

Drexel University

Department of Chemistry

Graduate Student Handbook

2004-2005

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I. Department of Chemistry

A. Welcome

On behalf of the Chemistry Department at Drexel University, I extend to you a warm welcome. From our beginning as a part of the Chemistry and Chemical Engineering Department of Drexel Institute of Technology (which became Drexel University in 1971), we have evolved into a separate department in the College of Arts & Sciences awarding both Masters and Doctoral degrees (the first Ph.D. in 1968) in all major areas of chemistry.

At Drexel we have strong nationally and internationally recognized programs in the areas of analytical, atmospheric, inorganic, organic, physical, and polymer chemistry. In addition, Drexel encourages interdisciplinary activities. Several of our faculty actively collaborate with scientists in areas such as computational science, biological chemistry, and materials science.

Two of our department's most important goals are to increase basic chemical knowledge and its application to fundamental basic research. At the same time, we want graduate students to appreciate practical applications of chemistry in solving the problems that we all face in the modern world. Our department is small enough to provide each student with individual attention while maintaining a community of scholars (faculty, postdoctoral associates, graduate and undergraduate students). The relatively small research groups enable close interaction between students and their Research Advisors. We regard such attention and interaction as important positive features of our program.

Within our department, students and faculty are investigating diverse and exciting research problems. These include developing improved methods for the analysis of trace constituents in air and water, synthesizing and characterizing compounds of medicinal and industrial interest, studying the utilization of various energy sources, developing techniques for studying interfacial phenomena, examining the function of biological macromolecules at the atomic level, preparing and studying the properties of new conducting polymers, characterizing laser-induced transient species, using spectroscopy to study molecular structure, investigating chemistry of the solid state, and developing improved methods for the prediction of catalytic activity. The wide range of faculty interests ensures that we can stimulate the interest of students.

This handbook contains some important information with respect to your graduate career, please read it carefully and review the information, if necessary, with your Faculty Advisor. Of particular help is the checklist at the end of the handbook (Appendix B).

If you intend to pursue a Ph.D. degree, you should also obtain from the Graduate Studies Office a copy of the *Graduate Studies Ph.D. Forms Booklet* (online at <http://www.research.drexel.edu/graduate/index.asp>).

Good luck and best wishes for your future in chemistry!

Peter A. Wade
Associate Professor and Interim Department Head
Department of Chemistry

B. Advanced Degree Programs in Chemistry

The Chemistry Department offers Master of Science (M.S.) and Doctor of Philosophy (Ph.D.) degrees in Chemistry with specialization in the areas of:

**Analytical
Atmospheric
Chemical Education
Inorganic
Materials
Organic
Physical
Polymer**

The M.S. degree is awarded to students who show competency at the advanced level in the major areas of chemistry. Both a thesis and non-thesis M.S. option is available. Most full-time students complete the M.S. degree within two academic years.

The Ph.D. degree is conferred in recognition of breadth of scholarship and scientific attainment plus demonstrated ability to investigate significant scientific problems independently and efficiently, rather than for completion of definite courses of study through a stated period of residency. A typical time for the completion of a Ph.D. by a full-time student is 5 years after completing the baccalaureate degree.

C. Admissions Requirements

1. Graduate School requirements

Refer to the section entitled "Admission to Graduate School" in the Drexel University Graduate Catalog (online at <http://www.drexel.edu/provost/catalog/grad.html>). This section discusses the recommended grade point average for undergraduate preparation, admission as a probationary non-matriculated student or as a non-degree student, and demonstration of competence in English for students whose native language is not English. The term "graduate" in this handbook conveys the same meaning as "post-graduate" does in other countries.

2. Departmental Requirements

Both full-time and part-time students are required to have a B.S. in chemistry or the equivalent. In other words, there must be evidence of adequate undergraduate preparation in chemistry, physics, and mathematics typically including: 34 semester (or 51 quarter credits) in undergraduate chemistry; including general and inorganic chemistry and qualitative analysis (10 semester credits), analytical (8 semester credits), organic (8 semester credits), and physical (8 semester credits), plus college physics, and differential and integral calculus. If some of the requirements are not met, you may still be admitted but required to make up any deficiencies perceived by the Department.

It is strongly recommended that you take and report to the department results of the Graduate Record Examination administered by Educational Testing Services, Inc. (Princeton, NJ). These scores are helpful, particularly if you are requesting financial support.

D. Advanced Status

a) Post-Masters status

Students who have taken graduate courses in chemistry beyond a fourth year of university may be eligible for post-M.S. status in Drexel's graduate program. Drexel then requires only 45 additional credits of work for the Ph.D., rather than an additional 90. However, you should not normally take a course for credit at Drexel if a course of similar content was part of your prior M.S. work. You should therefore ask advice (from the Graduate Advisor) as to which Drexel courses you should not enroll in. Your post-M.S. status will be validated by the Registration Exams: if your four "percentile" ranks on them do not total to at least 150, then your post-M.S. admission status will revert to post-baccalaureate status. If you enter with post-M.S. status, then you must commence taking cumulative exams within one calendar year. It is nonetheless advisable for you to take the graduate course sequence in your major, as the experience is usually helpful when taking the cumulative exams. These factors can create complications for students who wish post-M.S. status, so that you might find it more desirable to instead apply for transfer of credits from your prior work.

b) Transfer Credit

Up to 15 credits of graduate coursework at another university may be transferred for graduate credit at Drexel, in accord with the description in the "Transfer Credit" section in the University's Graduate Catalog, (online at <http://www.drexel.edu/provost/catalog/grad.html>) and with the approval of the Graduate Advisor and the Graduate Curriculum Committee. Credit transfer is initiated by consulting with the departmental Graduate Advisor or with the Graduate Curriculum Committee Chairman, who will normally be prepared to consider such requests only after you have progressed through your third quarter of study in good academic standing. The granting of transfer credit usually necessitates some evaluation of the content of the prior coursework, and the results of your registration exams are also taken into consideration in this regard. Naturally, any particular coursework that is counted toward a post-M.S. admission status cannot also be transferred in for the additional credits required for a Drexel degree.

