

Drexel University

Department of Chemistry

Graduate Student Handbook

2021

Graduate Student Handbook
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I. Department of Chemistry Graduate Program Overview

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 ([Department of Chemistry Web Site](#)). 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).

You should also download from the chemistry website the department and university forms ([Graduate College Resources](#)) that are pertinent to the graduate degree(s) you wish to pursue. Departmental forms C2 and C5 are also included at the back of this handbook.

Good luck and best wishes for your future in chemistry!

Joe P. Foley, PhD
Head of Department

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 Chemistry
Atmospheric Chemistry
Chemical Education
Inorganic Chemistry
Materials Chemistry
Organic Chemistry
Physical Chemistry
Polymer Chemistry

Several of the above areas have a biological component, *e.g.*, bioanalytical, bioinorganic, bioorganic, and biophysical. While students are free to conduct research in any of the above areas, the cumulative qualifying examinations are limited to the following areas: analytical, biological, chemical education, inorganic, organic, physical, material and polymer. Students should consult the Graduate Advisor or the Graduate Program Committee (GPC) if they have questions or requests about the cumulative exam subjects.

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 different from coursework-driven B.S. and M.S. degrees, in that it is self-driven, creative in nature and essentially research-based. 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 with insight. It is not earned through completion of courses, by accumulation of credits, or by the time spent in residency, which are secondary requirements. The role of the Research Advisor is to offer guidance and advice to the student, but it is ultimately the responsibility of the student to prosecute the research, develop original contributions to it, and obtain original results of significance suitable for presentation in a Ph.D. thesis, itself written with an appropriately high degree of literary skill. 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 dealing with Admission to Graduate School in the Drexel University Graduate Catalog ([Graduate College Resources](#)) and the attendant “Chemistry Factsheet” on the same web page. These discuss 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 some 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. Undergraduate chemistry coursework would typically include 34 semester (or 51 quarter) credits divided among general and inorganic chemistry (8-10 semester credits), analytical (6-8 semester credits), organic (6-8 semester credits), physical (6-8 semester credits) and unspecified chemistry electives (0-8). One to two semesters of college physics are also expected, along with differential and integral calculus. If some of the requirements are not met, an applicant may still be admitted but required to make up any significant deficiencies as determined by the Department.

For admission, it is strongly recommended that an applicant takes and reports to the department results of the Graduate Record Examination (GRE) administered by Educational Testing Services, Inc. (Princeton, NJ). GRE scores are helpful to the department and Office of Admissions. They are required if financial support is requested, i.e., a teaching fellowship (TF) and/or if the applicant wants to be considered for a Dean's Fellowship or a Provost's Fellowship (see section IV. Graduate Support). Exceptions to this requirement are made for internal applicants.

D. Advanced Status

1. Post-Masters status

Students who have previously obtained an M.S. degree in chemistry may be eligible for post-M.S. status in Drexel's graduate program. Given that the graduate course sequence in one's major area (analytical, inorganic, organic, physical, and polymer) is usually helpful in preparing for the cumulative exams (cumes), students may prefer to apply for transfer credits from prior graduate coursework rather than post-M.S. status, since the transferring of credits does not accelerate Ph.D. Candidacy requirements.

2. 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 ([Graduate College Resources](#)) and with the approval of the Graduate Advisor and the GPC. Credit transfer is initiated by consulting with the departmental Graduate Advisor or with the GPC Chairperson, who will normally be prepared to consider such requests only after a student has progressed through his/her 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 registration exams are also taken into consideration in this regard. Naturally, any course 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 Studies for any M.S. and Ph.D. candidate ([Graduate College Resources](#)). These are in such areas as maximum study and workload 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 requirements listed below, the Research Advisor may make additional requirements in the best interests of his/her student. The University requires all graduate 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 outside the student's major area to take. Importantly, a score in the 50th percentile or higher satisfies the criterion of reasonable proficiency for a sub-discipline outside the student's major area (see section II.C.2 for more details.).

Registration Exams are given in the week preceding the start of the fall term. If a student enters the program during other terms, he/she will be required to begin taking the registration exams on the first Saturday of the month following the entrance/admission to the program. If, after eight offered dates, a student has not taken all four exams, he/she will then be required to do the complete graduate sequence (3 courses) in the unexamined area(s).

