

Master of Chemical Sciences

Student Handbook

University of Pennsylvania



College of Liberal and Professional Studies
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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 webpages, or regular meetings with academic advisors. Students need to meet with their academic advisor at least once per semester 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 experience 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 Program 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 Program 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 4 years.

A. 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 SAS.

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 academic courses or a research course 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:

- MCS 5400 – *Pro-seminar* taught during fall semester of the 1st year, and
- MCS 6990 – *Capstone Research III & Seminar*, which students register for as completion of their research.

MCS 5400 – *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 and 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 6990 – *Capstone Research III & Seminar*

The research project, expected to span two to three terms with prior advisor approval, will culminate in a written scientific capstone paper and presentation(s). The class is taken after completion of the majority of research and will count as 1 CU towards the degree requirement.

Students also take 4-6 core courses in an area of concentration, which will help them acquire the skills necessary to master a subdiscipline in chemistry and prepare for their final capstone project. Ideally, each student will build 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

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

Students in 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 or Policy 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 concentration 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 discipline.

An optional *Independent Studies* course (MCS 5990 or MCS 5980) provides opportunities to conduct laboratory research in the Chemistry Department and learn specific analytical techniques appropriate for a future capstone project. The course may be repeated for credit with permission from the instructor, but only 1 CU may count toward the minimum 10 CUs required for the MCS degree.

A. Program of Study

Students should meet with their academic advisor and MCS Associate Director at least once a semester prior to registering for courses. This is especially important during a student's first semester when an **Academic Planning Worksheet** (Appendix A) 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 5210	Statistical mechanics I	1	CHEM 5220	Statistical mechanics II	1
CHEM 5230	Quantum chemistry I	1	CHEM 5240	Quantum chemistry II	1
MCS 5400	Pro-seminar	1	MCS 5990	Independent studies	1
			CHEM 5260	Chemical dynamics	1
SUMMER					
MCS 6970*	Capstone Research I Practicum	2			
FALL	COURSE	CUs	SPRING	COURSE	CUs
MCS 6980*	Capstone Research II	2	STAT 5000	Applied regression & analysis of variance	1
CHEM 5250	Molecular spectroscopy	1	MCS 6990	Capstone Research III & Seminar	1
Total CUs	10				

*MCS 6970 and MCS 6980 do not count towards the minimum 10 CUs required for the MCS degree; only 1 CU for Capstone Research III (MCS 6990) counts toward the degree. The tuition for MCS 6970 and MCS 6980 has been suppressed to 0.15 CU (~\$1,300) each.

B. 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 them 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 project may focus on research completed in a Penn laboratory or an off-campus location, or be a literature-based review, but ALL components will require an approved proposal prior to initiation and result in a final scientific capstone paper (see guidelines in Appendix C).

Students will be guided and evaluated by a committee composed of a primary reader, a secondary reader, and the MCS Associate Director. The capstone proposal will be developed by the student in collaboration with the student's academic advisor (or primary reader), 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 spring semester of the second year. For literature reviews, the time spent on the capstone will vary based on capstone proposal goals. 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 primary reader and secondary reader or 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 after a vetting process by the MCS Associate Director. 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.

C. 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 2 years. Part-time students typically complete the degree in 4 years, taking one or two classes per semester. Students are expected to complete their degree in 4 years. Students needing additional time to complete their degree must petition the Faculty Advisory Committee for permission to continue beyond the 4-year rule.

IV. Program Policies

A. 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 will meet every semester to 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 beginning 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 Worksheet](#) (see Appendix A). 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 academic advisor, 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, II, 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 19 or Appendix C for more detailed information regarding academic advising and faculty advisor selection protocol.

1. 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.

2. 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 when enrolled in MCS 9900.
- 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 two 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-”.

3. 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.

4. 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. *Starting Summer 2022, a Long Incomplete (II) is no longer available as a grading option.

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.

5. 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 2 weeks of the academic semester immediately following the semester in which the grade was received. The instructor must respond in writing to the student within 2 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.

B. Enrollment Status

1. Inactive status

Students who do not enroll in courses for four consecutive semesters, including summer, will be considered 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.

2. 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
- Complete 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 75% of students who take a leave

return to complete their MCS degree within 2 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 the MCS Associate Director is an important first step. Depending on their circumstances, students 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 MCS Associate 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. It is recommended that students on leave remain in contact with the MCS Associate 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 the MCS Associate 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 the MCS Associate 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 Director. If the request is approved, the Director 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 MCS Associate Director may deny any request for leave. In granting leaves, the decision of the Director 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 MCS Associate Director 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 semester'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

All relevant offices should be notified regarding a student's leave or drop. These offices may include the following, if applicable:

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

While Out

During the semester of their leave, students may call their program office if they have any questions. Students should be aware of the conditions for their return to Penn outlined in their leave of absence letter, because they will be required to fulfill them before they may re-enroll.

