



DOCTORAL STUDENT HANDBOOK

Ann Arbor, Michigan

2019

TO OUR STUDENTS

This handbook is intended to serve as a consolidated source of information and as a guide for the Chemistry faculty and graduate students of the University of Michigan to the guidelines relating to graduate study in the Department of Chemistry. Graduate students should also refer to the Rackham Graduate School website which outlines the Rackham Graduate School guidelines for graduate study at the University.

The Department of Chemistry Graduate Student Handbook contains information concerning the organization of the Department, its personnel, and their duties. We hope you will find it helpful and convenient for reference.

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WHERE TO GO FOR INFORMATION

Graduate Student Handbook

This Handbook is to be used as a guide to the rules and regulations that govern the graduate program both here in the Department of Chemistry as well as the University of Michigan. As a student you must familiarize yourself with requirements of the Department and the Rackham Graduate School. Graduate School rules/regulations can be found in their entirety on the Rackham Graduate School at http://www.rackham.umich.edu/policies/academic_policies/.

Graduate Mailboxes

Every graduate student will have their own mailbox located in Room 1416. In addition to receiving U.S. mail, you will also receive campus mail. Any messages from Faculty, Academic Services staff, Technical staff or the Rackham Graduate School will be put in your mailbox.

Graduate Bulletin Board

Boards are located in the 1500 complex outside the Graduate Studies offices, as well as down the main hallway of the '48 building. Job postings, events, and fellowships, scholarships and grants offered *outside* the University are posted here. Rackham Doctoral Degree deadlines and available campus resources are also posted here.

Graduate Advisors

First year students are assigned an advisor who is a member of the Graduate Committee (GC), a departmental committee that oversees the graduate program. Advising regarding coursework selection will be provided at Orientation, but you may contact your GC advisor at any time during your first year for guidance on any matter. After your first year, your Research Advisor (dissertation mentor) is your primary resource for academic advising as well as your mentor for your thesis project. In addition, staff in the Student Services office are an excellent resource.

Adam Matzger - Graduate Committee Chair
Mark Meyerhoff - Analytical
Alison Narayan- Chemical Biology
Nathaniel Szymczak - Inorganic
Adam Matzger - Materials
Pavel Nagorny - Organic
Eitan Geva - Physical Chemistry
Ginger Shultz – Chemical Education

Administrative Complex

The offices of the Chair, Assistant to the Chair, Chief Administrator, Building Manager, Student Services Manager, and Coordinators of Undergraduate and Graduate Student Services are located in 1500. The student services staff can provide help to graduate students in such areas as program requirements/regulations, finances/fellowships, insurance, conflict resolution, graduate student instructor appointments, and industrial recruitment visits/job opportunities. All room reservation requests can be sent to chemreservations@umich.edu. Building access and building/lab problems will be handled by Tracy Stevenson, Lab and Facilities Manager (1500C).

Shapiro Science Library

Graduate students are encouraged to use services and resources provided by the Shapiro Science Library (<http://www.lib.umich.edu/shapiro-science-library>). As a part of the M Library system, the Shapiro Science Library strives to support research, teaching, learning and scientific inquiry in Chemistry and other science disciplines. The Chemistry print collections are located on the 3rd and 4th floors of the Shapiro Library Building, along with excellent places for study and research. If you need any assistance for your information inquiry, please contact the Chemistry Librarian, or ask a librarian on <http://www.lib.umich.edu/ask-librarian>.

DEPARTMENTAL STAFF

Administration

Chair				Robert Kennedy
Associate Chair for Undergraduate Education				John Wolfe
Associate Chair for Educational Development				Brian Coppola
Graduate Committee Chair				Adam Matzger
Chief Administrator				Jan Malaikal
Assistant to the Chair				Alex Franklin

Student and Academic Services

Heather Hanosh	Student Services Manager	1500H	7-2990	hjholcom
Katherine (Katie) Foster	Doctoral Program Coordinator	1500I	4-7278	katfost
Brendan Locke	Funding & MS Program Coordinator	1500J	3-3832	bwlocke
Angela Cox	Undergraduate Program Coordinator	1500K	7-2858	abfoster
Emma Houle	Student Services Assistant	1500	3-5004	amhoule

Laboratories and Facilities

Tracy Stevenson	Building Manager	1500C	4-7316	steventi
Hawaii Maliga	Facilities Assistant	Dock	5-5034	hmaliga
Laurie MacDonald	Environmental Health/Safety Specialist	1614	4-7325	lanald
Chris Peters	Environmental Health/Safety Specialist	1608	3-4527	chrpeter
Anson Pesek	Environmental Health/Safety Specialist	1612	7-8932	ahpesek

Chemistry Graduate Student Organizations

Chemistry Graduate Student Council (GSC). The Chemistry Graduate Student Council (GSC) deals with academic and other issues of concern to graduate students in the Department. It serves as a tie between the faculty, graduate students, and staff. In addition to their academic responsibilities, the GSC also sponsors social events for faculty, graduate students, staff and their families from time to time. Any student interested in being on the GSC should email chemgsc-execs@umich.edu.

CSIE|UM (Chemical Sciences at the Interface of Education | University of Michigan). Long in the forefront of delivering innovative and quality instruction in Chemistry, the UM Chemistry Department pairs CSIE|UM participants (postdoctoral associates, graduate and undergraduate students) with faculty members working on revamping the curriculum, reworking laboratory instruction, exploring new approaches and technologies in pedagogy, and more. <http://sites.lsa.umich.edu/csie-um/>

CALC|UM (Chemistry Aligned with Life & Career | University of Michigan). CALC|UM is directed by the faculty, and co-designed and implemented with a core organizing committee made up of 10-15 students. Core objectives of the CALC|UM program are to: (a) increase student awareness and understanding of critical features of their future professional lives where their scientific expertise intersects with the other constituencies typical in an industry setting (business, law, informatics, etc.); and (b) provide opportunities for first-hand leadership and multi-disciplinary team experiences that are relevant to their future professional lives. <http://sites.lsa.umich.edu/calc-um/>

GRADUATE FACULTY

Name	Office	Phone	Uniquename	Title
Andrews, Philip	1198 300 NIB SPC	763-3130	andrewsp	Professor
Ault, Andrew	4545 CHEM	763-2283	aulta	Assistant Professor
Bailey, Ryan	4821 CHEM	764-1438	ryancb	Professor
Barteau, Mark	UM Energy Inst.	615-9521	barteau	Professor
Bartlett, Bart	2813 CHEM	615-9279	bartmb	Associate Professor
Biteen, Julie	2533 CHEM	647-1135	jsbiteen	Associate Professor
Blum, Joel	2534 CC Little	615-3242	jdblum	Professor
Bridwell-Rabb, Jennifer	4817 CHEM	763-1125	jebridwe	Assistant Professor
Brooks, Charles	2006A CHEM	647-6682	brookscl	Professor
Carlson, Heather	2555 CCL	615-6841	carlsonh	Professor
Castaneda, Carol Ann	3545 CHEM	764-8527	castanca	Lecturer III
Chen, Zhan	4809 CHEM	615-4189	zhanc	Professor
Coppola, Brian	2403 CHEM	764-7329	bcoppola	Professor
Fierke, Carol	4525 CHEM	936-2678	fierke	Professor Emerita
Frank, Aaron	3000 CHEM	615-2053	afrankz	Assistant Professor
Geva, Eitan	2000D CHEM	763-8012	etian	Professor
Goodson III, Theodore	4819 CHEM	647-0274	tgoodson	Professor
Gottfried, Amy	3533 CHEM	647-9540	acgottfr	Lecturer IV
Hakansson, Kristina	4521 CHEM	615-0570	kicki	Professor
Keane, Sarah	4022 CHEM	763-2332	sckean	Assistant Professor
Kennedy, Robert	4815 CHEM	615-4363	rtkenn	Professor & Chair
Kim, Jinsang	2090 H H Dow	936-4681	jinsang	Professor
Kopelman, Raoul	4744 CHEM	764-7541	kopelman	Professor
Koutmos, Markos	4525 CHEM	963-267	mkoutmos	Assistant Professor
Koutmou, Kristin	2549 CHEM	764-5650	kkoutmou	Assistant Professor
Kubarych, Kevin	4813 CHEM	764-7528	kubarych	Professor
Lehnert, Nicolai	2807 CHEM	615-3673	lehnertn	Professor
Maldonado, Stephen	4533 CHEM	647-4750	smald	Associate Professor
Mapp, Anna	4000 LSI	615-6862	amapp	Professor & Rackham Assoc Dean-Academic Pgms & Initiatives
Marsh, E. Neil	4537 CHEM	763-6096	nmarsh	Professor
Matzger, Adam	2823 CHEM	615-6627	matzger	Professor
McCrary, Charles	4807 CHEM	763-8060	cmccrory	Assistant Professor
McNeil, Anne	2817 CHEM	615-5204	ajmcneil	Professor
Meyerhoff, Mark	3306 CHEM	763-5916	mmeyerho	Professor
Montgomery, John	3819 CHEM	764-4424	jmontg	Professor
Nagorny, Pavel	3807 CHEM	615-2833	nagorny	Associate Professor
Narayan, Alison	4002 LSI	615-5505	arhardin	Assistant Professor
Nolta, Kathleen	3537 CHEM	763-5901	nolta	Lecturer IV
Pecoraro, Vincent	3823 CHEM	763-1519	vlpec	Professor
Penner-Hahn, James	4020 CHEM	764-7324	jeph	Professor
Poniatowski, Alexander	3541 CHEM	615-0725	aponiato	Lecturer III
Pratt, Kerri	3549 CHEM	763-2871	prattka	Assistant Professor
Ramamoorthy, Ayyalusamy	4024 CHEM	647-6572	ramamoor	Professor
Ruotolo, Brandon	4549 CHEM	615-0198	bruotolo	Associate Professor
Sanford, Melanie	2811 CHEM	615-0451	mssanfor	Professor
Schindler, Corinna	2815 CHEM	763-6853	corinnas	Assistant Professor
Sension, Roseanne	4529 CHEM	763-6074	rsension	Professor
Sherman, David	4036 LSI	615-9907	davidhs	Professor
Shultz, Ginger	2521 CHEM	764-7345	gshultz	Assistant Professor
Stephenson, Corey	3817 CHEM	763-8283	crjsteph	Professor
Szymczak, Nathaniel	3809 CHEM	615-4330	nszym	Associate Professor
Walters, Nils	2405 CHEM	615-2060	nwalter	Professor
Wang, Wenjing	4115A LSI	647-3226	wenjwang	Assistant Professor
Wolfe, John	3811 CHEM	763-3432	jpwolfe	Professor
Woodard, Ronald	4569 CHEM	764-7366	rww	Professor
Zellers, Edward	SPH2/ M6543	936-0766	ezellers	Professor
Zgid, Dominika	2000F CHEM	647-4495	zgid	Associate Professor
Zimmerman, Paul	2000E CHEM	615-0191	paulzim	Associate Professor

GRADUATE DEGREE PROGRAMS

This section provides information on the requirements for the degree of Doctor of Philosophy. A description of all graduate courses in chemistry is provided later in this section. The requirements stated here include those set by the Department and those set by the Rackham School of Graduate Studies. Students are urged to consult the Rackham Graduate School Academic Policies (<http://www.rackham.umich.edu/current-students/policies/academic-policies>).