Non-matriculated students planning to take only one or a few courses for credit in a particular area will generally be required to take the registration exam in that area. For these and all other exams, active cell phones are not permitted in the exam room.

2. *Course and Enrollment 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 (lecture courses, research, etc.) 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 the respective Research Advisor) must be taken from

CHEM 521/522/523/(771 or 772¹) (inorganic core sequence)

CHEM 530/531/755 (analytical core sequence)

CHEM 541/542/543 (organic core sequence)

CHEM 561/562/563 (polymer core sequence)

CHEM 557/558/(554, 555, or 752) (physical core sequence)

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

Finally, whereas the enrollment for a part-time student may vary, the minimum enrollment for all full-time students is nine credits per term. If you experience any difficulties in pre-registering for

¹or other inorganic course (e.g., 774) with Graduate Advisor permission

a class or research credits, please contact Ms. Tina Lewinski, Department Administrator (tml37@drexel.edu).

3. Plan of Study

At the point of choosing his/her Research Advisor a student should file a Plan of Study in consultation with the Graduate Advisor and his/her Research Advisor. A Plan of Study form (Form D-1) is available from the Graduate College ([Graduate College Forms](#)). The student should list courses (i) already taken, (ii) courses to be taken, and also (iii) provide tentative dates for his/her oral candidacy exam and Ph.D. defense. The Plan of Study must then be approved by the Research Advisor, the Graduate Advisor, and the Graduate Studies Office. Changes in the Plan of Study after submission must have the approval of the GPC.

4. 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. It is expected that Chemistry graduate students (and faculty) will follow the American Chemical Society's Academic Professional Guidelines ([ACS Professional Guidelines](#)), the "*Academic Employment Guidelines for Graduate Students and Postdoctoral Associates*" ([ACS Academic Employment Guidelines](#)) & "*The Chemical Professional's Code of Conduct*" ([ACS Professional Rules of Conduct](#)). The University's information about its policies is at [Drexel's Academic Dishonesty](#) webpage. Of note, is the sometimes-hazy distinction between fair quotation and plagiarism. In general, when one uses the actual wording of a source, it must be placed between quotation marks. Students are expected to abide by the guidelines at the [Academic Integrity webpage](#).

During 2007-2008, the Associate Vice-Provost for Graduate Studies put in place a procedure through which a student may appeal a decision made by the student's department. The final arbiter in this appeal process will be the Provost. In any case, the chain of responsibility for such matters is: Graduate Advisor & Grad. Curriculum Committee → Head of Dept. → CoAS Associate Dean for Graduate Studies → Dean of College of Arts & Sciences → Dean of Graduate College → Provost.

5. Departmental Seminar

All full-time and part-time Ph.D. students past their first year of study must enroll in CHEM 865, Chemistry Research Seminar, at least once per year. The outside speakers that we bring in provide students with an opportunity to obtain a broader perspective of research activities in a student's own and other fields of chemistry. All full-time students are encouraged to attend all departmental seminars unless it conflicts with a regularly scheduled teaching assignment.

First-year, full-time students (both M.S. and Ph.D.) must attend 9 seminars per academic year (AY), and first-year, part-time students must attend 6 seminars per AY or the off-campus equivalent (see below). Attendance requirements outside of those required for CHEM 865 for second-year and later full-time PhD students is 9 additional seminars per AY. Non-thesis M.S. students should never register for CHEM 865 more than once because additional enrollments will not be counted toward the 45 credits needed for the degree.

For part-time PhD students, because it is recognized that attendance at Drexel chemistry seminars is often a logistical hardship if not an impossibility, they are allowed to substitute equivalent

attendance at either or both (i) local chemistry-related professional society meetings in which a seminar-length oral presentation is given and (ii) chemistry seminars at their place of employment assuming the latter are offered and available to the student. Evidence for each alternative off-campus seminar attendance must be provided to the CHEM 865 instructor during the term in which the student registers for CHEM 865; such evidence includes but is not limited to (i) a picture of the seminar speaker's title slide or (ii) a confirmation of attendance by the research advisor who attended the same seminar. Registration into CHEM 865 should be once per academic year (AY) and in the term in which the part-time PhD student will have accumulated **9** equivalent off-campus seminar attendances; in most cases this will be in the spring term.