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 the MCS Associate Director and asking for the Request to Return From Leave form. Any return request submitted to the Associate Director 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.

3. Provisional admission

Some students seeking admission to the MCS Program 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 Program provisionally. Applicants accepted as provisional admits must adhere to the following:

- Full-time students must complete two required core graduate-level courses at Penn *and* the MCS 5400 Proseminar.
- 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 during their first semester, they must receive a "B-" or better grade in all of the courses.
- Students may not receive an Incomplete (I, II, 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.

4. 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.

5. 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 Penn, and they must submit final official

transcripts of any coursework completed prior to enrolling in courses for the MCS Program.

6. Transfer credit

Students who are admitted to 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 transfer credit approval prior to enrolling in the first semester of study. 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 should take 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.

C. 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](#)). 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 to apply for major grants and fellowships. Additional information can also be found in the [Grad Center webpage](#). MCS students might be eligible for Penn-based competitive funding opportunities:

- [GAPSA Fellowships and Student Travel Grants](#)
- [Dolores Zohrab Liebmann Fellowship](#)

1. 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 locations might offer a stipend for MCS students completing the capstone project at their facility.

V. Designing a Program and Course Registration

A. Student Advising

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. **The Director will also 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 5990 *Independent Studies*, MCS 6970 *Capstone Research I Practicum*, MCS 6980 *Capstone Research II*, MCS 6990 *Capstone Research III & Seminar*, and MCS 9900 *Capstone Continuation* with input from the secondary reader. Selecting an academic advisor requires preparation, which includes:

- Visiting the Chemistry Department's website to learn about faculty members who could potentially serve as academic advisors based on similar research interests.
- Attending poster sessions offered where Penn Chemistry faculty and graduate students present current research opportunities (beginning of Fall semester).
- Attending seminars and/or group meetings during fall semester (mid-September through mid-November). Student attendance at these seminars is highly recommended, regardless of their area of concentration.
- Participating in webinars and presentations given by representatives from off-campus locations during MCS 5400 *Proseminar*. Representatives will provide an overview of their institution and available projects.
- Watching videos of virtual poster sessions and/or scientific presentations given by Penn faculty members and off-campus representatives (these are posted in the MCS Canvas Community).
- Reading recent publications by the professor and their colleagues prior to meeting with them.

Students should meet with their academic advisor and MCS Associate Director at least once a semester to discuss their academic progress and choose courses for the following semester. The worksheet available in the 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 5400 *Pro-seminar* fall semester.
- In collaboration with the academic advisor and capstone supervisor or secondary reader, define a research project, draft a research proposal (see Appendix C), and get the proposal approved prior to starting the project.

Full-time 2nd year students are expected to:

- Be registered in *Capstone Research* courses (MCS 6970, MCS 6980) while completing the capstone requirement.
- Complete their research project, write their paper, and receive a grade for MCS 6990 *Capstone Research III & Seminar*.
- Make sure all requirements for graduation are met (see Section V below).

B. Course Registration Procedures

1. 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. The Associate Director will provide permits to students for courses after completing the academic advising sessions and [Academic Planning Worksheet](#).

2. [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.

3. [Registration](#)

The regular registration and add/drop period opens approximately 3 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.

When registering for courses, student should first:

- 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 graduate courses (numbered 4000 and above) may count toward the degree (the *first* set of four digits after the course subject is the course number (e.g., MCS [5400](#))).
- Full-time students typically enroll in three or four courses or research courses; students are not permitted to enroll in more than four courses per semester.
- Part-time students enroll in one or two courses per semester.

4. [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.

5. [Registering for MCS and non-MCS courses and permits](#)

MCS students may register for graduate courses (numbered 4000 and above) in other Penn departments and schools, if those courses are appropriate to the student's program. Students must 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 may also require permission from the instructor to register for courses outside

the Department of Chemistry. Courses that require special permission from the department or instructor are indicated in the course timetable as “Permit Required”. 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.

Students registering for MCS research courses must first meet with the Associate Director prior to requesting permission for the course.

Students will receive permits for the courses approved by the Associate Director. A permit is not a registration. Students must “claim” the permit by actually enrolling in the course through Courses@Penn. After both advance registration and regular registration are complete, the Registrar’s Office removes unused permits from students’ records.

6. 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 [LPS Academic Calendar](#) for deadlines to make registration changes and view financial obligations. Students are able to make changes in Courses@Penn. 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.

7. 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 Courses@Penn to add courses during this time and follow the MCS process for enrolling courses.

8. Dropping a course

Students may drop a course with no financial obligation until the published deadline in the current LPS Course Guide (approximately 2 weeks into the term). Students may also drop a course between the second and fourth weeks of the semester, but in so doing, they will incur a 50% financial obligation for 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 Course@Penn through the second week of the semester. After the second week, students must contact the MCS Associate Director directly to drop a course. When making registration changes via Courses@Penn, 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.**

9. Changing the 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. However, before doing so, 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.