Departmental requirements for graduate degrees are administered by the Graduate Committee, a committee of eight faculty members representing the various clusters. This Committee has been delegated the authority by the faculty to interpret rules and requirements and, when the circumstances warrant, to grant exceptions upon formal appeal. In the first year, each student will be provided formal academic counseling by a member of the Graduate Committee. The Committee is also a resource for any questions or concerns regarding progress to the Ph.D. and can assist with conflict resolution.

Course elections for each term must be reviewed either by the Graduate Committee or research advisor. Each student's standing in the program is reviewed by the Graduate Committee after each year and an appropriate report is transmitted to the student and/or advisor when needed. NOTE: Failure to follow the approved registration can place your standing in the Ph.D. program in jeopardy. Do not make unapproved changes in your schedule.

REQUIREMENTS FOR THE Ph.D. DEGREE

The degree Doctor of Philosophy is the highest degree conferred by the University. It is a research degree. It is never conferred solely as a result of study, no matter how faithful, extending over any prescribed time period or for any amount of course work or research accumulated. The degree represents more than merely the sum of semesters in residence and of credits for courses taken. The length of residence and the plan of study are of secondary importance. The degree is granted solely upon evidence of general proficiency and of distinctive attainment in the specialty field chosen by the candidate. The degree is granted particularly upon a recognized ability for independent and insightful investigation as demonstrated in a thesis based upon original research combined with creative scholarship and presented with a high degree of literary skill.

Rackham and Departmental Ph.D. Requirements

The basic requirements for the degree of Doctor of Philosophy set by the Rackham Graduate School and the Department include:

1. Minimum coursework in residence requirement (18 hours of graded graduate coursework registered as a Rackham student in Ann Arbor).
2. An overall GPA of B (3.0 on a 4.0 scale) grade point average or higher in the graduate student's record.
3. 4 credit hours of cognate coursework with a B- grade or better, in a minimum two courses.
4. Appointment of a Dissertation Committee to oversee the student's program and progress in research.
5. Completion of a public seminar.
6. Recommendation by the Department of specialization for admission to candidacy (Candidacy Exam).
7. Approval of the written dissertation by the Dissertation Committee and the Graduate Dean and a final oral examination by the Committee (Thesis Defense).

Departmental requirements are directed primarily towards giving students practice and skills in research, discovery, problem solving and creative learning, particularly in their area of interest. The requirements governing examinations and basic courses are designed to test and solidify the fundamental background of the student in the main branches of Chemistry while still encouraging an early start in research.

Examinations

Organic Proposition

Organic students must submit a written Original Research Proposition (of no more than ten pages) to the organic faculty. The Proposition consists of the identification and solution of an original research problem in Organic Chemistry. It will be judged both on the nature of the problem chosen and the proposed solution. Acceptable propositions are presented to the faculty periodically throughout the year. The research proposition is designed to be an opportunity for students to try out their ability to be creative, search the literature for new ideas and what was done previously, practice mechanism and problem solving and presentation skills, and to

become effective and confident in their ability to defend their own research ideas. Specific details regarding this requirement will be provided as a student begins their third year of study.

Candidacy Exam

Each Chemistry graduate student is subject to an oral candidacy examination by their Dissertation Committee. The Graduate Committee holds a yearly information session on preparing for this exam in the summer/ early fall term. This examination is held in the second year of enrollment and can be completed EITHER by the end of the fall term (end of December) or by the end of spring term (end of May). The timing of the exam should be decided via a discussion between the graduate student and their PhD advisor.

In preparation for the candidacy exam, each student should form a Dissertation Committee of 4 members consisting of their dissertation advisor, at least two Chemistry faculty members and one faculty member whose primary appointment is not in the Department of Chemistry (the cognate member). You should choose your committee in concert with your dissertation advisor and once the committee has been constituted, make sure to notify the Graduate Program Coordinator in the Student Services office so that the appropriate forms can be completed. For students planning to complete their candidacy in FALL term, these forms are due by October 15. For student planning to complete their candidacy in the WINTER term, these forms are due on February 15. These forms should be turned in, at a minimum 4 week prior to the candidacy exam.

As part of the candidacy exam, each student must submit a written proposal to his/her Dissertation Committee. The proposal should be sufficiently detailed so that the nature of the research problem and the direction of the effort is defined and characterized, but not more than ten double-spaced typed pages [including all text and graphics (sections a-d)]. Literature references are then added at the end.

The proposal should contain:

- a) Background
- b) Specific Project Goals
- c) Research Plan
- d) Preliminary Data
- e) Literature References

The proposal should be distributed to the student's Dissertation Committee at least two weeks prior to the exam.

At the Candidacy Exam, students present a brief summary of their research proposal; this may include preliminary research results but should not be a seminar-style presentation. Students will be examined on knowledge of the background subject areas and on their research plans. Students are expected to have a good understanding of the goals, directions, importance, and pathways of the proposed research. Students should be prepared to propose alternatives and discuss background material concerned with that proposal. Students should also show that they are making reasonable progress towards their doctoral research. The Dissertation Committee will determine a Chair (other than the research advisor) for the meeting and that Chair will be responsible for the conduct of the exam. The research advisor will be present, but will not participate in the examination except in limited consultation.

The Committee also reviews the student's course work and any progress reports. The Committee determines what additional courses, reports, or other study are required if, for any reason, the examination is not satisfactory. The Committee may decide to re-examine the student at a later time or recommend dismissal from the program. A subsequent review by the student's research advisor as to whether any additional requirements have been met does not necessarily require another meeting of the Dissertation Committee with the student. Students should inform the Graduate Office when their candidacy exams are scheduled. A report to the Dissertation Committee will be prepared and given to you by the Graduate Program Coordinator before the exam takes place.

Annual Evaluation & Mentoring Plan

All students from the second year to the completion of the Ph.D. degree requirements participate in a yearly evaluation of their progress towards the degree with their dissertation advisor. By May 15 of each year, students and faculty must complete the annual evaluation form. The form is completed jointly by the student and advisor and

reviewed by the Graduate Chair. The goal of this process is to assist students and advisors in overcoming any barriers to success and to facilitate open communication. Students who receive an evaluation of marginal or insufficient progress must take additional steps to remain in good standing in the program. If a student receives a marginal evaluation then a re-evaluation must be submitted by August 15. Students who are not making sufficient progress must schedule a committee meeting by June 15 for evaluation.

Data Meeting (8th Semester Meeting)

All chemistry graduate students will be required to have an 8th semester meeting with their Dissertation committee in the winter of their 4th year. The timing of this meeting will be determined for each student based on discussion with their faculty advisor, but *it must be completed by May 15th*. In rare exceptions (where students make exceptionally fast progress in their Ph.D. studies), this meeting may occur even earlier (6th or 7th semester, for example). In this meeting, the student must present a detailed discussion of his/her data in a clear and logical fashion, including major conclusions, and a detailed outline of the thesis. More than one such meeting may be required before actual writing of the thesis begins. Please notify the Graduate Program Coordinator in Student Services once the date for the data meeting is determined so that you can receive the appropriate paperwork. Students are then required to have a similar meeting every year after their Data Meeting if they have not graduated or scheduled their thesis defense (i.e. if they have not graduated or set a defense date of before August 31st of their 5th year, 6th year, etc. they are required to have a meeting).

Course Requirements/Registration

Departmental requirements for course work fall into two categories: (a) those specified by the Department and applying generally to all students, and (b) those specified by the student's area or by his/her Dissertation Committee and applying individually in terms of special field and interest.

A first year graduate research rotation course will be required of all Chemistry students (Chem 597). All first year students must also register for Chem 415 (Responsible Conduct in Chemistry Research).

Pre-Candidates in their 2nd year must register for Chem 990 (pre-candidate dissertation research) in addition to needed coursework, and all Candidates will register for 8 credits of Chem 995 (candidate dissertation research)—see 'Other Registration Information' below. A student seminar is usually given in the third year, students must register for the appropriate seminar course (Chem 800-805; please see section on seminars that follows).

At least 4 graduate level Chemistry courses are required by the Department in addition to the above. The Graduate School also requires four credit hours (usually two courses) of cognate coursework (i.e. outside the Chemistry Department or cross-listed courses).

In general, this translates to students taking a total of six courses during the course of the first two years, (two cognate courses and four Chemistry courses) in addition to the research rotation, research dissertation, and seminar courses. The various clusters have individual course requirements as listed below.

Analytical Chemistry: Any 3 of the 4 'core' analytical courses (or all 4): Chem 646, 647, 648, 649. The fourth Chemistry class may be any remaining 600 level analytical course or some other Chemistry graduate class.

Inorganic Chemistry: Chem 507 (Advanced Inorganic Chemistry), 616 (Physical Methods in Inorganic Chemistry), at least one of the following: Chem 508, 511 or 515, and one additional Chemistry course (free to choose).

Organic Chemistry: Four core Organic courses: Chem 540, 541, 543, and either Chem 542 (Organic Spectroscopy) or Chem 515 (Organometallic Chemistry). Chem 515 can also be taken as a cognate. The organic faculty require grades of B or better in Chem 540 and 541.

Chemical Biology: Two core Chemical Biology courses: Chem 525 and 526 (Chemical Biology I & II), and two additional Chemistry graduate courses (such as the Chemical Biology courses 505, 528 or 673), chosen based on your research interests.

Materials Chemistry: Chem 511 (Materials Chemistry) and either Chem 535 (Physical Chemistry of Macromolecules) or Chem 538 (Organic Chemistry of Macromolecules). Two courses from the offerings of any other Chemistry cluster (analytical, chembio, inorganic, organic, or physical) are required, noting that both courses must be from the same cluster. Two additional courses, one of which must be an approved materials course (check with advisor or the materials Graduate Committee advisor) are required to complete the six-course total.

Physical Chemistry: Four graduate-level courses in physical Chemistry: Chem 571 (Quantum Mechanics) and

Chem 576 (Statistical Mechanics) and two additional Chemistry graduate courses (Chem 567 (Kinetics) and Chem 580 (Spectroscopy) are recommended).