6. Thesis (M.S.) and/or Dissertation (Ph.D.)

All full-time students who have received financial assistance from the department are required to write a thesis or dissertation on original chemical research for their terminal degree (see the appropriate degree requirements below for more information). Exceptions to this requirement will be considered by the GPC on a case-by-case basis if and only if the research advisor supports the exception.

As of April 7, 2018, the process for Thesis/Dissertation Submission is as follows:

1. Format the thesis according to the standards in the Thesis Manual which includes directions and examples for referencing the primary scientific literature (i.e., peer-reviewed, scientific journal articles—a preferred source of information for the thesis), but does not provide examples for referencing either the secondary literature (books, monographs, edited books, handbooks, etc.) or information obtained from the internet (much less desirable except for peer-reviewed, on-line journals). Examples for referencing the secondary literature may be found in the instructions for authors of various peer-reviewed journals in a student's discipline (such as those published by the American Chemical Society); in addition to the book title, author/editor, and page numbers, it is generally a good idea to specify the chapter title and author when applicable.
2. The student submits the final copy of his/her thesis to his/her mentoring professor for final review and approval. The mentoring professor and Department Head will acknowledge their approval of the final thesis by signing the Completion form.
3. The student submits his/her thesis to the library electronically in PDF format according to the Thesis and Dissertation webpage. Importantly, a scanned copy of the signed Thesis/Dissertation Approval Form and Signature Page is included as Page 1 of the thesis/dissertation PDF. If a student hasn't already published some of the research in her/his thesis/dissertation but is planning to do so, the student has the option of delaying the public release of the thesis/dissertation by placing a temporary embargo of up to one year on the thesis/dissertation at the time of its submission.
4. The student submits the Graduate Program Completion Form to the Graduate College for final degree clearance.

7. Time limit for the M.S. and/or Ph.D. degree

As described on the website of the [Graduate College, Forms and Policies](#): “[All] students who enter graduate study at the post-master's or post-baccalaureate level must complete their studies for their graduate degree(s) **within seven years** after initial graduate registration. Those who receive a Master's degree from Drexel University and then transfer to a doctoral program are permitted **five years after registration at the doctoral level** to complete the Ph.D. degree.

In unusual circumstances, a student who finds that these time requirements are inadequate due to special circumstances must discuss this with his or her advisors. Together they may request an extension before the end of a student's stated time limit (either seven or five years). A student requesting an extension should work with his or her advisors to develop a plan of study and a time line for completion that is reasonable for the student. All formal extension requests must give a reasonable time for completion with an accompanying revised plan of study. Should an extension be required, please be aware that all courses will be reviewed for timeliness; some earlier coursework may have to be repeated.

Extension requests for master's students must be forwarded after approval by the mentoring professor (if on a research track) to the department's Graduate Advisor, who will make the final decision. Extension requests for doctoral students must be forwarded, after approval by the supervising professor and the department's Graduate Advisor, to the Graduate College, which will make the final decision."

B. 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 the student's major area. These courses should be approved in advance by his/her Research Advisor or the departmental Graduate Advisor. Thesis MS students should take the graduate course in Chemical Information Retrieval (CHEM 767).

2. Thesis Option

The chemistry faculty strongly recommends the Master's thesis option, but realizes that it is not always possible or necessary for all part-time graduate students. Within the thesis option, up to fifteen credits of CHEM 997 Graduate Research may be counted towards the Master's degree in chemistry. Additional CHEM 997 credits above this limit may be taken if needed to satisfy the 9 credit per term enrollment requirement for full-time students (Section II.A.2), but they cannot be counted towards the M.S. degree.

During the graduating quarter, a thesis M.S. student should be registered for CHEM 898, Master's Thesis. During the first quarter of coursework a student should choose a Research Advisor with whom to collaborate 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 GPC (See the C-5 form at the back of this Handbook). The acceptance by this committee of the M.S. thesis completes the thesis option requirements for the M.S. degree. Both the Thesis Review Manual, which describes the preparation and required format of the thesis, and the library binding requirements are available online as described above in section II.A.6. Note also Graduate College requirements: if one takes a Drexel M.S. degree (3.0 GPA required), one 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.