II. Advanced Degree Requirements

A. All Graduate Students

A section of the Drexel University Graduate Catalog entitled "Graduate Regulations" contains a number of general requirements of Drexel's graduate school for any M.S. and Ph.D. candidate (online at <http://www.drexel.edu/provost/catalog/grad.html>). These are in such areas as: maximum study and work load for teaching or research assistants, registration, plan of study, transfer credit, time limitations, and graduate degree requirements such as residency of at least

one academic year. In addition to those listed below, your Research Advisor, the Graduate Curriculum Committee, your Ph.D. Oral Committee and Department Head may make additional requirements in the best interests of the student and the department. The University requires all students to maintain a cumulative GPA of at least 3.0 (B average).

1. Registration Exams

All graduate students, upon entering the program, are required to take a series of two hour written exams in analytical, inorganic, organic, and physical chemistry. The purpose of these exams is to help assess a student's preparation in chemistry to provide a basis for advice on which courses to take. You will be required to make up any deficiency revealed by these exams. If you obtain a score lower than the 25th percentile (compared to statistics provided by the American Chemical Society), you will generally be required to take an additional core course in that area. Similarly, scoring above the 75th percentile will exempt you from the single core course requirement in that area. Exams are given in the week preceding the start of the fall term. If you enter the program during other terms, you will be required to take the registration exams the following fall or sooner if they are offered. Non-matriculated students pursuing either one or a few courses will generally be required to take the registration exam for that particular area.

2. Course Requirements

Although specific credit hour totals for advanced degrees are given in subsequent sections, some general requirements for all chemistry students include:

- At least 30 credit hours of graduate study must be done at Drexel.
- At least one complete sequence in the student's major area of interest (or other area chosen in consultation with your Research Advisor) must be taken from

CHEM521/522/523 (inorganic core sequence)

CHEM530/531/755 (analytical core sequence)

CHEM541/542/543 (organic core sequence)

CHEM561/562/563 (polymer core sequence)

CHEM557/558/659 (physical core sequence)

- At least one course from each of the following areas: analytical, inorganic, organic and polymer chemistry.
- At least one course from physical chemistry, which must be CHEM557 or CHEM555, i.e., classical thermodynamics or quantum mechanics.

In case any required course is not offered for a protracted period of time due to low enrollment, the Graduate Advisor may make special allowances.

3. Plan of Study

At the point of choosing your Research Advisor you should file a Plan of Study in consultation with the Graduate Advisor or your Research Advisor. A Plan of Study form (Form D-1) is contained in a packet available from the Graduate Studies Office (or online at

<http://www.research.drexel.edu/graduate/forms/phd.asp>. You should list courses taken and to be taken as well as tentative dates for your oral candidacy exam and Ph.D. defense. The Plan of Study must then be approved by the Graduate Curriculum Committee, the Graduate Advisor, the Department Head, and the Graduate School. Changes in the Plan of Study after submission must have the approval of the Graduate Curriculum Committee.

4. Annual Progress Report

All full-time and part-time research students are required to submit an annual progress report detailing their advancement in research for the preceding year. This two-page report should briefly describe what research was accomplished and how it fits in to your long-range research goals. You may include references for papers published and presentations given (either talks or posters at local or national meetings); if more than one author is listed you should carefully explain what portion of the work is your own. Your Research Advisor is required to acknowledge and may comment on this review. The Graduate Curriculum Committee will monitor your research progress using these reviews; if progress is deemed inadequate the Graduate Curriculum Committee may recommend that the student be dropped from the program. Feedback from the Committee will be through your Ph.D. Advisory Committee Chair, so you must submit a University D-5 form to the Department Graduate Advisor before submitting your first report. If you intend doing research only as far as the M.S. degree, then you need only name a chairperson for the Advisory Committee. Failure to turn in a report by the designated date will necessitate an oral presentation of the progress report to the full Graduate Curriculum Committee.

5. Academic Honesty

All students are expected to maintain the highest professional and academic ethics in all of their efforts, whether these efforts involve research or coursework assignments. Details of Drexel University's Academic Honesty Policy can be found on pages 42-44 of the 2004-2005 Official Drexel Student Handbook, which is available on the web at <http://www.drexel.edu/Studentlife/SLhandbook.htm>

B. Full-Time students

Any student who is receiving a teaching or research assistantship from the University is considered to be a full-time student and must fulfill the following requirements along with other full-time students.

1. Departmental Seminar

All full-time graduate students past their first year of study must enroll in CHEM865, Chemistry Research Seminar at least one-quarter per year. The speakers are usually from other universities, and provide you with the opportunity to obtain a broader perspective of research activities in your own and other fields of chemistry, both in the national and international arena. **ALL FULL-TIME STUDENTS ARE REQUIRED TO ATTEND ALL DEPARTMENTAL SEMINARS** unless it conflicts with a regularly scheduled teaching assignment.

2. Thesis

All full-time students who have received financial assistance from the department are required to write a thesis (or equivalent report) on original chemical research for their terminal degree (see the appropriate degree requirements below for more information). A student who finishes a M.S. degree, but continues into the Ph.D. program in Chemistry at Drexel is exempt from this requirement with respect to the M.S. degree.

C. Master of Science Degree

1. Course Requirements

The M.S. degree is awarded after satisfactory completion of a minimum of 45 credit hours in chemistry and related fields. Several general requirements are listed above in Section IIA2. The remaining credits may be chosen from approved graduate courses within the department or from other departments offering courses related to your major area. These courses should be approved in advance by your Research Advisor or the departmental Graduate Advisor.