Seminars

Students must present one seminar usually in the third year of their graduate career. It is necessary to register for 2 credit seminar course numbered Chem 800-805 during the term in which the seminar is to be given. A grade of “Satisfactory” or “Unsatisfactory” is given on the presentation. The student should contact the appropriate subarea/cluster coordinator at the beginning of the term to arrange for the seminar date and time and to discuss the format and topic of the seminar.

Participation in the departmental seminars is required. In addition to presenting a seminar, all students are minimally expected to regularly attend the seminar series associated with their area of interest. However, seminars relevant to a person’s interest and/or research (e.g., materials Chemistry or biologically related Chemistry) may appear in either series. The serious student will take advantage of all learning opportunities, and the seminar series represent excellent sources of up-to-date results and ideas.

Other Registration Information

The residency (time enrolled as a graduate student in our program) requirement for the Ph.D. degree provides for a minimum of seven terms of study and research beyond the bachelor’s degree. A student is considered full-time with registration of 9 hours per term for pre-candidates and 8 hours for candidates. One must be registered as a full-time student during the Fall and Winter terms unless on an approved leave of absence. You are not required to register for Spring/Summer unless you are defending your dissertation sometime between late May and August.

In electing Chemistry 990, (pre-candidate dissertation research-usually register in the 2nd year in addition to remaining required coursework), the number of hours taken for credit may range from one to eight per term as approved by the advisor; but a student must register for a total of 9 hours per term prior to candidacy. For Chemistry 995 (candidate research-usually register in the 3rd year and above), the number of registration hours is fixed at eight and the candidacy tuition fee is fixed (at an amount less than the regular pre-candidate full-time fee). After passing candidacy, a candidate may register for up to 4 credits per term in addition to 995 without incurring additional tuition.

Registration is required of any person using University facilities (classes, laboratories, libraries, computing center, consultations with faculty, etc.) in progress toward a degree, with the exception of Spring/Summer terms. During Spring/Summer you only need to register if you defend between May and August. You must register for the entire Spring/Summer term, regardless of which month you defend.

General Course Requirement Information - All Areas

Students entering with previous graduate credit from other universities in the U.S. may be excused from some of the preceding Chemistry course requirements by petitioning the Graduate Committee, but in any case, the minimum requirement will be one graduate lecture course in the student’s major field in Chemistry and one in any field in Chemistry. The Graduate Committee and the student’s Dissertation Committee both are charged with the responsibility to see that the individual student has a program of course work that is both broadly supportive of his/her specialized field of study and also indicative of the breadth and range of interest which the graduate student may need to call upon.

One of the requirements of the Department is for a student to be “in good standing” (see ‘Good Standing Policy’ section). Part of being in ‘good standing’ means that the student must maintain a grade point average of B (3.0 on a 4.0 scale) or better. Credit in independent research (Chem 990, 995) and seminar courses do not count in the GPA. Grades in both research and seminar courses accepted by the Graduate School are S (satisfactory) and U (unsatisfactory).

An Incomplete grade may be assigned to a student only if the unfinished part of the student’s work is small, the work is unfinished for reasons acceptable to the instructor, and the student’s standing in the course is a “B” grade or

higher. Grades of Incomplete can be changed to letter grades only if the incomplete work is made up within the time frame allowed by the instructor. Check in the Rackham website for specific information on the incomplete policy. "I" or "E" grades are not accepted for research rotation (Chem 597) and research courses (Chem 990, 995).

Research Requirements

Choice of Research Advisor

The choice of a Research Advisor generally occurs after the second term of enrollment. The formal steps preceding the choice include:

1. All first year graduate students are required to take two terms of the research rotation course, one in the fall and one in the winter (Chem 597) to gain practical lab experience. The purpose of this rotation course is to acquaint the students with the research efforts of the faculty they are primarily interested in. Rotation assignments are to help students decide which lab they may want to join at the end of the winter term. Graduate students must rotate in two different labs. Exceptions are rare and must be presented to the Graduate Committee for approval.
2. At the time of the first term counseling during Orientation, each student should discuss with their advisor on the Graduate Committee his/her research focus and interests. A Rotation Selection form will be in the Orientation folder. All students will interview at least five professors. Student should interview all assistant professors in their field of interest as well. This will allow incoming students to meet potential fall research advisors and allow them to become aware of the research going on in the department. Toward the end of the fall term, the student will decide on the second winter term rotation in a similar fashion.
3. During Orientation, students are also required to attend the Graduate Research Awareness Seminar Program (GRASP) given by faculty.
4. Until a research advisor is officially selected, the student should discuss any questions or problems with his/her Graduate Committee area advisor or the Chair of the Graduate Committee. After the research advisor is chosen, questions regarding course work, career objectives and goals, or any other concerns should be directed to the Research Advisor. However, the members of the Graduate Committee are always available for consultation, as are the staff in the Student Services office.
5. Near the end of the Winter term, after the rotations have been completed and the student has decided on his/her choice for Ph.D. advisor, he/she will submit an online research advisor selection form to the Graduate Student Services Office. The Graduate Committee will assist with advising issues, including the choice of a permanent advisor.
6. Formal approval by the Graduate & Department Chairs is required before the student is admitted to the research advisor's group. The student and the Research Advisor are jointly responsible for fulfilling the Departmental and Graduate School requirements for the Ph.D. degree. The Advisor's responsibilities begin at the time of his/her agreement to accept the student into his/her group. In addition to supervising the research, the Research Advisor is expected to guide the student on course elections, examinations, independent study pertinent to his/her general development as a scientist, and any other matters affecting his/her general progress toward a degree.

Forming a Dissertation Committee

A Dissertation Committee should be assembled by each graduate student in consultation with his/her Research Advisor early in the second year, before the candidacy exam. The composition of the Committee should be reported to the Graduate Student Services Office, by submitting the Departmental Dissertation Committee form, as soon as it is formed so it can be recorded at the Graduate School. The Research Advisor serves as Chair and shares with the Committee the responsibilities of guiding the student toward the doctoral degree. All Dissertation Committees must consist of at least four members, including the Research Advisor/Dissertation Committee Chair. At least two of the Committee members must be from Chemistry. At least one member (cognate) must be out of the Department (such

as Chemical Engineering, Mathematics, Physics, Pharmacy, Materials Science and Engineering, etc.). There are particular rules regarding who can serve as a cognate member, ask the Graduate Program Coordinator if you have any questions.

Functions of the Dissertation Committee

A meeting of the Dissertation Committee is required by the Department before the student can be advanced to candidacy. The Research Advisor and student are responsible for calling the meeting. For all students, the candidacy meeting is an examination and must be taken by May 31st of the second year.

The Dissertation Committee consults with the student and the Research Advisor as may be appropriate with respect to the student's development, as indicated by his/her course work, seminar participation, and experience in examinations and research performance.

In the aggregate, three formal recommendations (and three meetings) are required of the Committee: (1) one for advancement to candidacy which is made on a departmental form specifically approving the total program of courses or indicating remaining expected courses (this form will be given to you from the Graduate Student Services Office prior to your candidacy exam); (2) one for a Data Meeting to discuss if the student has gathered enough data to write a thesis satisfying the requirement of scientific merit and (3) one for acceptance of the dissertation certified on the form supplied by the Graduate School prior to the Oral/Thesis Defense.

The information needed by the Committee comes from consultations its members may have with the student, advisor, and from the:

- Summary of the student's academic record
- Meeting of the Dissertation Committee held at the student's Candidacy Exam
- Progress reports of the research submitted by the student.

Later information comes from:

- Data Meeting
- Review of the written dissertation
- Final meeting of the Dissertation Committee ("thesis defense") for approval of the dissertation and the degree

Candidacy Oral Examination

Admission to candidacy is required to take place by May 31st of the second year. Early candidacy is advantageous to be eligible for reduced tuition and for certain grants and fellowships administered by the Graduate School or the Chemistry Department. As a requirement for good academic standing, students must advance to candidacy by May 31st of their second year.

Before admission to candidacy can be recommended, the following requirements need to be met:

Pass the cognate course requirement by the end of the term that you are advancing to candidacy.

Achieve 3.0 or better grade point average (graded courses only).

Choose a Research Director/Advisor.

Have a Dissertation Committee appointed.

Pass the oral examination.

Be formally recommended for candidacy by the Dissertation Committee.

NOTE: Students advancing to candidacy in the Winter of their 2nd year must have completed all the courses required by their cluster and cognates by the end of winter term. Students advancing to candidacy in the Fall term must have completed at minimum all but 1 of the courses required by their cluster, as well as the cognates, by the end of Fall term. If a student is unable to meet these deadlines they should petition the Graduate Committee for an exception.

Data Meeting

In this meeting, the student must present a detailed discussion of his/her data in a clear and logical fashion, including major conclusions, and a detailed outline of the thesis. **See page 11 for more information.

Dissertation

The regulations governing the preparation of the dissertation are located on Rackham Dissertation website (<http://www.rackham.umich.edu/students/navigate-degree>). The subject matter of the dissertation is to be presented at a public seminar (Thesis Defense) in the last term of the student's program. The student is responsible for setting up his/her thesis defense in consultation with his/her Dissertation Committee.

The Department requires that the student present a detailed outline of the dissertation before actual writing begins at a pre-defense Data Meeting. At this point, if the Committee agrees, the candidate will then begin putting the thesis together. The dissertation must be submitted in draft form (i.e., before the final typing and final reproduction of figures) to the members of the Dissertation Committee for their suggestions at least two weeks prior to the defense. Modifications are much easier to make at this stage.

Beginning with the 2012-13 academic year, all dissertations will be submitted electronically to Rackham during the post-defense meeting. The final digital copy will be the copy of record. To submit your dissertation, you will access the Rackham dissertation online submission website. You will be asked to provide bibliographic keywords, or tags, that describe the content of your dissertation, including subject, concepts, theory and methods. These will help others to find and retrieve your dissertation. You will copy your abstract to the website and upload a PDF of the final digital copy of your dissertation. The staff of Rackham's Academic Records and Dissertations will review your submission, and may require you to make final changes before the submission is approved. No further changes will be allowed once the dissertation is approved and submitted. Rackham will hold your dissertation until your degree is conferred (which happens three times a year in April, August, and December). After your degree is conferred, Rackham will forward your dissertation as the copy of record to Deep Blue (<http://deepblue.lib.umich.edu/>), the permanent digital repository of the University Library.

Deadlines

The Graduate School establishes deadlines related to finishing the degree requirements. The first is related to the intended final term of enrollment. Full candidacy tuition must be paid in the term in which the final examination is held, but a grace period is allowed under which the examination may be held within about 30 days after the end of the term without paying additional fees. This grace period or 2nd "extended" deadline does not require formal request or approval, but the degree conferral date changes. The exact dates and conditions of the deadlines are posted each term in 1500 Chemistry and can be found at <https://www.rackham.umich.edu/current-students/policies/doctoral/phd-students/doctoral-degree-deadlines>.