3. Research Credits for Non-Thesis M.S.

A student may count up to nine credits of CHEM 997 towards a terminal non-thesis M.S. degree. However, he/she must submit a written report on the work that satisfies his/her Research Advisor. Students 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; three credits may be counted, if courses have been commenced and at least two passed. The requirements are different for students in the B.S./M.S. program; consult the Graduate Advisor or Department Head.

C. 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 general coursework; a thesis proposal; a candidacy exam procedure; a course on searching the chemical literature or technical writing (if the latter is approved by the Research Advisor) (see II.C.7); the first-authorship on a peer-reviewed paper (see II.C.9) and successful publication of a Ph.D. thesis (dissertation).

1. Course Requirements

Drexel University requires that 90 credits of graduate level work must be completed for the Ph.D. degree. Excluding research credits, the Chemistry Department requires a minimum of 21 credits of lecture coursework in chemistry, comprised of CHEM 767 (Chemical Information Retrieval), three core courses in the student's major area (Section II.A.2), and three additional graduate lecture courses (core or elective), of which at least two are in different chemistry areas outside the major area. Any remaining coursework will consist of more advanced graduate chemistry electives and special topics courses that are mutually agreed upon by the student and the Research Advisor; ideally, these courses should be specified when a Plan of Study (D-1 form) is submitted. Note that the Chemistry Department requires students to maintain a cumulative lecture course GPA of at least 3.0 in lecture courses offered by the department. If the GPA of a full-time student has been below 3.0 for two consecutive terms by the end of the winter term of his/her second year (by the end of the spring term for a part-time student), the student will not be allowed to move forward to Candidacy. Transfer of core course or elective credits from other institutions is possible, under conditions similar to those for the M.S. degree.

2. Proficiency Requirement in Chemistry Sub-Disciplines

The chemistry department requires PhD students to demonstrate a reasonable degree of proficiency in four sub-disciplines of chemistry—analytical, inorganic, organic, and physical. This excludes a student's major area in which s/he needs to be highly proficient, and the major area could be one of the four areas already mentioned or a different area such as chemical education, atmospheric, materials, or polymer chemistry.

There are three ways in which proficiency in the above four sub-disciplines can be demonstrated:

1. Earning a score of 50%ile or higher on the registration exam in the given sub-discipline. All students will have this opportunity since all incoming students are required to take the registration exams.

2. Earning a B or better grade in a graduate-level core course in that area taken in the first year for full time and during the first or second year for part time graduate students.
3. Achieving a score of B or better on an exam prepared by faculty in that area. The exam has to be taken prior to the end of the summer term of the first year (second year) for full time (part time) students. Each student can take only one exam for each subfield of chemistry. Students who plan to take exams should contact respective faculty members by the end of the respective spring term to set up the exam.

With respect to option 3, there are at least two ways to prepare for one or more end-of-summer-term area exam(s), and the student is encouraged to consider and adopt at least one of the approaches below:

- a. unofficial audit of the corresponding undergraduate course(s) if available
- b. self-study/review begun no later than the beginning of the winter term with guidance provided by the research advisor and/or faculty in the given area

If a modest degree of proficiency in the four sub-disciplines of chemistry is not achieved by the end of a full time PhD student's first year, the student will be given the choice of switching to our Master's Degree program or leaving the graduate program entirely. For part time PhD students, the requirement must be met at the end of his/her second year.

3. Thesis Proposal and Seminar

All Ph.D. students are required to write a Thesis Proposal related to their research. Content and format are described below. After final acceptance of the written proposal the student will give a 30-45 minute Thesis Proposal Seminar presentation related to their research. The student's presentation will be followed by a question and answer session during which the student should demonstrate proficiency with regard to the broader context of his research project. Altogether, the student's presentation and the subsequent examination shall not last longer than two hours. The purpose of the Thesis Proposal is to promote a greater fundamental understanding about the student's own specific research project. This will also provide context and perspective about previous accomplishments in the field by other research groups as well as her/his own. This will help the student become more knowledgeable about her/his research project by (i) promoting a greater fundamental understanding about the student's own specific research project and (ii) providing context and perspective about previous accomplishments in the field by other research groups as well as her/his own. The Research Advisor is expected to provide considerable input to the student about the breadth and depth of the literature review, the essential papers to read (and comprehend), the historical and current topics to include and/or emphasize in the seminar, and of course the details of the research project.