10. Withdrawing from a course

Students may withdraw from a course after the deadline to drop a course has passed (approximately 4 weeks into the semester). 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% 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.

11. 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 5980 or MCS 5990 *Independent Studies* only if they have not submitted a capstone proposal for approval. Students should first communicate their interests to the Associate Director of the MCS program, prior to approaching a faculty member. The Director will facilitate the process of identifying an appropriate faculty member for the student. Faculty members are not required to supervise an *Independent Studies* course.

MCS 5990 is designed to give students additional laboratory research skills in preparation for their capstone project, and requires an additional laboratory fee. 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). In order to be evaluated and receive a grade for MCS 5980 and 5990, students must submit a **Technical Research Report** describing research/laboratory activities.

Students interested in completing a literature review in preparation for drafting their capstone proposal can register for MCS 5980.

Clear goals for both types of *Independent Studies* courses are required. MCS students may register for up to two *Independent Studies* courses during their academic career; however, only 1 CU for MCS 5990 or 1 CU for MCS 5980 will count toward the minimum 10 CUs required for graduation.

Students must complete the online MCS 5980/5990 Registration Form (Appendix B), and the MCS Associate Director needs to approve it before the student can register for the class.

12. 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 work in a laboratory on or off campus without being registered in a research course.** Students must indicate how many hours per week they will be working on their capstone project.

- *Capstone Research I Practicum* (MCS 6970, 2 CU) – Advanced study and research in various branches of chemistry with the goal of advancing the capstone project usually taken during the summer. **A Capstone Research Proposal must be approved 2 weeks prior to research beginning.** This course does not count towards the 10 CUs minimum.
- *Capstone Research II* (MCS 6980, 2 CU) – For students working on their research project for the capstone requirement but who will not be completing or presenting the final report. May be taken more than once. This course is taken by students engaged in intensive research.
- *Capstone Research III & Seminar* (MCS 6990, 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.
- *Master's Continuation* (MCS 9900) (0 CU) – students enroll in this course if they fail to complete their Capstone when enrolled in MCS 6990. Students enrolled in *Master's Continuation* maintain access to the library and their Penn e-mail accounts. Students are allowed to enroll in this course twice; students not completing the program requirements after two semesters of *Master's Continuation* may be withdrawn from the program.

The cost of registration for *Capstone Research I Practicum* (MCS 6970), *Capstone Research II* (MCS 6980) and *Master's Continuation* (MCS 9900) is less than the cost of a regular course (approximately \$1,300 per course), and keeps the student's status active.

Students will be placed on academic probation if they need to enroll in *Master's Continuation* (MCS 9900) a second time, because it is an indication that they have not made significant progress on their capstone project. Students who wish to extend *Master's Continuation* registration beyond one semester must submit a revised timeline for capstone completion along with a justification at least one month prior to the semester's end. The request must be approved and signed by the student's academic and/or research advisor. 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 6970 and 6980, students must submit a **Technical Research Report** describing research progress to the MCS Associate Director and research advisor (see Appendix D). To receive a grade for MCS 6990 or 9900, students are required to submit a final Capstone Research paper, and give an oral and poster presentation.

13. 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 to study or research, students are considered to be full-time when enrolled in:

- three or four courses per semester
- *Independent Studies* (MCS 5980 or 5990)
- *Capstone Research I Practicum* (MCS 6970)
- *Capstone Research II* (MCS 6980)

- *Capstone Research III & Seminar* (MCS 6990)
- *Master's Continuation* (MCS 9900)

If a student is enrolled in two or fewer courses in a single semester (other than those described above) or is devoting less than 35 hours/week to research for their capstone project, they are considered part-time. Students who meet the requirements of a full-time student are automatically enrolled in Penn's student health insurance 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

A. Faculty Readers and Project Mentors

Students will be guided and evaluated by a committee composed of two faculty / expert academic readers and the MCS 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 grades for capstone courses, including MCS 6990. 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.

B. Capstone Research Project

It is expected that the capstone project will take two to three semesters to complete 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 should focus on a specific topic they decide upon in consultation with their academic advisor. Students will need to demonstrate 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 technical progress report(s), final capstone research paper, 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 their capstone research at the end of the first academic year during the summer and conclude at the end of fall or spring semester of the second year. Depending on the capstone option selected, students may begin working on their project as early as spring semester during their first year in the program. Students enroll in capstone research courses (MCS 6970 and MCS 6980) while they work on their project but are not completing or presenting the final report. Students register for MCS 6990 *Capstone Research III & Seminar* during their final semester just prior to graduation. The course

grade for capstone credit (MCS 6990) will be assigned with feedback from 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 their 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.