2. Thesis Option

The chemistry faculty strongly recommends the masters thesis option, but realize it is not always possible or necessary for all part-time graduate students. M.S. candidates who receive financial aid in the form of a teaching assistantship or tuition fellowship are *required* to enroll in CHEM898 (Thesis) and submit a M.S. research thesis or equivalent report. Within this option, Drexel's rule is that up to nine credits of course work may be replaced by CHEM997 (Research). During the first two-quarters of course work a student should choose a Research Advisor with whom to work in carrying out an original investigation in chemistry. The results will be written up in thesis form and submitted to a M.S. Thesis Review Committee consisting of the Research Advisor and two other departmental faculty suggested by the Research Advisor and approved by the Graduate Curriculum Committee. The acceptance by this committee of the M.S. thesis completes the thesis option requirements for the M.S. degree. A Thesis Manual, which describes the preparation and required format of the thesis, may be obtained either from the Graduate School Office or the Library. Note also the Graduate School requirement; if you take a Drexel M.S. degree, you need to apply for readmission to the graduate program (i.e., as a Ph.D. Applicant), and for this, a cumulative grade point average of 3.50 is required.

D. Doctor of Philosophy Degree

This degree is awarded in chemistry and earned in one of the areas of chemistry specified in section IB. The degree recipient must demonstrate scholastic breadth in chemistry as well as contribute significantly to scientific advancement in a chosen major area. Requirements of the program include course work, candidacy exams, a language requirement, and successful publication of a Ph.D. thesis.

1. Course Requirements

Drexel University requires that 90 credits of graduate level work must be completed for the Ph.D. degree. The Chemistry Department requires 30 credits of course work in chemistry,

including those outlined in Section IIA2. The balance can be made up of more advanced special topics courses and research credits. Transfer of credits is possible, under conditions similar to those for the M.S. degree. The Chemistry Department requires a student to maintain a cumulative GPA of at least 3.0 in the lecture courses offered in the department or the Graduate Curriculum Committee will recommend that the student not move forward to Candidacy.

2. *Ph.D. Candidacy Exams*

In order to become a Ph.D. degree candidate in chemistry at Drexel, you must successfully pass 5 of 10 written (cumulative) exams and pass an oral (proposal) exam.

a) *Written (Cumulative) Exams*

Written exams designed to evaluate your chemical knowledge (normally in your major area of interest) are given monthly during the academic year and occasionally during the summer at the discretion of the faculty. *You should begin taking these exams during your second year in the program.* Cumulative exams must be taken sequentially, with one unexcused absence allowed, until **five are passed or six are failed**. Six failures are a basis for dismissal from the Ph.D. program.

The topic(s) of the exams may, or may not, be announced prior to the exam, depending on the sub-discipline. Note that more than one examination may be taken on a given exam date; however, a maximum of ten attempts are allowed. If you do elect to take more than one exam on a particular date, you should notify the faculty proctor of your intentions prior to the examination. It is your responsibility to make sure that the appropriate faculty members are aware of the need to provide a cumulative exam for you to sit in any given month. This is particularly so if you are taking an exam outside your normal research field. At least three of the five passes must be in the student's selected area of specialization; it is therefore important that your specialization be chosen carefully in consultation with your selected Research Advisor.

b) *Oral Candidacy Exam*

A Ph.D. chemist is always confronted by the question "what is a worthwhile research program?" The ability to answer this question is as important as the learning of specific experimental skills and general principles. The Ph.D. with the ability to choose significant problems will make significant contributions in industry, government or academic research. The research proposal is an attempt to confront you early in your career with the problem of defining a worthwhile research program in chemistry. From the beginning of your graduate career (*not* just in the weeks before this research proposal is submitted), you should identify interesting and significant research problems and begin to think how you would solve them. It is particularly important that this be done during the second year, while you are taking cumulative exams.

The Oral Candidacy Exam involves two written items to be prepared by the candidate plus an oral presentation.

- 1.A written research proposal is required and is accompanied by an oral presentation. The research proposal shall not be directly related to your former or current Ph.D. thesis topic or to any other research you are carrying out, including work with an employer,

nor should your Research Advisor suggest the specific topic of the proposal. After you have thought of a topic, you should discuss it with your Research Advisor to determine if the area of research is suitable and sufficiently removed from your thesis topic. The topic must be approved in advance by the Chairman of your Ph.D. Candidacy Committee. A short summary is requested on the Graduate Curriculum Committee form. After your topic is approved, you should work independently on preparing both a written statement and your oral defense of the problem. Your chosen committee chairman should also be willing to offer some advice about the suitability of the topic and the worthiness of the draft proposal. The proposal is to be your original work. The experiments/computations you propose doing must not have been previously proposed or published. Previously published work mentioned in the proposal must be clearly and appropriately cited. The proposal will be no more than 15 pages long (no smaller than 12-point Times, single spaced), including figures, tables and bibliography. The Introduction will be not more than 5 pages long, while the Proposal section itself will be at least 5 pages in length. The oral presentation is modeled on a typical 25-minute ACS meeting presentation (corresponding to the equivalent of about 15 overhead projection transparencies)

- 2.A written summary of the candidate's Research Plan is also required. It is to be at most 5 pages long, describing the research progress that the Candidate has so far made in his/her own graduate research, and the plan and goals for carrying this research forward. Note that the annual research progress reports may be used as a basis for this summary.

The Committee will ask questions specific to the Proposal and may be expected to ask questions relevant to the Research Plan, as well as general questions related to the candidate's intellectual preparedness for the remaining graduate program experience. This portion of the exam typically lasts from one to two hours. Following the formal exam, the student will be excused and the committee will reach a decision, which will then be conveyed immediately by the Chairman to the student. The committee may pass, fail, or require additional satisfactory written material, in order to award a pass. A pass admits you to Ph.D. candidacy. In the event that you fail the exam, a second exam may be given at the discretion of the Ph.D. Oral Candidacy Committee, in consultation with your Research Advisor.