The Thesis Proposal shall be no more than 10 pages in length including the text, reaction schemes, figures, and tables; references and a cover page are not included in the page count. The format for the body of the text is as follows: 1-inch margins, single-spaced, with a 12-point font such as Arial, Helvetica, or Times New Roman. The content is described above, and the student should also seek input from her/his Research Advisor throughout the writing process.

Full-time students are required to submit their proposals to the Chairperson of her/his Thesis Proposal Committee by the end of week 7 in the Winter Quarter; the submission deadline for part-time students is week 7 in the Spring Quarter. At least 2 weeks prior to the submission of the thesis proposal students should submit a completed D-3 form with all signatures to the Graduate Advisor that specifies the members of the Thesis Proposal Committee (TPC). This advance filing of a D-3 form is necessary in order to allow time for the Graduate Advisor to review the composition of the TPC and for the student to make any necessary changes in the membership of the TPC in the event that one or more proposed committee members do not meet the eligibility criteria described later in this section.

The committee Chair is responsible for overseeing the review of the written proposal by all committee members within two weeks after its submission. Based on the individual reviews, the committee Chair opts for one of the following decisions: (i) accept as submitted, (ii) minor revision, (iii) major revision, or (iv) reject. If the verdict is minor revision, a revised proposal must be submitted to the committee Chair within two weeks. A final decision on acceptance by the Chair must be made within a week. If the verdict is 'major revision', a revised version must be submitted to the committee Chair within 6 weeks. The committee chair will then send the revised version to the members of the committee for their scrutiny. A final decision on acceptance has to be made within two weeks. After the proposal has been accepted, an oral exam has to take place within four weeks. The Chairperson of the Thesis Proposal Committee will appoint one member of the committee as minute taker. After the thesis proposal seminar and defense, the Thesis Proposal Committee will convene in the absence of the student. The verdict by the committee will be pass or fail. It has to be documented in the minutes. The minutes have to be signed by all committee members. If the student fails, a second oral exam should be scheduled within 6 weeks. If the student fails the second exam as well, he/she has to leave the program or pursue an MS degree.

For the Thesis Proposal Seminar and the preceding Thesis Proposal the following rules apply:

- Both must include a review of the essential literature (30-50% of seminar and paper)
- Students must distinguish between essential and non-essential background literature (they should not include everything that is vaguely relevant)
- Both must identify the gap in the knowledge base (or an interesting question or a new application) that the student's research aims to address in the future, and discuss the initial steps towards addressing this gap. Explain the significance thereof. (20-50% of seminar and paper).
- Both must describe their research progress thus far (even if preliminary) (10-30% of seminar and paper)
- The style of the paper should be similar to a research grant proposal or a targeted review article, but content should be as described above.
- References should be in proper and consistent format, see notes above about avoiding plagiarism and citation of sources. In his/her talk, references on each slide are preferable, so the audience knows which reference goes with which idea.

Full-time Ph.D. students are required to complete the Thesis Proposal requirement by the end of the Spring Quarter of their second year or, if they did not start in the fall term, at the end of the Summer Quarter of their second year in the graduate program. Part-time Ph.D. students are required to complete the Thesis Proposal requirement by the end of the Summer Quarter of their second year or, if they did not start in the fall term, at the end of the Fall quarter of their third

year in the graduate program. Except for a delay resulting from a revision of the written proposal required by student's Thesis Proposal Committee, the deadline for the completion of the Thesis proposal is firm for both full- and part-time Ph.D. students, i.e., there are no extensions.

Students who do not meet the above deadline will be required to present both the *first* Thesis Proposal Seminar and a *second* literature seminar within 3 months of the original deadline for the first Thesis Proposal Seminar, with the second seminar in an area outside the area(s) of the research group in which the student resides. Students who fail to meet the deadline for the second (penalty) literature seminar will be dismissed from the graduate program.

The Thesis Proposal Seminar Committee members will ask questions specific to the research seminar, as well as general questions related to the candidate's intellectual preparedness for the remaining graduate program experience. Combined with the student's presentation, the time for questioning of the student by the committee shall not exceed two hours. Following the committee's questioning, the student will be excused and the committee will reach a decision, which will then be conveyed immediately by the Chairperson to the student. A satisfactory outcome enables the student to continue toward the Ph.D. degree (begin taking or continue taking cumulative exams, etc.).