"Good Standing" Policy

A graduate student in the Department of Chemistry at the University of Michigan will be considered in "good standing" if he/she complies with all rules and regulations of the University, the College and the Department and performs the duties of his/her appointment as a GSI, GSRA or fellow in a professional and timely manner and if the following conditions are also met:

1. The student must maintain an overall GPA of greater than or equal to 3.00 for all academic courses taken, including cognate courses, throughout their residence in the program.
2. The student must take two terms of Graduate Research rotation course (Chem 597) and receive a passing grade in both terms.
3. The student must find a mentor who will agree to oversee their Ph.D. research by the beginning of the spring term (May 1) of their first year in residence.
*Under special circumstances, and with the approval of the Graduate Committee, the student may elect to enroll in a third research rotation during the Spring term. If so, the student must finalize the choice of their mentor by July 1 of their first year in residence.
4. The student must achieve Ph.D. candidacy by May 31 of his/her second year in residence. This will involve the following sequence of events (also see Candidacy Oral Exam section):
 - a. The student must assemble a suitable Dissertation Committee (faculty will sign form agreeing to serve on dissertation committee). For students planning to complete their candidacy in FALL term, their committee must be assembled by October 15. For student planning to complete their candidacy in the

WINTER term by February 15. These Dissertation Committee form should be turned in, at a minimum 4 week prior to the candidacy exam.

- b. The student must fulfill all minimum course requirements for a Ph.D. degree by the end of the Winter term of their second year.
 - c. The student must prepare a written candidacy proposal for his/her Ph.D. research and disseminate to his/her Dissertation Committee at least 2 weeks prior to their exam. The student must then meet with his/her Dissertation Committee no later than May 31 of the second year to take the required Oral Candidacy Exam. In the event that the student does not pass the Oral Exam on his/her first attempt they will then not be in good standing. The student will have until August 31 of that year to take the exam again, pass and regain good standing status.
5. The student must receive Satisfactory (S) grades for all terms enrolled in Chem 990 or Chem 995. If a student receives an 'Unsatisfactory' grade in Chem 995, this will trigger an immediate meeting of the Dissertation Committee to review the student's progress, and report back to the Graduate Committee. Based on this report, the Graduate Committee may determine that the student is not in "Good Standing" and recommend dismissal from the program. Alternatively, the Graduate Committee may recommend that the student find a new mentor.
 6. The student must receive a "Satisfactory" or "Marginal" assessment of progress by their Ph.D. mentor on their Annual Evaluation that is to be prepared by the student and advisor by May 15 of each year.
 - a. If the student receives a 'Marginal' rating on the Annual Evaluation, a re-evaluation must be completed by August 15th of that year. If a student receives an 'Unsatisfactory' rating on their re-evaluation, this will trigger an immediate meeting of their Dissertation Committee who must meet with the student by September 15 of that year to review the student's progress, and report back to the Graduate Committee. If the Graduate Committee agrees that the student is NOT making good progress, then the student is automatically no longer in good standing in the graduate program. The student would then have two options, (1) to change research groups or (2) to have a second dissertation committee meeting to re-evaluate their program; either option must be completed by December 15 of that year. If the dissertation committee re-evaluates the student and finds that they are still not making satisfactory progress the student will be dismissed from the program at the end of the fall term.
 - b. If a student receives an 'Unsatisfactory/Not Making Sufficient Progress' rating on the Annual Evaluation, this will trigger an immediate meeting of their dissertation committee who must meet with the student by June 15 of that year to review the student's progress, and report back to the Graduate Committee. If the Graduate Committee agrees that the student is NOT making good progress, then the student is automatically no longer in good standing in the graduate program. The student would then have two options, (1) to change research groups or (2) to have a second committee meeting to re-evaluate their program; either option must be completed by August 15 of that year. If the dissertation committee re-evaluates the student and finds that they are still not making satisfactory progress (either an insufficient or marginal rating) the student will be dismissed from the program at the end of the summer term.
 7. In addition to the general requirements cited above, the student must also fulfill all requirements (e.g., seminars, research proposals, etc.) set by the sub-area of chemistry that they choose to pursue as a graduate student in the program.

Approved by Graduate Committee May 2015

Masters Degree

The M.S. degree is distinguished from the Ph.D. degree by the fact that it is a degree related to course work. It is not considered to be on the pathway to a Ph.D. degree. Any Ph.D. student who fulfills the M.S. requirements may apply for this coursework degree.

The requirements for a Master's degree are:

- 24 course credits
- "B" (3.0) cumulative grade point average or higher
- Satisfactorily complete two graduate-level courses outside of Chemistry (cognate requirement is four hours of course credit).
- Meet all Area/Cluster Requirements.

The 24 credit hours may include up to 6 credit hours of graduate research (Chem 597). In addition, seminar courses numbered 800-805 will be counted only once. Chem 990 and Chem 995 do not count towards the 24 credits for the Masters Degree. A formal application must be filed with the Graduate School when the degree requirements have been met in order for the degree to be awarded (Contact the Graduate Program Coordinator to initiate the process).

NOTE: Students entering with a Master's degree from another institution cannot apply courses used to obtain the first M.S. toward a M.S. from Michigan. Furthermore, previous M.S. degree requirements must be substantially different from the Michigan M.S. degree requirements in order that a Michigan M.S. be awarded. An example of a substantially different previous M.S. degree is one based on a Master's research thesis. The M.S. thesis must be presented before approval for a Michigan M.S. degree will be granted.

Chronology of Ph.D. Degree

	Year 1			Year 2			Year 3	Year 4	Year 5
	Fall	Winter	Spring/ Summer	Fall	Winter	Spring/ Summer			
Summer research (option)	Fall research rotation	Winter research rotation	Full-time research						
		Choose lab for Ph.D.	Identify candidacy committee members	Candidacy exam	<i>Candidacy exams are due by end of Winter term</i>			Data meeting (end of year)	Submit and defend thesis
	2 courses	2 courses		2 courses			Give departmental seminar		
	<i>Organic students: submit and defend an original research proposal</i>								

First Year

Fall/Winter: Take two courses per semester and perform research rotations in two different labs

Spring/Summer: Identify lab for Ph.D. research, full-time research

Second Year

Fall/Winter: Complete remaining courses, perform research in Ph.D. lab,

Fall/Winter: Assemble Dissertation Committee, prepare for and pass the candidacy exam

Spring/Summer: Full-time research

Third and Fourth Years

Fall/Winter: present 2 credit student seminar during the 3rd year (timing and details of seminar requirement vary slightly between clusters)

Continue full-time dissertation research

Fourth/Fifth Years

With the Dissertation Committee, have the Data Meeting (8th Semester Meeting)

Write and defend thesis

Current Graduate Course Offerings

Descriptions of Authorized Courses

The offerings in any given term should be checked in the current time schedule (<http://www.ro.umich.edu/schedule/>). The entries below give the course number, title, credit hours, prerequisites and description of each course offered by the Chemistry Department. Chemistry courses cross-listed with other departments may be counted as a cognate course.

NOTE: The prerequisite courses listed below refer to the undergraduate Chemistry courses taught in the Department and are meant for undergraduates intending to take graduate courses. Graduate students should have completed similar undergraduate courses or performed well on area qualifiers. To compare your undergraduate course with Michigan's, check the Undergraduate Course Guide (<https://www.lsa.umich.edu/cg/>) for prerequisite course description.

415 Responsible Conduct in Chemical Research (1 hr.) Every discipline at the University of Michigan engages in research. The approach to performing research varies significantly between disciplines. Half of the course will be discipline-specific research methods and half will be the responsible conduct of research (RCR). This course will teach research methods for the natural sciences. Topic areas include:

- appropriate citation of sources and avoiding plagiarism
- authorship and publication practices and responsibilities
- acquisition, management, ownership and sharing of data
- research misconduct, including data fabrication and falsification
- personal, professional and financial conflicts of interest
- supervisory and mentoring relationships and responsibilities
- responsibilities of collaborative research
- protection of human beings and welfare of laboratory animals when research involves human participants and animal subjects.

This will include an overview of example research projects, the methods for performing research, and the tools needed. The mechanisms for communicating research, such as conferences, articles, papers and books will be discussed. In addition there are areas common to conducting research in any discipline, such as appropriate citation of sources, authorship practices, acquisition, management and sharing of data.

505 / BIOLCHEM 505. Nucleic Acids Biochemistry. (3 hrs.) This course will provide a high-level overview on the structure, function and biology of nucleic acids. After gaining a high-level background in nucleic acid structure and their interactions with proteins, we will study important RNA-based biological processes, including pre-mRNA splicing, translation, RNAi and RNA decay.

507 Inorganic Chemistry. (3 hrs.) The main topics include: fundamentals of group theory and applications in atomic and molecular structure, molecular vibrations, spectroscopic selection rules, and chemical reactivity; Fundamentals of coordination Chemistry, ligand field theory, molecular orbital theory and reaction mechanisms; and Applications of these concepts to contemporary problems in inorganic Chemistry, which have previously included bioinorganic, organometallics and inorganic materials Chemistry.

508 Advanced Bioinorganic Chemistry. (3 hrs.) Prereq. 302, 303 or equivalent. This course provides an introduction to the roles that metals play in biological systems such as metalloproteins, metalloenzymes and metal nucleic acid complexes. Using principles from inorganic Chemistry, a detailed understanding of the coordination Chemistry and function of transition metals in the context of biological systems will be obtained.

511 / MATSCIE 510 Materials Chemistry. (3 hrs.) Prereq. 430 or 461 or BIOLCHEM 415. This course presents concepts in materials Chemistry. The main topics covered include structure and characterization, macroscopic properties and synthesis and processing.

515 / MACROMOL 518 Organometallic Chemistry. (3 hrs.) Systematic consideration of modern aspects of organometallic chemistry including main group and transition metal complexes. The structure and bonding in organometallic compounds are covered. Particular emphasis is placed on applications of homogeneous organometallic catalysis in polymer synthesis, industrial processes, and synthetic organic Chemistry.

520 / BIOPHYS 520 Theory and Methods. (3 hrs.) Prereq. 420, 463 or BIOLCHEM 415. Methods of Biophysical Chemistry --- This course provides an overview of key methodologies of contemporary biophysics and biophysical Chemistry. Principles of structure determination by X-ray diffraction, solution and solid-state NMR and electron microscopy will be covered. A variety of optical spectroscopic techniques, including UV/Vis, fluorescence, circular

dichroism and cell imaging will be discussed. Methods for the separation and study of biological macromolecules and membranes including ultracentrifugation, chromatography, electrophoresis, mass spectrometry and calorimetry will be introduced.