The Candidate and his/her Research Advisor in mutual consultation selects the members and Chair of the Oral Candidacy Committee, in accordance with the university's general rules:

- The candidate's Research Advisor may not be a member of the Committee, and may contribute to the proceedings only if permitted by the Chair.
- The Committee *must* include one member from *outside the Department*, who may be from another university, and must be a tenured or tenure-track faculty member from a Ph.D. granting institution from an appropriate discipline.
- The Committee must include at least one member of the departmental Graduate Curriculum Committee.

- One voting member of the Committee who is of emeritus/retired status from Drexel or another chemistry graduate program is permissible.
- Note that a total of five committee members is required by Drexel – a sixth is strongly recommended in case of some unavoidable absence. Additional members not fulfilling the above requirements may serve, but have no vote.

Further details worth noting regarding the Oral Candidacy Exam are:

- A departmental C-4 form is required, as well as the university forms D-3 and D-4.
- The deadline for completing and passing the exam is the last day of the 12th quarter (3rd year) of full-time study. For full-time students entering with post-M.S. status, it is a year earlier. For part-time students, it is one year after completion of the cumulative exams.
- The University requires that the Candidacy Exam paperwork be filed with the Graduate Studies Office 4 weeks ahead of the scheduled exam date.
- The proposal and research plan must be given to the committee no less than 10 days in advance of the exam, and to the Chairman 15 days in advance. The Chairman will indicate to the student if there are significant problems with the proposal before it is distributed to other members of the committee.
- The title, date, time and location of the presentation must be advertised in writing in the Department and on the departmental web site at least a week in advance.
- There are three possible outcomes of the exam: Pass, Holding, and Fail. In the case of a "Holding" decision, additional materials will normally be required from the candidate. The Committee may wish to reconvene to adjudicate these, though perhaps relying on correspondence with the external examiner. The Chairman will normally arrange for the adjudication of any additional materials to be completed within one month of the initial exam.

The Graduate Curriculum Committee will provide a summary of the evaluation guidelines to assist both students and examiners.

c) Literature Seminar

Each student is required to give a 25-minute CHEM865 departmental seminar. This will be on a literature topic of the student's choice, and should be delivered no later than 12 months after the Oral Candidacy Exam and before the Final Defense. The student must assume the responsibility for scheduling of the seminar in advance by consultation with the CHEM865 seminar coordinator (note that seminar dates are assigned on a "first come, first served" basis).

The student will be assigned a grade by a group of no less than three faculty members who attend the seminar. The student's Research Advisor may not be one of the graders. At least one of these faculty members will be a member of the Graduate Curriculum Committee and at least one will also serve on the student's Ph.D. Candidacy Exam committee. The Graduate Advisor must approve the members of the evaluating group in advance.

3. Communication Requirement

The communication or language requirement may be satisfied by completing a graduate course in technical writing (e.g., TSCOM510 or TSCOM520) or Chemical Information Retrieval (e.g., CHEM767) or by demonstrating via written examination a reading knowledge of German, French, Japanese, or Russian*. If CHEM767 is taken, a second course in technical writing is highly recommended. *In special instances another language can be substituted, but only if it has a significant chemical literature.

4. Ph.D. Thesis

A Ph.D. thesis, the heart of the Ph.D. degree, must be written, normally accepted by the Research Advisor, approved by the thesis format examiner designated by the Graduate Studies Office, presented to the Ph.D. Thesis Examining Committee, and defended orally. You may obtain a Thesis Style Manual from either the Graduate School Office or the Library.

Members of your Ph.D. Thesis Examining Committee should be selected in mutual consultation with your Research Advisor as soon as the oral candidacy exam is passed. The Committee is normally composed similarly to (and is often the same as) the Ph.D. Oral Candidacy Committee. The Graduate Advisor and the Graduate Studies Office must approve the composition of the Ph.D. Thesis Examining Committee. In general:

- The candidate's Research Advisor may not be a member of the Committee, and may contribute to the proceedings only if permitted by the Chair.
- The Committee *must* include one member from *outside the University*, who must be a tenured or tenure-track faculty member from a Ph.D. granting institution from an appropriate discipline.
- The Committee must include at least one member of the departmental Graduate Curriculum Committee.
- One voting member of the Committee who is of emeritus/retired status from Drexel or another chemistry graduate program is permissible.
- Note that a total of five committee members is required by Drexel – a sixth is strongly recommended in case of some unavoidable absence. Additional members not fulfilling the above requirements may serve, but have no vote.

It is the responsibility of the student, not his/her Research Advisor, to submit an acceptable Ph.D. thesis. However, the final oral exam is not to be scheduled until the Research Advisor or the Graduate Advisor has accepted the thesis, as indicated by his/her signature on Graduate School form D-3 (Final Oral Exam). Members of the examining committee will often be willing to read and comment on at least one draft of the thesis before presentation of the finished version to the committee for the defense. A copy of the thesis must be received by each member of the examining committee no later than *two weeks* prior to the oral exam. The date, time, location and title of the oral presentation must be announced publicly in writing and on the departmental web site at least *one week* prior to the date of the oral presentation. Inclusion of a brief abstract with the announcement is encouraged. The oral exam consists of two parts:

- A public 50 minute seminar on the thesis research followed by general questions from the audience with the committee in attendance. You should contact the departmental seminar coordinator for the date of this part.
- A private (candidate plus committee) question/answer session, convening shortly after the public seminar.