C. 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	Two weeks prior to the start of the semester when the student intends to initiate the capstone project
Graduation application	Finishing spring semester: Feb 1 Finishing summer semester: Jun 1 (Feb 1 to participate in ceremony) Finishing fall semester: Oct 1
Capstone project oral and poster presentation	No later than three weeks before the last day of classes
Capstone project paper completed and approved	No later than one week after the last day of classes

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).

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

- Master of Chemical Sciences Capstone Project Proposal Cover Sheet Form & Signed by Research mentor (Primary and Secondary Readers; due after first year in May, before Capstone Research begins)
- Final Capstone Research Paper with corrections and signed by Research Advisor (Approved) Form
- [Scholarly Commons Application](#) (to publish the student’s work in Penn’s online repository; unless Research is embargoed/confidential)

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 9900) during the subsequent semester until the complete and approved capstone project report and oral and poster presentations have been submitted to the MCS program. **Students are allowed to enroll in *Master’s Continuation* (MCS 9900) a maximum of two semesters.** 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 semester 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 semester in which they complete their capstone and receive a grade.

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

VII. University Policies and Resources

A. 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.

B. 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 semester may receive a PennCard, which must be carried at all times.

C. 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 Courses@Penn (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.

D. Path@Penn

[Path@Penn](#) 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.

E. 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 email 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](#).

F. Academic Support Services

The [Weingarten Center](#), located at 220 South 40th Street, Suite 260, 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 semester for LPS students. Special workshop series are also offered for international students.

The Weingarten Center also provides comprehensive professional services and programs for students with disabilities to ensure equal academic opportunities and participation in University sponsored programs. Reasonable accommodation for 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. For more information about the Weingarten Center, visit their website or call 215-573-9235.

Other support services include:

- [University Life](#)
- [Marks Family Writing Center](#)

G. Room Reservations

Students can reserve rooms in our Chemistry 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's 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 for reservations. 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 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](#).

H. 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).

I. 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 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.*

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. Students should 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.

J. Counseling and Psychological Services

[Counseling and Psychological Services](#) (CAPS) are for students of the University of Pennsylvania. All counseling services are free and confidential. If students have an emergency that cannot wait, they should call 215-898-7021 and press 1 to talk to a clinician 24 hours a day, 7 days a week. Students can also drop-in and meet with a clinician during regular business hours, or connect via telehealth. Their counseling services are located at 3624 Market Street, First Floor West.

CAPS provides a variety of counseling services, including individual therapy, couples/family therapy, group therapy, crisis management, referral services, and outreach and prevention. They also offer [international student programs and resources](#).

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.

K. Student Registration & Financial Services

Student financial aid, including applications and disbursement of money, are handled through [Student Registration and Financial Services](#) (SRFS). 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.

L. 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.

M. 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). Students can also use the services of [Penn Chemistry Computing](#).

N. 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 [Digital Media Lab](#) and [virtual PC lab](#).

O. 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.

P. Information for International Students

International students are responsible for maintaining their proper student visa status and for complying with any administrative and registration deadlines that come from the Registrar and MCS Program. 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 3819-33 Chestnut Street, Suite 305 and can be reached by [submitting a form online](#) or calling 215-898-4661. To schedule an appointment, do so online through [iPenn](#).

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) Complete the tutorial in iPenn (before or after you arrive in the US), and 2) Complete the arrival form in iPenn (after you arrive in the U.S.). Both steps must be completed after arrival in the U.S. – and within 15 days of the program start date listed on your I-20 document (F-1 students), or 20 days for DS-2019 (J-1 students).

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.

Q. 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.

R. 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.

S. 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, which can be found here: [Sexual Harassment Policy](#). The official office for reporting, initiating a formal complaint, and investigation of violations of the Sexual Misconduct Policies, including violations of the Sexual Harassment or Sexual Violence Policies, is the Office of the Associate Vice President for Equity and Title IX Officer. The contact information for that Office is:

Associate Vice President for Equity and Title IX Officer

3901 Walnut Street, Suite 320

Phone: 215-898-2887

Email: TitleIXOfficer@upenn.edu

T. 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 2 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.

U. 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.

V. 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. For additional information about Penn's [Equal Opportunity and Affirmative Action Policy](#).

W. 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 while enrolled as a student in the MCS Program must be submitted to the MCS Associate Director.