The Ph.D. student presenting the seminar, in consultation with his/her Research Advisor, selects the Chair and members of the Thesis Proposal Seminar Committee, in accordance with the university's general rules for the selection of doctoral student committees:

- The Ph.D. student'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 an appropriate discipline in a Ph.D.-granting institution. The external member should be an expert in the field of the student's research.
- All members of the committee should be research active. Research active is someone who has published in the primary literature within the last 3 years, or is currently advising graduate students. Ideally a majority (3 out of 5 committee members) should publish in the field of the student's research. In the case that sufficient expertise is not present in the department a suitable solution is the use of 2 external members that are experts in the field of the student's research. Personality conflict is generally not a valid reason for excluding a faculty member in our department from a committee, when that faculty member is an expert in the respective field of research.
- One voting member of the examining committee who is of emeritus/retired status from Drexel (as an "internal" member) or another chemistry graduate program is permissible.
- Note that although 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.
- The Graduate Advisor has been asked by the faculty to make sure all committees are in line with the above rules. In some ambiguous cases, the Graduate Advisor will consult with the Chair of the GPC prior to making a decision. The Graduate Advisor can refuse to sign if the committee does not meet the above criteria, keeping in mind that committee members that

are experts in the field of the student's research should be used unless such experts do not exist in the region.

- Ideally, one should use the same committee for all Drexel PhD hurdles (or a subset thereof)

Further details worth noting regarding the Thesis Proposal Seminar are:

- The Thesis Proposal Seminar must be scheduled at least 3 weeks in advance (preferably more) and no later than four weeks after the written proposal has been accepted by the Thesis Proposal Committee.
- It may be required to use a sign-up sheet, to ensure that student seminars are spaced out evenly throughout the term, and that seminars do not occur during finals week.
- The Research Advisor will advise the student on the suitability of her/his Thesis Proposal Seminar (breadth and depth of the literature search, the essential papers to read, the historical and current topics to include and/or emphasize, etc.), as well as the title and abstract that must be distributed at least 1 week in advance to the Chemistry Department for announcement/publicity purposes.
- The student must ensure that all the members of his/her Thesis Proposal Committee know in advance the date, location and time of the Seminar.
- The title, abstract, date, time and location of the Thesis Proposal Seminar must be advertised in writing in the Department and on the departmental web site at least a week in advance.

3. Ph.D. Candidacy

The University considers students "Ph.D. Applicants" until they have passed into Ph.D. Candidacy status. In order to formally become a "Ph.D. Candidate" in Chemistry, a student must have (a) earned five cumulative exam points (see below), (b) completed 45 credits of graduate work (or 15 credits at Drexel, if he/she entered with "post-Masters's" status) and (c) passed the Thesis Proposal Seminar. Once these conditions are met the University D2/2A forms have to be submitted to the Graduate Advisor (along with a copy of the M.S. transcript if he/she entered post-M.S.).

Transfer students, who have obtained candidacy status at another institution can have their status recognized if the Graduate Program Committee deems respective requirements at the student's former institution equivalent to those of our program. Minimal requirements are an oral exam comparable with our Thesis Proposal seminar and the passing of some type of comprehensive or cumulative exam. The student should have a comparable number of credits taken in his/her portfolio. His/her coursework should have involved at least two semester courses or three quarter courses in the field of his/her specialization.

4. Written (Cumulative) Exams

Written exams designed to evaluate a student's knowledge of chemistry (normally in his/her major area of interest) are given monthly during the academic year and occasionally during the summer at the discretion of the faculty. They are normally held on the first Saturday of each month, in Disque 307 at 10:00 am; the exact dates and times are posted on the Departmental website.

All Ph.D. students must begin taking cumulative exams no later than the beginning of their second year in the program. Cumulative exams must be taken sequentially, with one unexcused

absence allowed, until **five points are accumulated or ten exams have been taken**. Failure to accumulate 5 points after 10 exams is a basis for dismissal from the Ph.D. program. The Department requires that the student is registered for at least one course during the term in which he/she takes the first cume.

There are three possible outcomes of a cumulative exam: high pass (2 points), pass (1 point), and fail (0 points). Although the precise thresholds for a high pass and pass are determined by the cume-writer/grader and communicated to the cume-taker prior to the administration of the exam, the minimum thresholds are 75% and 50%, respectively.