III. Graduate Advising

Students who have selected a Research Advisor should consult that person for information and advice on the graduate program in chemistry. For more general or procedural information full-time students should consult with the Departmental Graduate Advisor, while part-time students should confer with either the Departmental Graduate Advisor or the Department Head.

IV. Graduate Assistantships

Financial aid is typically available in the form of teaching assistantships, research assistantships, and tuition fellowships, which are awarded on a competitive basis. Both incoming and resident graduate students are considered on request for the award of a departmental teaching assistantship. Research Assistantships are available from research grant funds administered by individual faculty members. ***You should note that the university does not allow you to hold any other employment in addition to a full assistantship.***

A. Teaching Assistantship (TA)

The basic stipend is currently (2004-2005) \$13,737 for a 9-month year. First year students are also eligible to receive an additional \$3000 stipend for teaching over the first summer term. As departmental need arises, students beyond the first year may receive a stipend for summer teaching. Holders of teaching assistantships usually also receive remission of the (substantial) costs of tuition. There are two levels of Teaching Assistantship stipends: pre-candidacy and post-candidacy. The pre-candidacy stipend (\$13,737 for a 9-month year) is normally awarded to all students not having completed the Ph.D. Oral Candidacy Exam. The higher post-candidacy stipend (currently \$14,430 for a 9-month year or \$4810 per term) is normally awarded beginning the term following successful completion of the Ph.D. Oral Candidacy Exam.

In return for these advantages, the department expects each teaching assistant to carry out his or her duties conscientiously and responsibly. Indeed, failure to do so (*e.g.*, not enforcing the eye protection or other safety requirements in lab classes) can result in the withdrawal of the assistantship. If, because of some emergency (such as illness or getting snowed-in during winter), you are unable to attend a class, make sure that you have made a mutual "back-up" agreement with another instructor, so that one can take the other's place at short notice. The faculty generally does likewise.

The duties of a teaching assistant are somewhat similar to those of the other teaching staff in the department, generally involving the instruction and guidance of undergraduates in

laboratory and recitation classes, most frequently in freshman chemistry courses (CHEM101-CHEM167). Each teaching assistant works in conjunction with, and under the guidance of one of the chemistry faculty, who has responsibility for the design and execution of the course sequence, and for giving the lectures in the course. When assigned to a course, you should therefore consult with the faculty member who is in charge of the course to determine what your duties will be for the coming quarter. The Associate Head of Department is responsible for constructing the teaching duty assignments.

The types of activities in which you will find yourself involved include: running labs and recitations, grading of students' labs, recitation quizzes and exams, and helping faculty to develop and prepare materials for labs and exams. This translates into an average of six hours per week of classroom activity, and roughly twice that number of hours per week of related work outside the classroom.

New teaching assistants are usually assigned to one of the freshman sequences. Because these are large courses, there are often substantial numbers of recitation and/or lab instructors involved, so that it is necessary to hold informational/organizational meetings weekly; attendance at these is mandatory.

B. Tuition Fellowships

Tuition fellowships are only awarded in conjunction with graduate teaching assistantships. In the first year of graduate study up to 9 credits per quarter are awarded; more senior students may receive less than this, according to the needs of their Plan of Study and departmental budget allowance.

C. Research Assistantship (RA)

Research assistantships are arranged with the Research Advisor if funds are available. The Research Assistantship stipend is determined at the discretion of the Research Advisor. Part of the working relationship between a Research Advisor and a research student is that there must be a mutual agreement as to what tasks and responsibilities are involved in a particular research assistantship. When you become interested in doing research work with a given faculty member, you may want to inquire about the possibility of a Research Assistantship.

D. Satisfactory Progress

Continuation of any of the above forms of financial aid is contingent on satisfactory academic performance. Performance is evaluated annually by the Graduate Curriculum Committee and based upon the student's academic transcript and research progress reports. The department generally supports Ph.D. candidates (through stipend and/or tuition remission) for no more than 20 quarters of graduate work, while thesis M.S. candidates are limited to 8 quarters of financial aid.

E. Taxes on Fellowships

Some foreign student holders of graduate fellowships (*e.g.*, the P.R.C., Poland) find that tax treaties between their home country and the U.S. hold advantages for them with respect to Federal income taxes, which U.S. Residents rarely escape. City of Philadelphia and Pennsylvania state income taxes on Fellowship stipends are difficult to avoid. Tuition Fellowships are usually not taxed.

V. Course Selection

A. Core Courses

1. Analytical Chemistry

CHEM530, Spectroscopic Methods, Fall: Introduction to optics, interaction of electromagnetic radiation with matter, design of optical instruments, survey of spectroscopic methods of analysis.

CHEM531, Chromatographic Methods, Winter: Principles of separation (solubility, intermolecular forces), survey of chromatographic instrumentation (pumps, injectors, columns, detectors), survey of chromatographic methods.

CHEM755, Mass Spectrometry, Spring: Basic interpretive skills for organic & biochemical analysis; survey of ionization methods, ion selection or separation techniques and detection; applications in chemistry & biology.

2. Inorganic Chemistry

CHEM521, Inorganic Chemistry I, Fall: Electronic configuration of the elements and related chemical properties. The nature and structure of simple binary and ternary inorganic lattices as a function of constituent element type. Intermolecular interactions. Born-Landé model. M^{n+} in solution, chelation, macrocycle effect, HSAB principle. MO's for diatomics; bands, conductors.

CHEM522, Inorganic Chemistry II, Winter: Molecular symmetry and group theory with applications to the bonding, magnetic and optical properties of inorganic molecules. Transition metal cations in crystal fields of various symmetries, crystal field stabilization energy. Molecular orbital construction for polyatomic and centric molecules. Relationships between structure and vibrational spectra for inorganic molecules.

CHEM523, Inorganic Chemistry III, Spring: Organometallic compounds. Kinetics of complex formation, electron-transfer. Metal ions in biological systems.