Appendix A - MCS Curriculum



Academic Planning Worksheet

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

Pro-seminar 1 CU

- MCS 5400 Pro-seminar I (1 CU)

Capstone Research

- MCS 6970 Capstone Research I Practicum (2 CU), cost ~\$1.3K
- MCS 6980 Capstone Research II (2CU), cost ~\$1.3K, may be repeated 2x
- MCS 6990 Capstone Research III & Seminar (1 CU)*
- MCS 9900 (Master's Continuation; (0 CU) cost ~\$1.3K
*only 1CU (MCS 6990 will be counted in the 10 CU required for graduation)

Additional Electives – 1-2 CUs minimum

- CHEM 7xxx (This course if offered under different titles, is worth 0.5 - 1 CU, and students may register for it more than once.)
- MCS 5980 (Independent Studies: Literature Review)
- MCS 5990 (Independent Studies: Research Techniques)
- Other:

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

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

Biological

- CHEM 5510 Biological Chemistry I
- CHEM 5520 Biological Chemistry II
- CHEM 5550 Macromolecular Crystallography: Methods/Applications
- CHEM 5670 Bioinorganic Chemistry

Inorganic

- CHEM 5620 Inorganic Chemistry II
- CHEM 5640 Organometallics
- CHEM 5650 Main Group Chemistry
- CHEM 5670 Bioinorganic Chemistry

Organic

- CHEM 7460 Intermediate Organic Chemistry
- CHEM 5430 Modern Organic Synthesis
- CHEM 5640 Organometallics
- CHEM 7510 Chemical Biology (1 CU) or CHEM 5410 Physical Organic Chemistry (0.5 CU)

Physical

- CHEM 5210 Statistical Mechanics I
- CHEM 5220 Statistical Mechanics II
- CHEM 5230 Quantum Chemistry I
- CHEM 5240 Quantum Chemistry II
- CHEM 5250 Molecular Spectroscopy
- CHEM 5260 Chemical Dynamics

Materials (Organic Track)

- CHEM 7640 Materials Chemistry
- CHEM 7460 Intermediate Organic Synthesis
- CHEM 5430 Modern Organic Synthesis or CHEM 5640 Organometallic Chemistry
- 2 materials courses

Materials (Inorganic Track)

- CHEM 5620 Inorganic Chemistry II
- CHEM 5650 Main Group Chemistry
- CHEM 7640 Materials Chemistry
- 2 materials courses

Electives for Material Science - 2-4 CUs

Electronic & Optical Devices and Sensors	MSE 5360, MSE 6110, 6400
Energy and Sustainability	MSE 5450
Nanotechnology	MSE 5250, MSE 5650
Fundamentals of Materials, Intro to Polymers	MSE 5070, MSE 5800
Machine Learning	MSE 5760

Environmental (Organic Track)

- CHEM 7460 Intermediate Organic Synthesis
- CHEM 7080 Photochemistry (0.5 CU) and CHEM 7410 Spectroscopy (0.5 CU)
- CHEM 5640 Organometallic Chemistry
- 2 environmental courses

Environmental (Biological Track)

- CHEM 5510 Biological Chemistry I
- CHEM 5520 Biological Chemistry II
- CHEM 5550 or CHEM 7510 or BIOL 5210 Molecular Genetics
- 2 environmental courses

Electives for Environmental Science – 2-4 CUs Modeling (M) or Policy (P)

Fall Courses

Course Number	Course Title
ENVS 5220 660	<u>Sustainable Agriculture and Product Stewardship.</u>
ENVS 5404 660	<u>Wetlands</u>
ENVS 5600 660	<u>Developing Environmental Policy (P)</u>
ENVS 5706 660	<u>Modeling Geographical Objects (M)</u>
ENVS 6300 660	<u>The Future of water</u>
ENVS 6500 660	<u>Sustainability and Anthropogenic Impacts</u>
ENVS 6540 660	<u>Corporate Sustainability Management & Communication</u>
ENVS 6551 660	<u>The Principles of Mapping for Environmental Justice</u>
ENVS 6611 660	<u>Floodplain Management in a Changing Climate</u>
DYNAM 6190 001	<u>Organizational Project Management</u>
DYNAM 6580 001	<u>Fundamentals of Sustainability</u>
EESC 5200 690	<u>Aqueous Geochemistry</u>
EESC 5630 695	<u>Hydrology</u>
EESC 5720 695	<u>Environmental Due Diligence (P)</u>

Spring Courses

ENVS 6060 660	<u>Studying Ornithological Principles & Behaviors to Indicate Ecosystem Health</u>
ENVS 6160 660	<u>Risk Assessment: Science & Policy Challenges (P)</u>
ENVS 6290 660	<u>The US Water Industry in the 21st Century</u>
ENVS 6410 660	<u>World Water Forum</u>
ENVS 6440 660	<u>Energy, Waste & the Environment (M)</u>
ENVS 6480 660	<u>Food & Agricultural Policy</u>
ENVS 6810 660	<u>Modeling Geographic Space (M)</u>
ENVS 6820 660	<u>Leading Change for Sustainability</u>
ENVS 6840 660	<u>Ecology, Management, and Advocacy of Urban Forests</u>
GEOL 6430 690	<u>Sustainable Development of Water Resource Systems</u>
GEOL 6440 690	<u>Our Industrial/Environmental Legacy: Contaminated Site</u>
GEOL 6610 690	<u>Environmental Groundwater Hydrology (M)</u>

MCS COURSE LIST

NOTE: This is a selection 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 5210 (1 CU) Statistical Mechanics I. (Ph, Fall) Prerequisite(s): CHEM 2220 or equivalent with permission from instructor. Principles of statistical mechanics with applications to systems of chemical interest.