521 / BIOPHYS 521 Techniques in Biophysical Chemistry. (3 hrs.) Prereq. 430, 461 or BIOLCHEM 415. This course is team-taught and is the second of a two-term biophysical Chemistry series, BIOPHYS 520/521, but it can be taken as a stand-alone course. BIOPHYS 521 provides an overview of the theory and application of spectroscopical techniques of UV/Vis, IR, Fluorescence, Single Molecule Detection, CD, and NMR. Other topics covered include X-ray crystallography, computational methods, light scattering, ultracentrifugation. When possible, hands-on opportunities in applying some of these techniques will be offered.

525 / CHEMBIO 525 Chemical Biology I. (3hrs.) Exploration of the application of chemical principles to biology. Together with CHEM 526, this constitutes a comprehensive one year introduction to the field of chemical biology.

526 / CHEMBIO 526 Chemical Biology II. (3hrs.) Exploration of the application of chemical principles to biology. Together with CHEM 525, this constitutes a comprehensive one year introduction to the field of chemical biology.

528 / BIOLCHEM 528 / MEDCHEM 528 Biology and Chemistry of Enzymes. (2 hrs.) Prereq. 501 or BIOLCHEM 550. This course will explore the roles of organic and organometallic cofactors in biology. Topics covered will be cofactor assembly, cofactors as sensors, and cofactors in enzyme Chemistry, with an emphasis on modulation of cofactor reactivity by complexation with the protein. The lectures will be complemented by assigned reading material from the primary literature and will assume basic familiarity with bioorganic Chemistry.

536 / MACROMOL 536. Laboratory in Macromolecular Chemistry. (3 hrs.) Prereq. 535 or Phys 418/permission. Experimental methods for the study of macromolecular materials in solution and in bulk state.

538 Organic Chemistry of Macromolecules. (3 hrs.) The preparation, reactions, and properties of high molecular weight polymeric materials of both natural and synthetic origin.

540 Organic Principles. (3 hrs.) Mechanisms of organic chemical reactions, stereochemistry, and conformational analysis. The important types of organic reactions are discussed. Basic principles are emphasized; relatively little attention is paid to the scope and synthetic applications of the reactions.

541 Advanced Organic Chemistry. (3 hrs.) Prereq. 540. Synthetic Organic Chemistry. The scope and limitations of the more important synthetic reactions are discussed within the framework of multi-step organic synthesis.

542 Application of Physical Methods to Organic Chemistry. (3 hrs.) Applications of infrared, ultraviolet, nuclear magnetic resonance spectroscopy, optical rotatory dispersion/circular dichroism spectroscopy, mass spectrometry and other physical methods to the study and identification of the structure and reactions of organic compounds.

543 Organic Mechanisms. (3 hrs.) Students will learn to propose and write reasonable mechanisms for organic reactions, including complex multi-step processes. Knowledge of the details of the fundamental organic reaction processes will also be gained.

548 New Frontiers at the Chemistry/Biology Interface. (1 hr.) Students attend seminars that describe topics at the frontiers of Chemistry and Biology.

550 / EDUC 550 Chemistry Education. (3 hrs.) Chemistry Education Research and Practice. This course will prepare future secondary and post-secondary chemistry educators to translate chemistry education research into effective classroom practice. Students will read and critically evaluate literature from top Chemistry Education and Science Education Journals. Students will learn about, prepare, and test their own formative and summative assessments. Students will practice student-centered classroom techniques and reflect on and develop their own teaching identity and style. Students will learn about issues of diversity and equity and learn strategies to foster inclusivity in the science classroom.

551 / BIOINF 551 / BIOLCHEM 551 / BIOMEDE 551 / PATH 551 Proteome Informatics. (3 hrs.) Introduction to proteomics, mass spectrometry, peptide identification and protein inference, statistical methods and computational algorithms, post-translational modifications, genome annotation and alternative splicing, quantitative proteomics and differential protein expression analysis, protein-protein interaction networks and protein complexes, data mining and analysis of large-scale data sets, clinical applications, related technologies such as metabolomics and protein arrays, data integration and systems biology.

567 / AOSS 567. Chemical Dynamics. (3 hrs.) Prereq. 461 or AOSS 479. Chemical Kinetics is the study of the rates and mechanisms of systems undergoing chemical change. The extraction of rate data from reacting systems and the utilization of such data in other reacting systems is central to Chemistry in the laboratory and in the

practical worlds of combustion science, atmospheric science, and chemical synthesis. This course introduces the treatment of complex chemical systems and fundamental ideas about chemical reaction rates in gases and in solutions. Computer software is utilized to treat complex reaction systems.

570 Molecular Physical Chemistry. (3 hrs.) Prereq. Permission of Instructor. Designed for non-specialists lacking a solid background in physical Chemistry. Meets along with Chem 461. Should not be elected by students specializing in physical Chemistry. This is the second of the three-term physical Chemistry sequence CHEM 260/461/463. CHEM 461 builds on the introduction to quantum mechanics that was given in CHEM 260. Students will use the Schrödinger Equation in 1-, 2-, and 3 dimensions to solve exactly a series of important chemical problems including the harmonic oscillator, the rigid rotor, and the hydrogen atom. Group theory is introduced as an aid for understanding spectroscopic selection rules. Advanced spectroscopy, including transition probabilities, normal vibrational modes, and photoelectron spectroscopies are introduced and then used to deduce molecular structure. The valence-bond and molecular orbital theories of chemical bonding are discussed, and methods for performing quantum chemical calculations, including variational and perturbation methods, are introduced. The quantum mechanics of spin and angular momentum are discussed and used to interpret magnetic resonance spectra.

571 Quantum Chemistry. (3 hrs.) Prereq. 570. This course is the first of a two-term physical Chemistry series: Quantum Chem 571/Statistical Mechanics/576. Review of quantum mechanics from a postulational viewpoint; variational and matrix methods, time-independent and time-dependent perturbation theory; applications to molecular systems including potential energy surfaces and reaction pathways.

576 / APPPHYS 576 Statistical Mechanics. (3 hrs.). Constitutes with 571 as a two-term series for students specializing in physical Chemistry. The foundation of equilibrium statistical mechanics and applications to problems of chemical interest. Included are discussions of imperfect gases and liquids, mixtures, solids, quantum statistics, surface Chemistry and polymers.

580 Molecular Spectra and Structure. (3 hrs.) CHEM 580 is an advanced physical Chemistry graduate course on molecular structure, dynamics and spectroscopy. Tentative list of topics:

1. A survey of quantum Chemistry
2. Quantum dynamics in Hilbert space.
3. Quantum dynamics in Liouville space.
4. Green function/operator techniques.
5. The quantum master equation.
6. Mixed quantum classical dynamics.
7. Electromagnetic radiation and radiation-matter interaction.
8. Optical response.
9. Optical response of a multi-level system governed by a quantum master equation.
10. Mixed quantum-classical approaches for calculating optical response tensors.
11. The Brownian oscillator model.

597 Intro to Graduate Research. (3 hrs.) First year only. All Chemistry Ph.D. students are required to take a first-year graduate research course both Fall and Winter Academic Terms. This course consists of practical hands-on experience in a faculty's lab. Students receive training in research methods and techniques necessary for the successful conduct of dissertation research as the new curriculum changes require.

602 / BIOLCHEM 602 / BIOPHYS 602 / PHRMACOL 602 Protein Crystallography: Principles of Macromolecular Crystallography. (3 hrs) Fundamentals of the methods for determining 3-dimensional structures of large molecules by X-ray crystallography. Aimed at students who expect to use crystallography as a major tool for their research, and at those who want in-depth knowledge of the methods in order to analyze structure data.

616 Advanced Inorganic Chemistry. (3 hrs.). (Prereq.: basic knowledge of group theory). The application of theoretical principles to understand the theoretical background of key optical and vibrational spectroscopic techniques. These include electronic absorption, electron paramagnetic resonance (EPR), magnetic circular dichroism (MCD), Mossbauer, and resonance Raman spectroscopy. In addition, a brief introduction to magnetism and magnetic susceptibility, and modern quantum-chemical calculations (in particular, density functional theory) is provided.

646 Separation Processes. (3 hrs.) This course will cover theory and practical applications of modern chromatography, electrophoresis, centrifugation, and other chemical separation methods. Instrumentation and interface to mass spectrometry will also be covered. This course will be valuable for students of chemical, biological, or environmental sciences who use separations techniques or who will specialize in the development of such methods.

647 Mass Spectrometry. (3 hrs.) This course is focused on gaining a deep understanding of the physical principles of this technique, including generation and measurement of high vacuum, sample introduction systems, ionization methods, ion optics, mass analysis, ion detection, electronics, and data processing. Methods for tandem mass spectrometry (MS/MS) experiments are also discussed in detail, including collision induced dissociation, surface induced dissociation, photo dissociation, and techniques involving radical ion Chemistry, *e.g.*, electron capture and transfer dissociation, as well as implementation of MS/MS on various mass analyzers.

648 Analysis Spectroscopic and Imaging. (3 hrs.) Prereq. 447 or equivalent/permission. Theory, practice and application of spectrochemical techniques for analysis and research with emphasis on emission and absorption spectroscopy in the principal regions of the electromagnetic spectrum.

649 Electrochemistry. (3 hrs.) Prereq. Permission. The course will introduce and discuss the fundamental processes necessary for understanding electrochemical systems. The common methods and interpretation of experimental data will be presented. A description of experimental design and instrumentation will be given. As time permits, current and special topics in electrochemical research will be discussed.

673 / BIOLCHEM 673. Kinetics and Mechanism. (2 hrs.) Prereq. BIOLCHEM 550 or CHEMBIO 501. This course will cover the investigation of enzyme mechanisms with an emphasis on kinetic and thermodynamic methodology, including: ligand binding to macromolecules, transient kinetics, steady-state kinetics, and kinetic isotope effects. The key kinetic and thermodynamic concepts that govern the action of enzymes, and the thought processes required to deduce catalytic and kinetic mechanisms will be explored. Topics will be treated from both a "gut-feeling" and a mathematical perspective, and applications to real systems, including experimental methods, data analysis, and common errors/fallacies/abuses, will be considered in detail. Because computer methods for analyzing and simulating data have taken a prominent place in the field, the use of software from kinetics research will be emphasized through numerous "hands-on" exercises.

720 Chemical Sciences at the Interface of Education Seminar (CSIE). (1 hr.) Prereq. Instructor permission. Professional Development and Organizational Leadership in Chemistry --- Participants in this seminar will plan, develop, and implement workshops, seminars, and other relevant sessions for the CSIE / UM and CALC / UM programs, with an explicit emphasis on developing academic organizational leadership skills.