3. Organic Chemistry

CHEM541, Organic Chemistry I, Fall: Spectroscopic methods of analysis, including mass spectrometry (MS, principles of MS, the mass spectrum, fragmentation mechanisms, special topics), Infrared (IR, principles of IR spectroscopy, the infrared spectra of functional groups), Ultraviolet Spectroscopy (UV, principles of UV, UV absorption by organic functional groups, special topics); Nuclear Magnetic Resonance (NMR, theory of NMR, Proton NMR (chemical shifts, coupling constants, structural determination using NMR, shift reagents and Chiral solvating agents), Carbon NMR (FT-NMR, chemical shifts, special topics).

CHEM542, Organic Chemistry II, Winter: Static or "Classical" Stereochemistry (stereoisomerism, chirality, stereogenic and chirotopic atoms, internal stereocomparisons [homotopic and heterotopic groups and faces, prochirality, applications to NMR, asymmetric syntheses, biochemical problems such as enzyme reactions and configurational determinations], conformational analysis of cyclic and acyclic molecules. Dynamic Stereochemistry (relationships between structure, geometry and reactivity, physical methods of conformational determinations, use of stereochemistry in mechanistic studies.

CHEM543, Organic Chemistry III, Spring: Mechanisms of organic reactions and the techniques of studying them: acyl and alkyl substitution, carbocations, carbanions, free radicals, carbenes, nitrenes, ylides, simple kinetics, isotopic labeling, cross-over experiments, acidity concepts, substituent effects, Hammett equation.

4. Physical Chemistry

CHEM557, Physical Chemistry I, Fall: first law of thermodynamics; thermochemistry; temperature dependence of ΔH ; flames and explosions; heat capacities, molecular basis of heat capacities; entropy and the second law of thermodynamics; the third law of thermodynamics and absolute entropies; free energy; chemical equilibrium; phase equilibria; Clapeyron and Clapeyron-Clausius equations; activities of solution-phase species; Raoult's law; Gibbs-Duhem equation; colligative properties; thermodynamics of ions in solution; Nernst equation; electrochemical cells; Carnot heat engine; refrigerator and heat pump.

CHEM558, Physical Chemistry II, Winter: Statistical Thermodynamics. Statistical mechanics of distinguishable and indistinguishable particles; Boltzmann statistics; Bose-Einstein and Fermi-Dirac statistics; Einstein and Debye heat capacities; partition functions; thermodynamic functions for ideal gases; chemical equilibria.

CHEM659, Physical Chemistry III, Spring: Experimental spectroscopy; review of quantum mechanics; interaction of electromagnetic radiation with molecules; Atomic spectroscopy; molecular orbital theory; electronic spectroscopy; vibrational spectroscopy.

CHEM555, Quantum Chemistry Of Molecules I, Winter: Quantum mechanics of simple systems (particle in box, harmonic oscillator, hydrogen atom), approximation techniques (variational principle, perturbation theory [time independent]), many electron atoms (Slater determinants and configurations, Pauli principle, Hund's Rules, term symbols), simple M.O. theory (diatomics, correlation diagrams-united atom limit and separated atom limit), Huckel M.O. approximations.

5. Polymer Chemistry

CHEM561, Polymer Chemistry I, Fall: Scope of polymer chemistry & science; structure/property relations; step (condensation), free-radical, cationic anionic, group-transfer, ring-opening polymerization; stereochemistry of polymerization; coordination and metathesis polymerization; non-classical chain polymerization; inorganic polymers; reactions and degradation of polymers; template polymerization; biological polymers.

CHEM562, Polymer Chemistry II, Winter: Kinetics and thermodynamics of polymerization; theories for and control of step-polymerization and gelation; copolymerization composition; polymerization-depolymerization equilibria; polymer characterization; determination of molecular weight and its distribution by end-group analysis, membrane osmometry, vapor-phase osmometry, light-scattering, solution viscosity, and gel-permeation chromatography.

CHEM563, Polymer Chemistry III, Spring: Basic concepts on the properties of materials; rubber elasticity; morphology; viscoelasticity; T_g and T_m theories; thermal analysis; dynamic mechanical analysis; X-ray diffraction; spectroscopic techniques; thermodynamics of polymer solutions; conformational analysis and computational methods; basic testing, fabrication and processing; electrical, optical and magnetic properties; frontiers in polymer research.

B. Special Topics Courses

In addition to the graduate courses listed in the Graduate Catalog, each quarter the graduate faculty offer a variety of special topics courses (CHEM680-0XX & other CHEM700-CHEM800 level courses) worth 1-5 credits. A listing of those courses currently on the books is given below. These courses are not usually taken during the first couple of quarters of study, because they usually have content more specialized than that of the core courses and are often more research-oriented. Consult the Graduate Catalog and the quarterly class listing schedule for more information.

Several of these are seminar-style courses in the various areas of Chemistry, such as the CHEM860-series. Not all courses are offered every year, if you are interested in a particular course you should contact the listed faculty member for course schedule information. Note that the number of these course credits that can be counted toward the requirements for the M.S. or Ph.D. is not unlimited (particularly for seminar-type courses); you should consult one of the

Graduate Advisors regarding this issue. This also applies to CHEM865 (Chemical Research Seminar), credit for which can be counted once toward the M.S. degree.

