulfillment of
the requirements for
the degree of

Masters of Chemical Sciences

Presented *date of the presentation*
Commencement *date of commencement for term*

Master of Chemical Sciences Capstone Report of Linus C. Pauling presented on *date of presentation*.

APPROVED:

Academic Advisor (Research Advisor), representing Area of Concentration

I understand that my Capstone Report will become part of the permanent collection of the University of Pennsylvania Master of Chemical Sciences Program. My signature below authorizes release of my final report to any reader upon request.

Linus C. Pauling, Author

Table of Contents

Abstract.....	i
Approval Page.....	ii
Dedication.....	iii
Acknowledgements.....	iv
Table of Contents.....	v
List of Figures.....	vi
List of Schemes.....	vii
List of Tables.....	viii
List of Appendices.....	ix
Introduction.....	1
Materials and Methods.....	5
General Considerations.....	5
Experimental.....	6
Results and Discussion.....	15
<i>Subtopic 1</i> (not required).....	15
<i>Subtopic 2</i> (not required).....	18
<i>Subtopic 3</i> (not required).....	24
Conclusion and Future Work.....	29
References.....	30
Appendices.....	34

V. Guidelines for Oral Presentation

Students' abstracts from capstone reports will be compiled, printed, and bound for distribution during an individualized capstone presentation.

Students will summarize their capstone project objectives, design, and results during a 30-minute presentation, depending on the scope of the project, followed by questions and answers. The length of the presentation will depend on the presentation style. All committee members must be present at this presentation. Faculty members attending the event will be asked to evaluate speakers to provide them with helpful feedback regarding their presentations. All students will be evaluated by the presentation and their ability to answer questions.

Here are some guidelines to help students prepare for their oral presentation.

Wear suitable, professional clothing and be aware of their body language. Use best practices discussed in the Pro-seminar courses. Be aware of their audience so that they can address possible points of confusion and keep them engaged.

The structure of their talk will be slightly different than their written report. They will have to tell listeners what they plan to say, share the information succinctly, and finally summarize key points that they want them to remember. In other words:

- Share what they plan to say
- Say it
- Summarize what they said

When students share the details of their project, they should start with an introduction explaining their objectives, describe the methods used, summarize the results, and highlight their conclusions. Let the audience leave having learned one new thing. Emphasize this point! What is it that they want the audience to remember about their work?

Use transitions appropriately to help guide listeners through their presentation. Use dramatic pauses to give the audience time to think about what they are saying; don't fill in pauses with "um" or "you know" phrases. Avoid colloquialisms and slang. Utilize gestures and vary vocalizations to emphasize key points and engage the audience. Avoid distracting mannerisms like jingling coins in a pocket, drink water excessively to cure a dry throat, or wave around a pointer unnecessarily. Don't stand in front of the screen and do NOT read their slides!

Students should use on average 1 slide per minute – so no more than 10-15 slides for their presentation. Don't put too much information on each slide, share too many details, or meander. Use good visual aids (include color, simplicity is desired, writing needs to be large enough to read from the back of a room). Practice their talk. Make sure that they can deliver their presentation within the 15-minute time limit, and when their time is up – STOP! No one appreciates it when they go over. It is unprofessional.

Respond to questions in a concise fashion. Remember, only one person in the audience (the person who asked the question) may be interested in their response. Students may have several people who are interested in asking questions after their presentation.

PowerPoint Presentation Guidelines

- Keep words large enough---at least size 24.
- Limit the number of words put on a single slide.
 - Avoid paragraphs
 - Use bullet points
 - Use succinct phrases instead of sentences
 - Limit each slide to 6 bullet points
- Fancy is not always better; stick with simple fonts.
 - Fonts "with feet" are easier to read (in a phrase)
 - Fonts "without feet" make nice titles
- Choose color combinations that make text easy to read.
- Limit graphics to 1-3 per page; too many graphics can be distracting.
- Slides are designed to supplement the presentation---not to BE the presentation. Keep it simple, and don't read the presentation word for word from the slides.
- Fill out a storyboard before beginning to put the presentation together. It will help to stay organized, and things will get done faster.
- Basic rule of presentations----Bells and whistles are fun to put in, but they tend to be distracting for the viewer. Make sure that special effects have a purpose.
- Proofread and spell check! Proofread and spell check! Proofread and spell check!
- Use one transition for all slides.
- Every bullet is followed by a capital letter; each bullet has eight words or less- no complete sentences- no periods, question marks, or exclamation points- no ALL CAPS.

MOST OF ALL, remember that the PowerPoint presentation is supposed to ENHANCE the students' talk... not "become" the talk!

VI. Guidelines for Poster Presentation

Poster Guidelines

Students can inexpensively create a poster using a graphics software package such as PowerPoint. Posters can be printed at the Department of Chemistry, Weigle Information Commons located in the Van Pelt Library, or there are other commercial options. Make their presentation as visual as possible. Information can be transmitted more efficiently with a picture, figure, or graph. Additional guidelines will be posted in the MCS canvas community.