CHEM 5220 (1 CU) Statistical Mechanics II. (Ph, Spring) Prerequisite(s): CHEM 5210.

A continuation of CHEM 5210. The course will emphasize the statistical mechanical description of systems in condensed phases.

CHEM 5230 (1 CU) Quantum Chemistry I. (Ph, Fall) Prerequisite(s): CHEM 2220 or equivalent with permission from instructor. The principles of quantum theory and applications to atomic systems.

CHEM 5240 (1 CU) Quantum Chemistry II. (Ph, Spring) Prerequisite(s): CHEM 5230. Approximate methods in quantum theory and applications to molecular systems.

CHEM 5250 (1 CU) Molecular Spectroscopy. (Ph, Fall)

This course is broken into two sections: (1) optics, and (2) theory of spectroscopy including the discussion of techniques and examples. In the first section you will be introduced to both linear and nonlinear optics, through thinking about how to design optical components in the laboratory setting. The second part of the course is a more traditional spectroscopy course, where different spectroscopies in the visible and infrared spectral region will be discussed. This part of the course will focus on understanding what we can learn from using spectroscopy and what sort of dynamical processes can be observed with different spectroscopic techniques. Topics to be covered include, but are not limited to: optics, time-dependent perturbation theory, lineshapes, density matrix, group theory, selection rules.

CHEM 5260 (1CU) Chemical Dynamics. (Ph, Spring) Prerequisite: CHEM 5230

Theoretical and experimental aspects of important rate processes in chemistry.

CHEM 5410 (1 CU) Physical Organic Chemistry. (O, MO, Spring) Prerequisite(s): CHEM 7640

Chem 5410 is a high level overview of classical physical organic chemistry. Overview of the principles governing organic bonding, structure, and properties. Quantum calculations as well as laboratory thermodynamic and kinetic measurements used in understanding organic chemical reactions will be surveyed. Mechanisms will be discussed but will not be covered in detail.

CHEM 5430 (1 CU) Modern Organic Synthesis. (O, Fall) Prerequisite(s): CHEM 5440 or CHEM 7460 or permission from instructor. 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 5510 (1 CU) Biological Chemistry I. (B, O, Fall) Prerequisite(s): ([CHEM 2420](#) OR [CHEM 2425](#)) AND [CHEM 2210](#) AND [CHEM 2510](#) or its equivalent and permission of instructor. Structure, dynamics, and function of biological macromolecules. Properties of macromolecular assemblies, membranes and their compartments.

CHEM 5520 (1 CU) Biological Chemistry II. (B, Spring) Prerequisite(s): CHEM 5510 or permission of instructor. Physical and chemical description of macromolecular information transfer. Gene organization, replication, recombination, regulation and expression.

CHEM 5550 (1 CU) (BMB 5540) Macromolecular Crystallography: Methods and Applications. (B, MO, Fall)

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 5580 (0.5 CU) (BMB 5580) Biomolecular Spectroscopy and Microscopy. (B, MO, Spring or Fall)

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 5620 (1CU) Inorganic Chemistry II. (I, MI) Prerequisite(s): CHEM 2610 (Inorganic Chemistry I) 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 5640 (1 CU) Organometallics. (O, I, Fall)

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 5650 (1 CU) Main Group Chemistry. (I, MI, Fall or Spring)

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 5670 (1 CU) (BMB 567) Bio-inorganic Chemistry. (B, I, MI, Spring or Fall)

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 6010 (0.5 CU) Chemical Information (All, Spring or Fall)

This course examines the structure and organization of the chemical literature and introduces techniques of searching this literature, focusing on the logic and thought processes necessary for effective information retrieval. Each technique is illustrated using information tools available at the University of Pennsylvania, and we take an "under the hood" look at the organization and functionality of each tool introduced. Students should choose a course section based on their preferred area of chemistry research: organic, inorganic, biological, and physical chemistry; all four sections are taught at a level appropriate for graduate students and advanced undergraduates. Topics vary by section, but all students learn the basics of subject, author, structure, and reaction searching, and a unit on ethics in publication and scholarly communication completes the course.

CHEM 7210 (0.5 CU) Mathematics for Chemistry (Ph, Spring or Fall)

This course examines the basic mathematics needed for physical chemistry, including (but not limited to) a brief review of linear algebra, Fourier transforms, delta functions, optimization, and the residue theorem. Depending on the year, selected other topics will also be included.