743-744 Special Topics in Organic Chemistry. (2 hrs.) Prereq. 541. Hetero-organic Chemistry: open chain nitrogen compounds, organometallic compounds, heterocyclic compounds.

800-805 Individual Student Seminars. (2 hrs, all terms). Prereq. Graduate standing. Every student is **required** to present a student seminar on a topic approved by research advisor. Each student must register for this in the term he/she expects to present it, typically in the fall/winter of the 2nd year.

800 – Chemical Biology

801 – Analytical

802 – Inorganic

803 – Organic

804 – Physical

805 – Materials

990 Dissertation Research/Precandidacy. (1-8 hrs. every term except Spring/Summer) Prereq. Instructor permission. Election for dissertation work by doctoral student not yet admitted as a Candidate.

995 Dissertation Research/Candidacy. (8 hrs. every term. In Spring/Summer only if defending). Prereq. Instructor permission. This course number is used for doctoral research by students who have been admitted to candidacy.

Cognate Courses

The Graduate School requirement of at least four cognate credit hours, a minimum of 2 courses total (outside the department and on the Department approved cognate list) is interpreted to allow courses in departments whose subject matter is related in some significant way to chemical professional interests. Please consult with a Graduate Committee advisor or your Research Advisor for additional courses. See list below for the approved cognates. Check the time schedule for courses offered in a particular term. If there is a course that you would like to take that is not on this list, you must send an email to the Graduate Program Coordinator with a paragraph stating why you would like to take the course and attach the syllabus for the course and a statement from your advisor saying they support your petition. The petition will then be taken to the Graduate Committee for approval and you will be notified of the decision. This must all be done BEFORE you register for the course.

Cognates are intended to enhance the scientific training of each graduate student. Exceptions to the approved cognate course list are made by the Graduate Committee. Courses from the following areas are usually approved for cognate credit:

Atmospheric and Oceanic Science, Biology, Biological Chemistry, Chemical Engineering, Electrical Engineering and Computer Science, Environmental and Industrial Health, Geological Science, Macromolecular Science, Materials Science and Engineering, Mathematics, Medicinal Chemistry, Pharmacology, Nuclear Engineering, Physics, Statistics

COGNATE COURSES

(This is just a guide. These courses may/may not be available. Please consult the time schedule.)

BIOINFORMATICS

524/525 Foundations in Bioinformatics and Systems Biology
527 Introduction to Bioinformatics
528 Advanced Applications of Bioinformatics
545 Molecular Genomic and Epigenetic Data Analysis
551 Proteome Informatics

BIOLOGICAL CHEMISTRY

515 Intro to Biochemistry
530 Structural Biology in Solution (Protein Interactions?)
550 Macro Mol Structure and Function
640 Post-transcriptional Gene Regulation
650 Mechanisms of Eukaryotic Gene Expression
660 Protein Biochemistry

BIOPHYSICS

503 Macromolecular NMR Spectroscopy
520 Methods and Theory
521 Techniques in Biophysical Chemistry
602 Principles of Macromolecular Crystallography
608 Biophysical Principles of Microscopy

BIOSTATISTICS

501 Introduction to Biostatistics
581 Biostatistical Modeling in Clinical Research

CANCER BIOLOGY

554 Cancer Pathogenesis and Treatment

CELLULAR AND DEVELOPMENTAL BIOLOGY

530 Cell Biology
682 Organogenesis of a Complex Tissue

CHEMICAL ENGINEERING

470 Colloids and Interfaces
512 Physical Polymers
527 Fluid Flow
528 Reactor Engineering
538 Statistical and Irreversible Thermodynamics
542 Transport Phenomena
696 Selected Topics: Hydrogen Technology I: Production and Storage

CLIMATE

401 Geophysical Fluid Dynamics
451 Atmospheric Dynamics I
463 Air Pollution Meteorology

467 Biogeochemistry
473 Climate Physics
479 Atmospheric Chemistry

EARTH

422 Principles of Geochemistry
455 Determinative Methods in Mineralogical and Inorganic Materials
478 Geochemistry of Natural Waters

EDUCATION

Learning Theory

831 Theory and Research on Learning and Instruction in Science
832 Theory and Research Development in Science Teaching
606 Developmental and Psychological Perspectives on Education
662 Learning and Development in Higher Education
708 Cognition and Instruction in the Classroom
710 Learning, Thinking, and Problem Solving
791 Foundations of Teaching and Learning

Assessment

695. Research and Educational Practice
705. Evaluating Educational and Social Programs

Instructional Design

834 Designing Science Learning Environments
626 Principles of Software Design for Learning

Other general classes

864 The American College Student
762 Curriculum in Postsecondary Education
640 Independent Study in Educational Studies

ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

402 Computer Programming for Scientists & Engineers
413 Monolith Amplifier Circuits
414 Introduction to Micro Electro Mechanical Systems (MEMS)
434 Principles of Photonics
470 Computer Architecture
537 Classical Optics
598 Special Topics in Electrical Engineering and Computer Science

ENVIRONMENTAL HEALTH SCIENCES

570 Water Quality Assessment & Management
574 Environmental Chemistry
576 Microbiology in Environmental Health
582 Principles of Community Air Pollution
652 Evaluation of Chemical Hazards
672 Life Cycle Assessment: Human health and environmental impacts
874 Aerosol Chemistry, Physics and Impacts

ENTREPRENEURSHIP

599.030 Project Management

HUMAN GENETICS

541 Molecular Genetics

MACROMOLECULAR SCIENCE/CHEMISTRY

518 Organometallic Chemistry
536 Laboratory in Macromolecular Chemistry
538 Organic Chemistry of Macromolecules

MATERIALS SCIENCE AND ENGINEERING

410 Biomedical Materials Considerations
412 Polymeric Materials
465 Chemical and Structural Characterization of Materials
500 Materials Physics & Chemistry
512 Polymer Physics
514 Composite Materials
515 Mechanical Behavior of Solid Polymetric Materials
517 Advanced Functional Polymers
535 Kinetics, Phase Transformations and Transport
555 Nanostructures of Energy Conversion and Storage
560 Structure of Materials
562 Electron Microscopy I

MATHEMATICS

404 Differential Equations
416 Theory of Algorithms
417 Matrix Algebra I
419 Linear Spaces and Matrix Theory
420 Matrix Algebra II
425 Intro to Probability
450 Advanced Math for Engineers
451 Advanced Calculus I
555 Intro to Complex Variables
556 Applied Functional Analysis
590 Topology/Geometry

MECHANICAL ENGINEERING

599 Molecular Fundamentals of Energy Conversion
599 Introduction to BioMEMS and Microfluidics

MEDICINAL CHEMISTRY

532 Bioorganic Principles
534 Modern Techniques in Drug Discovery & Development

MICROBIOLOGY AND IMMUNOLOGY

504 Cellular Biotechnology
540 Immunology
640 Molecular and Cellular Immunology

MOLECULAR CELLULAR DEVELOPMENTAL BIOLOGY

610 Principles Neuroscience I (cross-listed with NeuroSci 601)

NUCLEAR ENGINEERING

441 Nuclear Reactor Theory I
442 Nuclear Power Reactors
515 Nuclear Measurements Laboratory
521 Radiation Materials Science I
522 Radiation Materials Science II
590 Special Topics II: Methods & Practice in Scientific Computation

NATURAL RESOURCES & ENVIRONMENT

NRE 501 Science and Management of Great Lakes

PHARMACOLOGY

612 Seminar in Antimicrobial and Cancer Pharmacology
615 Molecular Neuropharmacology
620 Business of Biology
621 Translational Pharmacology: From Drug Discovery to Therapeutics

PHARMACEUTICAL SCIENCES

701 Physiochemical Concepts of Drug Development and Delivery

706 Biologic Products: Recombinant Proteins, Cell Therapies and Biosimilars

PHYSIOLOGY

576 Signal Transduction (WI terms only)

PSYCHOLOGY

731 Physiological Psychology (Drug Abuse, Brain & Behavior section only)

PHYSICS

401 Intermediate Mechanics

402 Light

405 Intermediate Electricity and Magnetism

406 Statistical and Thermal Physics

411 Introduction to Computational Physics

417 Macromolecular and Biophysics I

441 Advanced Laboratory I

463 Introduction to Solid State Physics

STATISTICS

425 Introduction to Probability and Statistics

500 Statistics

Revised 8/2017

FINANCIAL INFORMATION

Financial Support

The Chemistry Department is committed to providing all graduate students full financial support for up to five years of their graduate program tenure. This support frees the student to concentrate on research and full-time study. Students receive aid through a combination of teaching or research assistantships and fellowships that provide tuition, excellent health care benefits, and stipend. Students must be making satisfactory progress toward the Ph.D. degree to be eligible for support. Graduate students holding at least a quarter-time appointment as a Graduate Student Instructor or Graduate Student Research Assistant will have the full tuition waived. Unless covered by a fellowship, students pay the registration, lab and student fees each term.

Fellowship support may be in the form of a fellowship awarded directly to the student by a national agency or research foundation (e.g., NSF), by the Department, the University, or Rackham.

Rackham Fellowships, Awards, Grants & Scholarships.

Rackham provides a variety of faculty nominated, Department nominated, and student initiated funding opportunities. Selection of departmental nominees is made by the Chemistry Department Graduate Committee. These fellowships are typically awarded on the basis of scholastic record and the student's research achievements. Follow the link at the following site for detailed guidelines for each competition, including eligibility requirements, nomination forms and selection criteria: <http://www.rackham.umich.edu/funding>

Fellowships Awarded by the Chemistry Department. These include industrial, Rackham, and endowed fellowships, in addition to traineeships.

Chemistry Graduate Student Instructorships (GSIs).

This appointment is made to qualified Chemistry graduate students (and to those in closely-related fields) who have an aptitude and interest in teaching. The conditions of this appointment are governed by the agreement which exists between the Graduate Employees Organization (GEO) and the University (<https://hr.umich.edu/sites/default/files/geo-contract.pdf>). The standard half-time appointment calls for an average of eight contact hours per week and up to 20 hours per week for all teaching-related activities. These hours include, in addition to actual contact time, preparation, grading, attending staff meetings, office hours and similar duties. All Graduate Student Instructors are required to attend a Chemistry Department GSI training program during Orientation. This is given the week before Labor Day. In addition to the Department's GSI training, all international students (with some exceptions) are required to take a 3-week training course and Oral English Test through the English Language Institute (<https://lsa.umich.edu/eli/gsi-program/gsi-courses/eli-994-college-teaching-at-the-um.html>), usually given in July/August.

Chemistry Graduate Student Research Assistantships (GSRAs).

Research assistantships are provided by a Research Advisor from grant funds under his/her supervision. In those cases where the student will be engaged in his/her dissertation research, full-time activity is expected; otherwise, conditions of the appointment are governed by the standard employment practices of the University.