Course	Course Title	Usual Instructor	Notes
CHEM551	Radiochemistry		
CHEM554	Chemical Kinetics		
CHEM656	Quantum Chemistry II	Rosenthal	
CHEM780	Experimental NMR Lab		1,2
CHEM751	Magnetic Resonance in Chemistry	Nath	
CHEM752	Biophysical Chemistry	Addison	
CHEM753	Chemical Instrumentation Lab	Owens	1,3
CHEM755	Mass Spectrometry	Owens	1
CHEM767	Chemical Information Retrieval	Owens	1
CHEM771	Organometallic Chemistry	Addison	
CHEM772	Inorganic Biochemistry	Addison	
CHEM773	The Solid State		1
CHEM774	Electrochemistry for Chemists	Addison	
CHEM782	Electronics for Chemical Instrumentation I	Bandy	
CHEM783	Electronics for Chemical Instrumentation II	Bandy	
CHEM788	Atmospheric Chemistry	Bandy	
CHEM789	Experimental Design & Statistics in Chemistry	Owens	1
CHEM791	Modern Organic Synthesis Topics	Wade	
CHEM792	Advanced Organic Synthesis I	Hutchins	1
CHEM793	Advanced Organic Synthesis II	Hutchins	1
CHEM794	Organic Reaction Mechanisms	Wade	
CHEM862	Topics in Inorganic Chemistry	Addison	1
CHEM865	Chemistry Research Seminar		4
CHEM866	Topics in Polymer Chemistry	Wei	
CHEM868	Topics in Analytical Chemistry	Bandy/Foley/Owens	1
CHEM997	Research	Assoc. Head	5
CHEM898	M.S. Thesis	Assoc. Head	5,6
CHEM998	Ph.D. Thesis	Assoc. Head	7

Notes:

- (1) These courses have been offered regularly recently.
- (2) This course has CHEM541 as prerequisite/co-requisite.
- (3) Should not be taken for more than 6 credits total.
- (4) This course is normally scheduled to meet weekly each quarter. Attendance by all full-time graduate students is required.
- (5) Student continuing without break toward the Ph.D. degree may count up to 9 credits of thesis and/or research toward the M.S. degree, as long as they have at the point of graduation with their M.S. successfully passed their cumulative exams.
- (6) For M.S.- thesis option candidates only.
- (7) Enrollment for "Ph.D. Candidates" only.

VI. Selection of Research Advisor

It is required for all graduate students wishing to engage in research to select a Research Advisor who is a full-time tenure track faculty member in the department. It is possible to perform graduate research under the direction of one of the research faculty associated with the department as a co-advisor, but the Research Advisor must be in full agreement with the arrangement.

During the first three quarters of study a Ph.D. student should speak with as many of the faculty as possible, including all those in the student's major area of interest, about present and future research plans. It is required that you interview at least four faculty members about research. You must submit the departmental form C-2 signed by those faculty members interviewed before a choice of Research Advisor is approved. Typically, graduate students should interview faculty members during the fall, winter and spring quarters. Feel free to ask for reprints of recent papers, preprints of papers in press, and planned research as reflected in submitted research proposals. When both you and the faculty member reach agreement regarding the general area of research to be done for the Ph.D. thesis, you should fill out Graduate School Form D-2. You should choose your Research Advisor no later than the end of the third quarter of your first year. Thus, you will be expected to start research before or during your first summer of residence at Drexel.

Even with the best planning it sometimes becomes necessary for a student to switch Research Advisors. It is recommended that the student discuss the situation with either the Graduate Advisor or Department Head prior to completing and submitting a new C-2 form. Students may switch Research Advisors once during their graduate program. Except under exceptional circumstances approved by the Graduate Curriculum Committee, switching Research Advisors for a second time is not permitted.

VII. Appendices

A. Department Directory

1. Chemistry Department Personnel

Interim Department Head

Dr. Peter Wade

Associate Department Heads

Dr. Joe Foley & Dr. Kevin Owens

Graduate Advisor

Dr. Anthony Addison

Graduate Curriculum Committee

Dr. Joe Foley, Chairperson

Dr. Anthony Addison

Dr. Jean-Claude Bradley

2. Chemistry Department Faculty

Name	Office	Office phone	Lab phone	Title	Area
Dr. Anthony Addison	12-418	895-2646	895-1697	Professor	Inorganic
Dr. Alan Bandy	5-411	895-2640	895-1890	Professor	Atmospheric/ Analytical
Dr. Jean-Claude Bradley	12-510	895-2647	895-1806	Associate Professor	Materials
Dr. Joe Foley	12-211	895-6218	895-1702	Professor	Analytical
Dr. Robert Hutchins	12-507	895-2638	895-1676	Professor	Organic
Dr. Kevin Owens	5-415	895-2621	895-6276	Associate Professor	Analytical
Dr. Carey Rosenthal	12-405	895-2641		Associate Professor	Theoretical
Dr. Reinhard Schweitzer-Stenner	12-218	895-2268		Associate Professor	Physical
Dr. Karl Sohlberg	12-222	895-2653	895-6951	Assistant Professor	Theoretical/Physical
Dr. Sally Solomon	12-224	895-2642	895-1693	Professor	Chemical Education
Dr. Peter Wade	12-306	895-2638	895-1699	Associate Professor	Organic
Dr. Yen Wei	12-211	895-2650	895-1644	Professor	Polymer/Materials

3. Associated Research Faculty

Name	Office	Office phone	Lab phone	Title	Area
Dr. Yury Gogotsi	CAT 431	895-6446		Professor	Materials Science & Engineering
Dr. Donald Thornton	5-413	895-2657	895-1890	Research Professor	Atmospheric/ Analytical
Dr. Jian-Min Yuan	12-819B	895-2722		Professor	Physics

4. Chemistry Department Staff

Name	Office	Phone	Title
Mr. Thomas Cachaza	12-113	895-2661	Glassblower II
Dr. Jeff Honovich	5-410	895-2643	Electronic Instrumentation Specialist
Ms. Virginia Nesmith	12-305	895-2638/2639	Office Services Coordinator
Ms. Edith Smith	12-314	895-2660	Operations Manager
Mr. Edward Thorne	12-316	895-1331	Laboratory Technician III

5. College and University Personnel

Name	Office	Phone	Title
Dr. Donna Murasko	9b-4020	895-2620	Dean, College of Arts & Sciences
Ms. Charlene Nessler	1-200	895-2498	Director of Graduate Studies

Notes:

All telephone numbers are in area code 215.