CHEM 7410 (0.5 CU) Spectroscopy (O, Spring or Fall) Prerequisite CHEM 7460 or CHEM 5430

The course will provide a continuation of material covered in Chemistry 7460 and Chemistry 5430, as well as spectroscopy of organic compounds focused mainly on NMR. Topics will include advanced organic mechanisms, electronic structure calculations of organic molecules related to their structure, reactivity, and spectroscopic properties, and Organic Spectroscopic methods for the determination of structure using NMR.

CHEM 7420 (0.5 CU) Medicinal Chemistry and Drug Design (O, Spring or Fall)

CHEM 7430 (0.5 CU) Heterocyclic Chemistry (O, Spring or Fall)

CHEM 7450 (0.5 CU) Total Synthesis (O, Spring)

CHEM 7460 (1 CU) Intermediate Organic Chemistry (O, Fall)

CHEM 7510 (1 CU) Chemical Biology (O, B, Spring)

CHEM 7610 (0.5 CU) Coordination Chemistry (I, MI, Ph, Fall or Spring)

CHEM 7620 (0.5 CU) Xray I (Ph, MI, I, Fall or Spring)

CHEM 7630 (0.5 CU) Xray II (Ph, MI, I, Fall or Spring) Prerequisite CHEM 7620

CHEM 7640 (1 CU) Materials Chemistry (MI, MO, Spring)

This course will provide an introduction of structure-property relationships in materials chemistry on length scales from atomic dimension up to the microscale and then draw on examples of Chemical design for "Energy and Environmental Sustainability." We will introduce the "12 Principles of Green Chemistry" and "12 Principles of Green Engineering" as a guide to modern materials chemistry design and follow a trajectory that proceeds with increasing length scales of ordering in the solid state. We will introduce techniques of x-ray, neutron, electron, and ion beam based scattering, real space imaging and spectroscopies and use these to explore non-crystalline materials (amorphous, glasses, and time permitting quasicrystals and aperiodic systems) and crystalline solids. Studies will proceed from atomic scales through nanoscale, mesoscale, and micro-scale discussing the emergence of band structure and delocalized electronic and optical properties that emerge due to the finite scale of ordering and influence of the surface. Select examples will be drawn from advances in materials for in solar energy utilization with photochemistry and photoelectrochemistry and materials for photovoltaic and enabling advances electrochemical energy conversion and storage.

CHEM 7650 (0.5 CU) Chemistry of the f-block Elements (I, MI, Ph, Spring or Fall)

CHEM 7660 (1 CU) Electrochemistry: Methods and Chemical Appl. (I, MI, Ph, Sp/Fall)

CHEM 7670 (0.5 CU) Applications of Group Theory (O, I, MI, Spring or Fall)

MCS 5400 (1CU) 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 5980 (1 CU) Independent Studies: Literature Review. (ALL) 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 5990 (1 CU) Independent Studies: Research Techniques. (ALL) May be considered part-time of 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 6970 (2 CU) Capstone Research I Practicum* (ALL) May be taken by students developing the research project for the capstone requirement but who will not be completing or presenting the final capstone paper. 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 engaged in intensive usually during the summer following

the first year. This course does not count towards the 10 CUs minimum. *tuition cost for this course is diminished to ~\$1.3K/semester

MCS 6980 (2 CU) Capstone Research II* (ALL) May be taken for multiple course unit credit for students continuing the research project for the capstone requirement but who will not be completing or presenting the final capstone paper. 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 research. This course does not count towards the 10 CUs minimum. *tuition cost for this course is diminished to ~\$1.3K/semester

MCS 6990 (1 CU) Capstone Research Paper & Seminar (ALL) Required course for students completing the research project, and submitting the final capstone paper and presentations. Advanced study and research in various branches of chemistry with the goal of finishing the capstone project.

MCS 9900 (0 CU) Master's Continuation. (ALL) Students enroll in this course if they fail to complete their Capstone in the term when they are enrolled in MCS 6990 and may be taken twice only. *tuition cost for this course is diminished to ~\$1.3K/semester

Appendix B - MASTER OF CHEMICAL SCIENCES FORMS

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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: _____
- Oral Presentation (defense) Completion date: _____
- Final Report – electronic Submission date: _____
- Final Report – hard copy Submission date: _____
- Poster – electronic Submission date: _____
- Poster – presentation Submission date: _____
- Completion of Capstone Project Signed by MCS Associate Director 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: _____



Independent Study Course Approval Form

Information to be provided by student:

Student's name: _____
Last Name (please print) First Name MI.