Travel Funds. The Rackham Graduate School provides up to \$800-\$1,050 for travel to domestic (up to \$1300 for international) professional conferences and meetings. You can only receive one travel grant per fiscal year (July 1 – June 30). Refer to Rackham's website for detailed information and forms to apply for travel funds: http://www.rackham.umich.edu/funding/from_rackham/student_application/rackham_conference_travel_grant/.

Stipend Payment Schedules

Stipends for teaching and research appointments are paid in four equal installments per term. Checks are available on the last working day of each. They are mailed to your current address in Wolverine Access (<http://wolverineaccess.umich.edu>) or directly deposited into your bank account, which can also be set up in Wolverine Access. Full information is available on your appointment confirmation. Fellowship and training grant payments are also typically paid monthly, though the payment dates are usually closer to the middle of the month. Please see the Student Services Manager if you have questions or problems with payments.

Supplementary Income

Appointment to a half-time assistantship or to an equivalent fellowship is intended to provide sufficient financial support to enable a student to devote full time to his/her graduate program. Consequently, a condition of the appointment is that no outside employment be undertaken other than tutoring. In conditions of unusual financial stress, such as may result from extra dependents or special circumstances, the student should discuss projected additional employment with his/her Research Advisor and the Chair of the Graduate Committee.

Tutoring

Tutoring not only offers the graduate student a chance to obtain a small supplementary income, but also offers a chance to better his/her teaching methods and to review the basics of a particular course. At the beginning of the semester, a questionnaire will be sent out to determine each graduate student's willingness to tutor and his/her preference for specific courses. A composite of the results will be made available to all undergraduate students. It should be stressed that there are no recommendations made on these sheets. The principal restriction on tutoring is that Graduate Student Instructors must not tutor students enrolled in the course in which they are teaching.

Loans

Loan funds administered through the Office of Financial Aid (<http://www.finaid.umich.edu>) are available to meet the needs of any educational expense for students while enrolled in the University. The extent of this financial need must be clearly established by providing a complete statement of the applicant's financial resources and expenses for the academic year.

Loans are NOT available for any non-educational expense which is normally financed by a commercial lending institution, nor are they available for the repayment of previously incurred indebtedness. The graduate college does have a Rackham Graduate Student Emergency Fund (<http://www.rackham.umich.edu/prospective-students/funding/student-application/graduate-student-emergency-funds>) that is intended to help meet the financial needs of Rackham graduate students who encounter an emergency situation or one-time, unusual, or unforeseen expenses during their degree program.

Income Tax Liability

Current practice is subject to review by the IRS and may change at any time. Graduate Student Instructor and Graduate Student Research Assistantship stipends are considered salary for services performed and, as such, are subject to withholding and income tax. Under the income tax law of 1986, stipends for fellowships and other forms of student aid are subject to income tax and must be reported quarterly. It is the student's responsibility to report fellowship/award aid to the IRS.

RESOURCES

In addition to your Advisor, the Student Services staff, the Graduate Committee (including the Chair), and the Rackham Graduate School staff, there are many resources on campus to help you succeed in the Chemistry Ph.D. program.

Mentoring Resources

- ***How to Get the Mentoring You Want*** <http://www.rackham.umich.edu/downloads/publications/mentoring.pdf>
A general guide for graduate students about the importance of the student-mentor relationship.
 - **Mentoring Others Results in Excellence (MORE)** <http://www.rackham.umich.edu/diversity-equity-inclusion/mentoring> A senior faculty committee providing information and resources on mentoring to students and faculty.

Selected Campus Academic Resources

- **Center for Research on Learning and Teaching (CRLT)** <http://www.crlt.umich.edu/>
CRLT offers programs and services designed to support graduate students in all stages of their teaching careers from training for their first teaching experience through preparation for the academic job market.
 - ✓ Preparing Future Faculty Conference
 - ✓ U-M Graduate Teacher Certificate
 - ✓ Seminars for Graduate Student Instructors
- **Sweetland Center for Writing** <http://www.lsa.umich.edu/sweetland/>
The Sweetland Center for Writing supplements formal writing instruction by providing free programs that help students understand assignments, develop ideas, support arguments and claims, cite sources, and revise at the paragraph and sentence level.
 - ✓ Writing workshops
 - ✓ Writing references and resources
 - ✓ Peer tutoring
 - ✓ Dissertation Writing Institute
- **English Language Institute (ELI)** <http://www.lsa.umich.edu/eli>
The English Language Institute offers opportunities for students to participate in courses and workshops aimed at improving their language and communication skills.
 - ✓ English for Academic Purposes Courses
 - ✓ Workshops
 - ✓ Writing Clinics
 - ✓ English Learning Links
- **Center for Statistical Consultation and Research (CSCAR)** <http://cscar.research.umich.edu>
CSCAR emphasizes an integrated, comprehensive statistical consulting service, covering all aspects of a quantitative research project ranging from the initial study design through to the presentation of the final research conclusions.
 - ✓ Workshops and seminars
 - ✓ Software help
 - ✓ Software access
 - ✓ Spatial Analysis/GIS
- **Scholar Space** <http://www.lib.umich.edu/scholarspace>
Scholar Space teaches individuals how to use technology in coursework, teaching, or research.
 - ✓ One-on-one technology consultations
 - ✓ Workshops
 - ✓ Digitalization of documents
- **University of Michigan Library** <http://www.lib.umich.edu/>
MLibrary supports, enhances, and collaborates in the instructional, research, and service activities of the faculty, students, and staff, and contributes to the common good by collecting, organizing, preserving, communicating, and sharing the record of human knowledge.
 - ✓ Borrowing and circulation
 - ✓ Course reserves
 - ✓ Instruction and workshops

Selected Sources of Campus Support

- **The Career Center** is committed to preparing U-M students and alumni to be active, life-long learners in developing and implementing their career decisions. <http://www.careercenter.umich.edu/>

- **Center for the Education of Women (CEW+)** offers support services to students, faculty, staff and community members. <http://www.cew.umich.edu/about>
- **Counseling and Psychological Services (CAPS)** offers a variety of confidential services to help students resolve personal difficulties. Services include brief counseling for individuals, couples and groups. <https://caps.umich.edu>
- **Department of Recreational Sports** is the place for fun and fitness on campus. Rec Sports offers both informal activities and structured programs: Club Sports, Challenge Program, Drop-in Program, Intramural Sports and/or Outdoor Adventures. <https://recsports.umich.edu/>
- **International Center** provides a variety of services to assist international students, scholars, faculty and staff. <https://internationalcenter.umich.edu/>
- **Psychological Clinic** provides psychological care for students. Services include consultation, short-term and long-term therapy for individual adults and couples. <http://www.psychclinic.org/>
- **Department of Public Safety (DPS)** provides information on crime prevention strategies, the law enforcement authority of the University police, and policies and statistics about crime on campus. <http://www.dpss.umich.edu/>
- **Sexual Assault Prevention and Awareness Center (SAPAC)** provides educational and supportive services for the University of Michigan community related to sexual assault, dating and domestic violence, sexual harassment, and stalking. <https://sapac.umich.edu>
- **Spectrum Center**
Spectrum Center provides a comprehensive range of education, information and advocacy services working to create and maintain an open, safe and inclusive environment for lesbian, gay, bisexual, and transgender students, faculty, and staff, their families and friends, and the campus community at large. <https://spectrumcenter.umich.edu/>
- **Services for Students with Disabilities (SSWD)** provides services to students with visual impairments, learning disabilities, mobility impairments, hearing impairments, chronic health problems and psychological disabilities, so they may enjoy a complete range of academic and non academic opportunities. <https://ssd.umich.edu/>
- **University Health Service (UHS)** is a health care facility, located on central campus that offers many outpatient services in one building for U-M students, faculty, and staff. Many of UHS services provided to registered students are covered by the Health Service fee. <https://uhs.umich.edu/>

Conflict Resolution

- **Office of the Ombuds** is a place where student questions, complaints and concerns about the functioning of the University can be discussed confidentially in a safe environment. 6015 Fleming, Phone: (734) 763-3545 <https://ombuds.umich.edu>
- **Office of Student Conflict Resolution (OSCR)** Promotes justice by facilitating conflict resolution for the Michigan community and creating a just and safe campus climate. 100 Student Activities Building, Phone: (734) 936-6308. <https://oscr.umich.edu/>
- **Rackham Graduate School's Designated Resolution Officer (RO)**
Advises faculty, staff and students on matters related to student emergencies, crisis situations, disputes, and student conduct violations. The RO also provides information about Graduate School and University policies and procedures, makes referrals, and provides resources when appropriate. <https://rackham.umich.edu/academic-policies/section9/>

****For a more comprehensive list of 'Mental Health and Wellness' resources, please see:**

<http://www.umich.edu/~mhealth/students.html>

Leave of Absence Policy

Effective Fall 2010, Ph.D. students may request a temporary leave of absence when certain life events prevent continued active participation in their degree program. The policy enables students to officially suspend work toward their degree for a limited time.

Students may request a leave of absence as early as six months prior to the term the leave is to start. A leave will be granted to students for illness (either physical or mental) or injury, to enable them to provide care or assistance for family or dependents, to allow them to meet military service obligations, or for other personal reasons.

See Rackham's Leave of Absence Policy for a checklist for graduate students, faculty and staff.

<https://rackham.umich.edu/academic-policies/section2/#2-2-2>

<https://rackham.umich.edu/navigating-your-degree/leave-of-absence/>

USE OF THE CHEMISTRY BUILDING

Keys

The issuance of keys to the Chemistry Building carries with it the following responsibilities:

1. Keys will not be issued to undergraduates students.
2. Keys must be returned to the Key Office upon graduation or when no longer needed. Key deposits are \$20.00 per key.
3. Lost keys must be reported promptly to Tracy Stevenson, Room 1500c.
4. No duplicates are to be made or allowed to be made from keys issued to individuals.
5. The holder of a key must not permit the use of that key by unauthorized persons, nor must he/she use that key to admit unauthorized persons.

Building Use Regulations

The Chemistry Building customarily is open from 7:00 a.m. until 6:00 p.m. Monday - Friday and from 11:30 a.m. to 6:00 p.m. on Saturdays, and 11:30 am to 10 pm on Sunday. It is accessible via MCard access. It is closed on holidays. During times that the building is closed, the University Division of Public Safety and Security (DPSS) is responsible for the proper use of the building. They may request identification of all persons in the building during these hours, together with evidence of authorization for being in the building. DPSS has the authority to request all unauthorized persons to leave the building at hours when the outside doors are locked. Department rules state that the doors to all offices and laboratories must be kept locked. This is necessary to prevent entry by unauthorized persons and reduce the possibility of theft.