Format requirements and tips:

- Posters should not be larger than 4' x 4' in total size
- Key topics should expand on the key statements made in students' abstract
- Avoid clutter – limit their presentation to the main ideas, emphasizing important points
- Keep the lettering simple – use no more than three different font sizes (largest for the title; 2nd largest for section titles; smallest for text (usually 24 font readable from a distance of 3-4')).
- Keep the colors simple – too much color can be distracting, while too little color can be boring
- Proofread – a LOT – prior to printing

Poster Evaluation Criteria

Faculty members will be asked to consider the following criteria when evaluating abstracts and poster presentations

- ORIGINALITY – How original is the concept presented in the poster, or how original is the new approach to an old problem? (15 points)
- SIGNIFICANCE – How significant or relevant are the conclusions in meeting the project's objectives and/or increasing understanding of a particular problem within a scientific discipline? (15 points)
- ORGANIZATION – How logical are the ideas presented in the poster design? How clearly written and free of grammatical errors is the presentation? (20 points)
- METHODS – If applicable, how suitable is the design for the stated objectives, how appropriate are the analytical techniques, and/or how complete was the literature review? (15 points)
- VISUAL IMPACT – How effective is the presentation visually? How valuable is each figure and graph in furthering viewers' understanding of the subject? (15 points)
- DISCUSSION – How knowledgeable and conversant is the student with the work presented? Did the student present him/herself in a professional manner? (20 points)

Scores with comments will be available to students within 1-2 weeks of the end of the event.

Poster Checklist

- Titles, authors, and institutional affiliations are listed
- Key statements required are included in abstract and poster content
- Logical sequence of information flow
- Photographs graphs, tables and charts are used whenever possible to display data or convey important information
- Each section is concise and clear
- Text can be read from 3' to 5' away
- Same font is used throughout
- Color, lines, boxes, and arrows are used to emphasize important points

VII. Capstone Evaluation Tools

Speaker Evaluation Form

Speaker: _____ Date: _____

Title: _____

Time Taken: _____

Instructions: Using the below scale, circle the number or word alongside each statement that best describes students' opinion. If they do not have an opinion, leave that line blank.

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

TOPIC PRESENTED:

- | | | | | |
|---|---|---|---|---|
| 1. The talk took into consideration the audience's technical background | 1 | 2 | 3 | 4 |
| 2. The purpose & key points were clear | 1 | 2 | 3 | 4 |
| 3. The ideas & information presented were valuable | 1 | 2 | 3 | 4 |
| 4. Related topic to audience | 1 | 2 | 3 | 4 |
| 5. Engaged the audience effectively | 1 | 2 | 3 | 4 |
| 6. Purpose statement was presented | 1 | 2 | 3 | 4 |

THE SPEAKER:

- | | | | | |
|--|---|---|---|---|
| 1. Conveyed ideas clearly | 1 | 2 | 3 | 4 |
| 2. Was knowledgeable about the subject matter | 1 | 2 | 3 | 4 |
| 3. Communicated in an understandable way | 1 | 2 | 3 | 4 |
| 4. Was responsive to questions from the group | 1 | 2 | 3 | 4 |
| 5. Was capable of answering questions from the group | 1 | 2 | 3 | 4 |

DELIVERY:

- | | | | | |
|---|---|---|---|---|
| 1. Appropriate tone, posture, and gestures | 1 | 2 | 3 | 4 |
| 2. Minimal use of fillers (<i>um, like, and ah</i>) | 1 | 2 | 3 | 4 |
| 3. Effective visual aids | 1 | 2 | 3 | 4 |
| 4. Acted in a professional manner | 1 | 2 | 3 | 4 |

BODY OF THE SPEECH:

- | | | | | |
|---|---|---|---|---|
| 1. Well-structured organization | 1 | 2 | 3 | 4 |
| 2. Main points clearly stated | 1 | 2 | 3 | 4 |
| 3. Addressed the main ideas | 1 | 2 | 3 | 4 |
| 4. Adequate transitions between ideas | 1 | 2 | 3 | 4 |
| 5. Experimental rationale and design clearly stated | 1 | 2 | 3 | 4 |
| 6. Use of evidence (statistics, etc.) | 1 | 2 | 3 | 4 |
| 7. Demonstrated data analysis, problem solving and critical thinking skills | 1 | 2 | 3 | 4 |
| 8. Quality of research presented | 1 | 2 | 3 | 4 |

9. Sources properly cited	1	2	3	4
10. Research contributed to advancing the field	1	2	3	4

CONCLUSION:

1. Summary of ideas	1	2	3	4
2. Presented reasonable conclusion(s)	1	2	3	4
3. Responded to questions	1	2	3	4
4. Engaged the audience most of the time	1	2	3	4