Penn ID Number: _____

LPS degree program in which student is enrolled: BA/BFA MES/MSAG MCS Other

Title of independent study: _____

Term and year of independent study: _____
Term Year

Will this be a Lab Project? YES NO If, Yes Which Lab _____

Information to be provided by the supervising instructor:

Instructor's name: _____
Last Name (please print) First name

Faculty appointment: Standing faculty member Lecturer

Instructor's signature: _____ Date: _____

Information to be provided by the sponsoring department or program:

Course number (see following note): _____ - _____ - _____
Dept Name Course Num. Section Num. (provided by LPS)

Department or program: **Department of Chemistry/ MCS**

Name of authorized representative: **Ross** **Tina**
Last Name (please print) First Name

Title/Position: **Associate Director of MCS Program**

Phone number: **215-898-5892** Email: **tmross@sas.upenn.edu**

Signature of approval by sponsoring department or program representative:

Signature: _____ Date: _____

Official Use by LPS:

Approved: YES NO

LPS Advisor Signature: _____ Date: _____

Processed by: _____ **38** Date: _____

Appendix C - MASTER OF CHEMICAL SCIENCES CAPSTONE GUIDELINES

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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. Capstone Research detailed information and formatting suggestions are available in the Capstone Research Syllabi for MCS 6970, 6980 and 6990.

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 6990
	Secondary reader	Help guide development of and approve proposal; advise throughout the project; edit and evaluate final report; assign grade for MCS 6990 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 6990) 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 6990 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 6980 or 6970 *Research*. Students will submit progress reports of their work in order to obtain a grade in MCS 6980 and MCS 6970.

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	Work on capstone project; register for Capstone Research I - MCS 6970
Fall – year 2	Work on capstone project; register for Capstone Research II - MCS 6980
Spring – year 2	Register for MCS 6990; 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 6990 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 9900) 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 result 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 Form

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 Capstone Research Paper

Work with students project supervisor and committee members to develop an outline for a final capstone research paper, 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 Capstone Research Paper 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. Intensive research is the preferred scientific study for the Capstone Research Paper, however occasionally a student may conduct a Capstone Literature Review (aka secondary research) for their method of study. Capstone Research detailed information, guidelines and formatting suggestions are available in the Capstone Research Syllabi for MCS 6970, 6980 and 6990.

V. Capstone Evaluation Tools

Seminar Speaker Evaluation Form

Speaker: _____ Date: _____

Title: _____

Time Taken: _____

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

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

TOPIC PRESENTED:

- | | | | | |
|----------------------------------------------------|---|---|---|---|
| 1. The purpose & key points were clear | 1 | 2 | 3 | 4 |
| 2. The ideas & information presented were valuable | 1 | 2 | 3 | 4 |
| 3. Engaged the audience effectively | 1 | 2 | 3 | 4 |
| 4. 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 |

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 |
| 2. Experimental rationale and design clearly stated | 1 | 2 | 3 | 4 |
| 3. Demonstrated data analysis, problem solving and critical thinking skills | 1 | 2 | 3 | 4 |
| 4. Sources properly cited | 1 | 2 | 3 | 4 |
| 5. 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 |

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** _____

Capstone Research Supervisor Evaluation Form

Thank you for providing an educational research opportunity for one of our MCS students. Your 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: _____

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. Relationships with others:

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

5. Work ethic:

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

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)

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

- Yes No

MCS 6990 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: _____

Appendix D - Technical Research Report Format

MCS Course 5990, 6970, 6980 (Circle One)

Technical **Research** Report (1-3 pages)

Date:

Your Name:

Research Advisor/Principal Investigator:

MCS Concentration:

Research Title:

Summary of Research

General Introduction

1-3 paragraphs

Your Research Proposal Concentration Summary

Include your Specific Aims and Statement of Significance

Research Methods You are working on:

Include Chemdraw Schemes or Synthesis (Organic), Figures (other)

And/or Tables

Note Challenges: (3-5)

Action Items: (3-5)

References (3-10): American Chemical Society Style For Example-

1. Taichi, K.; Masayuki, G.; Kazuo, T. ; Yoshiki, C. Modulation of stimuli-responsiveness toward acid vapor between real-time and write-erase responses based on conjugated polymers containing azobenzene and Schiff base moieties. *J. Polym. Sci.* **2021**, *14*, 1596-1602.
2. Lunde, S. A.; Sydnes, M. O. One-pot procedures for the formation of secondary aryl amines from nitro aryls. *Syn. Lett.* **2013**, *18*, 2350-2344.
3. Jayaraman, S.; Rajendiran, B.; Kumaraguru, D.; Ayyanar, S. Synthesis, characterization and photophysical studies of self-assembled azo biphenyl urea derivatives. *Photochem. Photobiol. Sci.* **2016**, *15*, 211-218.
4. Yamada, H.; Kukino, M.; Wang, Z.; Miyabara, R.; Fujimoto, N.; Kuwabara, J.; Matsuishi, K.; Kanbara, T. Preparation and characterization of green reflective films of polyaniline analogs containing azobenzene units. *J. Appl. Polym. Sci.* **2015**, *132*, 41275/1-41275/7.