Special Rooms

The Departmental Instrument rooms and the “hands-on” instrument laboratories, and other rooms containing specialized equipment for general use require cooperative procedures. Before using equipment in such rooms for the first time, obtain instructions as to the proper operating procedures from the appropriate person. Report any damage or malfunction to the designated person in charge of the equipment or the responsible staff member. At the conclusion of your work, always clean up the area.

Classrooms

Classes begin at the designated start-time and end 10 minutes before the designated end-time to accommodate students travelling across campus for classes. Teachers and other persons using classrooms should follow this schedule so that classes coming into the room can do so on time. It is expected for persons using the blackboards to clean them before leaving the room for another class.

Bicycles, Rollerblades

These items are for outdoor use and should not to be brought/worn into the building at any time.

Radios

At all times, radios and other sound equipment must be kept at a sufficiently low volume so that they do not become a nuisance. Similarly, conduct in the building should be such as not to interfere with classes or research activities in progress. The Chemistry Building is a place for study and research. Conditions which interfere with these objectives should not be allowed to develop.

Emergency and Safety Regulations/Emergency Telephone Numbers

In case of emergency, use a campus-only phone and dial 911, give description and location of emergency. The Division of Public Safety & Security can also be reached by dialing 3-1131. University-only telephones are located on the east wall of the lower Atrium and on the wall outside the Administrative Complex (1500). If you dial 911 on a cell phone, please be sure to tell them you are calling from the University of Michigan Chemistry Building.

Fires

The Division of Public Safety & Security feels that we should report all fires, since what might appear to be a small fire could get out of control and a few minutes delay in calling might result in a serious situation. Under any circumstances, if an extinguisher is used, even partially, Tracy Stevenson (Room 1500c) or Christopher Peters (Room 1608) should be notified immediately in order to have it refilled before it may be needed again and if they are not available (after –hours/weekend) call 911 and let them know that you used a fire extinguisher to put out a fire. They will gather some information and may or may not come to inspect the scene.

Alarm System

The building has been equipped with an automatic dual-activated detection system which has both heat and smoke sensors. The systems may be activated by either type of sensor or by the manual operation of the lever at any of the standard red alarm boxes.

Upon activation of the system, warning horns sound continuously and the Division of Public Safety & Security responds by dispatching a campus police officer to investigate the cause of the alarm and by contacting the fire department, if necessary.

Response to the Fire Alarm

Leave the building at once! Do not assume that it is a false alarm. Do not attempt your own investigation. Class instructors should direct their students to the nearest exit.

If you have first-hand information, meet the firemen at the loading dock on the north side of the building; otherwise, stay away from the dock so that emergency vehicles and personnel can get to the building. When the warning horns shut off AND you receive the “All Clear” command from the Facilities Manager, a Safety Officer with “Fire” vest or the Chief Administrator, it is then safe to re-enter the building.

Security

The Chemistry Building contains a large amount of dangerous and/or flammable substances and also a great deal of expensive and delicate equipment. It is therefore particularly vulnerable to petty thievery and to attempts at malicious mischief. Strangers, and particularly youngsters, can seriously injure themselves by wandering into hazardous areas. For these reasons, doors to individual office and laboratories areas should always be locked. If persons are found in areas where they appear to have no business, they should be questioned and directed to the location they are seeking. If they seem to have no valid reason for being where they are, they should be ushered out courteously but firmly. Call DPSS (763-1131) if the situation warrants further investigation.

Permission to be in the building during the hours when it is locked (10:00 p.m. until 7:00 a.m. weekdays; 10:00 p.m. Friday until 7:00 a.m. Monday) is granted to members of the Chemistry Department. The presence of unauthorized individuals in the building after it is locked should be reported immediately to the Department of Public Safety at 763-1131. Particular care should be taken with keys to various rooms in the building and any loss should be reported immediately. In the case of untoward events such as theft, arson, or vandalism, notify the Division of Public Safety & Security, using any University phone dialing 911 immediately. Do not call the Ann Arbor Police. The Department of Public Safety will evaluate the situation and take additional action if necessary.

Injuries

First-aid treatment for injuries should be limited to common sense emergency treatment only. Examples might include severe cuts where profuse bleeding dictates the use of compresses or a tourniquet, chemical splashes which call for immediate flooding with water for 15 minutes followed by washing the exposed area for an additional 15 minutes, chemicals in the eye which should be washed copiously with water (note the drench hoses which are located throughout the building in the laboratories), and moderate burns for which the best first aid is flooding with cold water to reduce the flesh temperature.

If there is a relatively minor injury to any individual, notify Christopher Peters immediately. His phone number is 763-4527 and his pager number is 734-651-6289. If he is unavailable, notify Tracy Stevenson at 764-7316.

If the injury has occurred after normal working hours and the individual requires medical attention, call 911 for transportation to the Emergency Room. If, at any time, there is a life threatening injury, call the Department of Public Safety (x911) immediately for assistance. Then contact Christopher Peters or Tracy Stevenson and appraise them of the situation. If an injury occurs after 5pm or on a weekend, a report will need to be filed with Christopher

Peters as soon as possible, contact Chris Peters or Tracy Stevenson immediately to notify them of the accident. If an injury that requires medical treatment happened to an employee during working hours, the individual will be taken to M-Works. If an injury happens to a student, the student will be taken to Health Services.

Emergency equipment, such as fire extinguishers, are located on each floor of the Chemistry Building. Please notify Tracy Stevenson, Room 1500C (Safety Warden) whenever you see safety equipment which is dislocated or in poor condition, or if you find a hazardous situation which cannot easily be remedied. No person is permitted to work in the building alone at any time in the conduct of experiments which could possibly cause burns, blindness, or other physical disability. Some other person must be near enough to give first-aid and assistance in case of accident (Buddy Rule). Compliance with this rule often entails considerable cooperation in hours when only a few are working in the building. It also means that rear and side doors to research rooms in which work is going on should always be open to allow ready entrance and exit in case of accident.

General Precautions

The general accepted safety principles and practices for the department, and specifically for individual research laboratories, are contained within the Chemical Hygiene Plans (CHPs) that are located within each respective research laboratory suite. Familiarization with the contents of this departmental safety manual (CHP) is essential to working safely in the Chemistry buildings.

Safety glasses or goggles are required to be worn in all laboratories, instrument rooms, chemical storage rooms and other areas where hazardous work is being performed. Under no circumstances are contact lenses to be worn in an eye protection area. Safety glasses, including prescription, are available at low or no cost to the individual from the Department of Occupational Safety and Environmental Health. See Christopher Peters, Room 1608, to obtain the glasses.

Federal and State law requires that all containers in which chemicals are stored are to be properly labeled as to their contents, hazards associated with handling these materials and safety precautions that must be followed. Gas cylinders, which present a special physical hazard, must be securely fastened to benches, tables and/or walls with appropriate supports. When stored or not in use, gas cylinders need to have their safety caps in place. Under no circumstances are cylinders to be stored in the halls. Hoods are critical to the safe operation of a laboratory and the wellbeing of its occupants. The proper use of the double sash, two speed hoods that are currently in place in the Department is important to provide a maximum level of safety. Correct operating procedures are posted on each hood and are described in the Chemical Hygiene Plan. Following these instructions carefully will insure proper usage of the hoods and maximum safety to the user.

Conservation of resources is critical to the Department and the University. Ensure that all water, nitrogen, electricity and other utilities are turned off when not in use. All non-rigid lines that carry fluids (water, nitrogen, etc.) are to be properly fastened with clamps or wire. Reinforced Tygon tubing is recommended.

If an experiment needs to be run overnight or through a weekend, a sign indicating that it is not to be disturbed must be attached with contact information on it in case of emergency. Security has been known to close water valves and turn off electricity to equipment left running after hours. Names, addresses and telephone numbers of persons to be notified in case of emergencies must be posted on the corridor doors of each laboratory.

Use common sense when working in a laboratory. Remove or repair any and all hazards, be they physical, electrical or chemical. A safe working environment requires a concerted effort by all parties. If there is a safety problem that needs to be resolved, notify Christopher Peters (Room 1608) or Tracy Stevenson (Room 1500c).

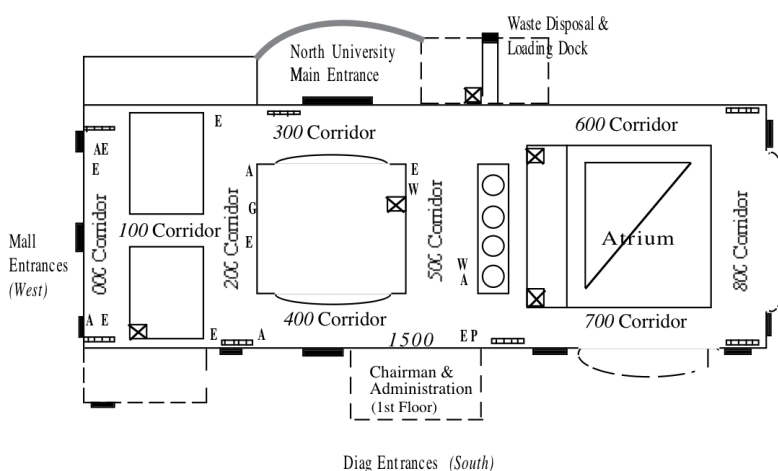
Maintenance

All maintenance items such as lights out, malfunctioning switches, plugged sinks, leaking radiators, etc., should be reported to Anson Pesek (CHEM 1612) or to the facilities website <https://requests.fo.umich.edu/>. Floods should be reported immediately to Tracy Stevenson or Anson Pesek. If after hours, call 647-2059 and report the problem.

Energy Considerations

Chemistry, as one of the most energy-intensive activities in the University, can contribute a great deal toward holding energy costs down. Everyone in the Department needs to help eliminate wasteful use of energy. Room lights, particularly in classrooms should be turned off when leaving; furnaces, pumps, heaters of all kinds and other items of equipment using electrical energy should not be left on for any purpose. Hoods, particularly in teaching laboratories, should be turned down or off when they are not needed. Hoods are high consumers of energy, not only because of the energy to operate the fans but also because they exhaust a large volume of tempered air outside the building. The cooperation of everyone in the building is necessary to keep growing energy costs within bounds.

930 North University Avenue



Chemistry Administrative Complex, Room 1500; Mailboxes, 1500o & 1531.

The first digit gives the floor on which room is located.

The second digit gives the corridor on that floor.

The last two digits give the room number in that corridor.

(Three digit numbers preceded by an "A" are found in the basement.)

The letters on the diagram indicate the locations of the following safety devices:

P - Emergency Phone

E - Fire Extinguisher

A - Fire Alarm

W - Water Fountain

Stairway 

Elevator 