COMMENTS:

If you could improve one element of the presentation, I would suggest that you try to:

Evaluator: _____

Overall Score: _____ (Scale of 1 to 10: 1 being poor and 10 being excellent)

Poster Evaluation Form

Evaluators: Please consider the following criteria when evaluating oral presentations:

- ORIGINALITY – How original is the concept presented in the poster, or how original is the new approach to an old problem? (15 points)
- SIGNIFICANCE – How significant or relevant are the conclusions in meeting the project's objectives and/or increasing understanding of a particular problem within a scientific discipline? (15 points)
- ORGANIZATION – How logical are the ideas presented in the poster design? How clearly written and free of grammatical errors is the presentation? (20 points)
- METHODS – If applicable, how suitable is the design for the stated objectives, and how appropriate are the experimental design and rationale? (15 points)
- VISUAL IMPACT – How effective is the presentation visually? How valuable is each figure and graph in furthering viewers' understanding of the subject? (15 points)
- DISCUSSION – How knowledgeable and conversant is the student with the work presented? Did the student present him/herself in a professional manner? Was the material explained at the appropriate level to the audience? (20 points)

Student Name: _____

Title of Presentation: _____

Criteria	Comments	Points
Originality (15 pts. max)		
Significance (15 pts. max)		
Organization (20 pts. max)		
Methods (15 pts. max)		
Visual Impact (15 pts. max)		
Discussion (20 pts. max)		
TOTAL (100 pts. max)		

Name of Evaluator: _____

Signature: _____ Date _____

Project Supervisor Evaluation Form

Thank you for providing an educational research opportunity for one of our MCS students. The completion of this form will allow us to assess the student's performance during the project and provide the student with valuable feedback regarding his/ her strengths and weaknesses as a prospective professional in this field.

Name of Student: _____

Student's Major Advisor: _____

Sponsoring Organization: _____

Project Start Date:

Project End Date:

Student's Research Project Overview or title: _____

Please comment on the following 5 areas:

1. Overall attitude toward project assignment(s):

Enthusiastic? Indifferent? Eager? Bored? Receptive? Disinterested? Diligent? Not energetic?

2. Effectiveness in executing assignments:

Productive? Learns quickly? Self-starter? Problem solver? Fails to understand or following directions?
Meets deadlines? Requires close supervision? Needs to ask more questions?

3. Originality / Contribution to research project:

Contributed to experimental design? Demonstrated problem solving and critical thinking skills? Depth of knowledge at the master's level? Up to date in current research? Data analytical skills? Quality of conclusion?

4. Dependability:

Responsible? Uses good judgment? Hesitant to make decisions? Follows through consistently on assignments? Persistent?

5. Relationships with others:

Considerate? Friendly? Distant? Team Player? Shy? Cooperative? Respected? Brash? Receives suggestions well? Tactful? Mature? Argumentative? Honest? Objective?

6. Work ethic:

Prompt? Tardy? Wasteful? Professional attitude? Appropriate dress and grooming? Makes excuses? Poised? Accepts praise and criticism appropriately?

What type of feedback have you provided this student and his/her performance during the project? In what way was work progress reviewed and how?

How has this student responded to your suggestions for carrying out his/her work assignments?

OVERALL EVALUATION of student's current level of work experience and education:

- Outstanding (performed well beyond expectations)
- Very Good (high quality performance)
- Good (performed all tasks as expected)
- Marginal (performance mostly inadequate - needs improvement)
- Unsatisfactory (please contact the PSM coordinator)

Has the general content of this evaluation been discussed with the student?

Yes

No

Would you be willing to consider another student from the University of Pennsylvania MCS Program?

Yes

No

Additional comments (optional):

MCS 699 Capstone Project Evaluation

Student name: _____ Date: _____

Title of project: _____

Evaluation Criteria	Does not meet expectations	Meets expectations	Exemplary performance
Written work: Clearly articulated project goals, methodology, results, and discussion OR clearly articulated thesis supported by appropriate library research, selected examples and critical analysis			
Research Skills: Completed project goals, acquired new analytical skills, and analyzed data appropriately OR effectively sourced information, created an appropriate bibliography, and used other relevant research materials			
Technical Knowledge: Demonstrated knowledge in the research area at the master level, cites relevant and current research, and applies knowledge gained towards the development of the research project			
Critical Thinking: Demonstrated capability for independent research and/or work in the area of concentration			
Supervisor's Evaluation: Completed project goals as described in the capstone project proposal			

Assessment of the overall performance of the student is based on the items above:

Criteria	Performance Ratings		
	Must Revise and Resubmit Capstone Project Report	Completed MCS Capstone Project	
	Does not meet expectations	Meets expectations (B)	Exemplary performance (A)
Grade is:			

Examiner: Please provide written commentary below as needed.

Name of the Evaluator: _____

Signature: _____

Date: _____