Building Information: 1-Main Building, 5- Stratton Hall, 9b- MacAlister Hall, 12- Disqué Hall

B. Timeline Checklist

Attendant to several of the items documented in this handbook there are formalities that must be observed. You may obtain from the Graduate Studies Office a book containing forms (or online at <http://www.research.drexel.edu/graduate/forms/phd.asp>) that must be filed at the appropriate times. **It is very important for you to attend to the timely filing of each form since you will be held responsible for meeting various deadlines.** For most students, the third quarter on this checklist will be the spring quarter, with you having entered as a full-time student in the preceding fall quarter. For part-time students, the department attributes status with half the chronological weight of full-time status. You are considered to be full-time in the program if you register as a full-time student or receive any stipend from the University while enrolled in any graduate courses.

Deadline	Form (1)	Action
Beginning of third quarter		Interview prospective Research Advisors
End of third quarter	D-1	File <i>Plan of Study</i>
End of third quarter	C-2	File <i>Graduate Research Advisor Interview Form</i>
End of third quarter	D-2	File <i>Supervising Professor Appointment Form</i>
End of third quarter		Start doing research
Start of second year		Start taking cumulative exams
End of second week of given quarter		Apply for M.S. degree (at SAS) if appropriate
Start of third year	C-4	File <i>Ph.D. Oral Candidacy Exam Form</i>
Four weeks prior to candidacy exam	D-3	File <i>Candidacy Examination Appointment Form</i>
Day of candidacy exam	D-4, D-4a	Bring <i>Candidacy Examination Forms</i> to oral exam
After passing candidacy exam	D-5	File <i>Thesis Advisory Committee Appt Request Form</i>
Within one year of candidacy exam	C-3	Schedule departmental literature seminar
Four weeks prior to Ph.D. exam		Submit Ph.D. thesis to format checker
Four weeks prior to Ph.D. exam	D-6	File <i>Final Oral Defense Committee Appointment & Schedule Form</i>
Day of Ph.D. exam	D-7	Bring <i>Report of the Final Oral Defense Committee Form</i> to exam
When thesis corrections finished		File <i>Completion Form</i>
One month prior to commencement		File <i>Application for Ph.D. Degree Form</i> (at SAS)
Before leaving Drexel		Return all keys and other borrowed items

Notes: Further detailed information is contained on the forms themselves.

- (1) University forms (D-1 through D-7 and the Completion Form) must be filed with the Graduate Studies Office; Department forms (C-2 through C-4) must be submitted to the Chairperson of the Graduate Curriculum Committee.
- (2) Ph.D. students & thesis-M.S. students.
- (3) The Graduate Advisor or Graduate Curriculum Committee Chairperson can check over your coursework with you.
- (4) File with Chairperson of Graduate Curriculum Committee.
- (5) The student will be notified officially of the result by the Graduate Studies Office.

C. Department Forms

- 1. Graduate Research Advisor Interview Form (Form C-2)**
- 2. Literature Seminar Form (Form C-3)**
- 3. Ph.D. Oral Candidacy Exam Form (Form C-4)**
- 4. Masters Thesis Review Committee Form (Form C-5)**

CHEMISTRY DEPARTMENT
C-2
GRADUATE RESEARCH ADVISOR INTERVIEW FORM

STUDENT NAME: _____

I am interested in starting my _____ MS-thesis research
_____ Ph.D. thesis research

Interviewed faculty signatures (below):

Date:

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

I have interviewed the above faculty members (at least 4) and have chosen

_____ as my faculty advisor.

I agree to act as research advisor to the above student. The student's "specialty area" for cumulative exams will be: _____.

Research Advisor signature _____ Date: _____

If co-advisor is selected, this person is _____

Co- Advisor signature _____ Date: _____

Departmental full-time Graduate Advisor **or** Department Head signature:

_____ Date: _____

Submit completed form to Graduate Curriculum Committee Chairperson. Ph.D students must also submit Drexel forms D1, D2 & D5.

cc: File, Research Advisor

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**CHEMISTRY DEPARTMENT
C-3
LITERATURE SEMINAR FORM**

STUDENT NAME: _____

Title of Literature Seminar: _____

Date/time of Seminar: _____

Location of Seminar: _____

Suggested Faculty Graders:

Research Advisor signature _____ Date: _____

Graduate Advisor signature: _____ Date: _____

Submit completed form to Graduate Advisor.

cc: File, Research Advisor

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CHEMISTRY DEPARTMENT
C-4
Ph.D. CANDIDACY COMMITTEE FORM

STUDENT NAME: _____

Research Advisor: _____ Proposed Oral Date: _____

Proposal Topic (Title): _____

Proposal Summary (1 paragraph):

Ph.D. Research Topic (Title): _____

Ph.D. Research Summary (1 paragraph):

Proposed Oral Committee: _____ Chairperson

_____ (external dept. member)

Research Advisor signature _____ Date: _____

Graduate Advisor signature _____ Date: _____

Submit completed form to Departmental Graduate Advisor. Also now submit Drexel form D-3.

cc: File, Research Advisor

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CHEMISTRY DEPARTMENT
C-5
MASTERS THESIS REVIEW COMMITTEE

STUDENT NAME: _____

Title of Masters Thesis: _____

Expected Completion Term/Date: _____

Suggested Thesis Reviewers:

Research Advisor signature _____ Date: _____

Graduate Advisor signature: _____ Date: _____

Submit completed form to Graduate Advisor.

cc: File, Research Advisor

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