First year cume options: Prior to the beginning of the second year in the PhD program, a student can elect to take *one* cumulative exam on the topic of her/his choosing² with no requirement to take a second cumulative exam in the first year. If a first-year student elects to take a *second* cumulative exam, however, then *that student must begin taking cumulative exams once a month without interruption* except for the summer period when no exams in the relevant sub-discipline are offered (August, September, and possibly July).

The topic(s) of the cumulative exams may, or may not, be announced prior to the exam, depending on the sub-discipline. It is a student's responsibility to make sure that the appropriate faculty member(s) is/are aware of the need to provide a cumulative exam for him/her to take in any given month. This is particularly so if the student is taking an exam outside the chemistry sub-discipline specified on his/her C-2 form. At least three of the five passes must be in the student's selected area of specialization; it is therefore important that the area of specialization is chosen carefully in consultation with his/her Research Advisor.

5. Thesis Advisory Committee

Following the completion of the cumulative exams, the Ph.D. Candidate must select, in consultation with her/his Research Advisor, a Dissertation Advisory Committee (Form D-3). The DAC shall have at least five members, two of whom shall represent an area outside of the candidate's area of specialization. At least one of committee members shall come from outside of the Chemistry Department. The student's research advisor can be a member of the committee. It is desirable that non-Chemistry faculty who served on the Thesis Proposal Committee also serve on the DAC. The tasks of the DAC are described in section II.C.6. Assembling the committee and obtaining approval from the Graduate Advisor is the obligation of the student, who has to submit a D3 form. The Final Oral Defense Committee shall contain all members of the candidate's DAC with the exception of the student's Research Advisor. In addition, a tenured or tenure-track faculty member from another PhD-awarding institution shall join the committee as an additional outside member. This outside member must be an expert in the field in which the candidate has worked for his/her thesis. He/she should be a research-active member of his/her faculty. The choice of the outside member has to be approved by the GPC Chair and by the College of Graduate Studies (as stipulated in the Graduate College's handbook).

6. Annual Check of Progress

After having passed their Thesis Proposal Exams in their second year, all full-time and part-time research students are required to meet at least three members of their Dissertation Advisory Committee (DAC, section II.C.5) during the spring term of their third year, fourth year, etc. If

²from among the topics announced by the faculty members who are writing cumulative exams that month.

possible one of the outside members of the DAC shall be present. Students have to arrange for this meeting and inform the Graduate Advisor and the GPC chair once the meeting has been scheduled. They should send a three-page report about their research progress one week before their meeting with the committee. That report summarizes their accomplishments and lists their publications and conference presentations. At the meeting the student will present his or her research to his/her DAC, which will discuss with him/her the content of the presentation and the progress of his/her research. The annual review should be comprised of a 20-minute presentation and 30 minutes of questions or of a combination not to exceed 50 minutes. After the meeting the DAC will meet and discuss the performance. The latter can be judged as either ‘satisfactory’, ‘needs improvement’ or ‘unsatisfactory’. If the verdict is ‘needs improvements’ or ‘unsatisfactory’ the DAC will stipulate corrective actions and expectations with regard to future performance. In the case of unsatisfactory performance the student will be asked to convene another meeting after 6 months, at which his/her progress and his/her compliance with suggestions will be checked by the committee. If the latter deems the performance still as ‘unsatisfactory’, the DAC will recommend to the GPC to dismiss the student from the graduate program. In the case of a ‘needs improvement’ judgment at the end of a regular annual meeting the student has to obtain a ‘satisfactory’ on his/her performance at his/her next annual meeting. Two consecutive ‘needs improvement’ judgments will be considered as ‘unsatisfactory’ and will trigger another review after 6 months as described above. All decisions of the DAC will be documented by minutes and by the D-3B form.

7. Communication Requirement.

The communication or language requirement may be satisfied by completing a graduate course in Chemical Information Retrieval (CHEM 767) or Technical Writing (e.g., COM 510) if the latter is approved by the Research Advisor.

8. Thesis Pre-Defense

The Ph.D. Candidate will meet with his or her full Thesis Advisory Committee including its outside member at least 6 months prior to planned thesis defense in order to ensure that the student has laid the foundation of the submission of a thesis and a final defense. It is the student’s responsibility to schedule this meeting with his/her committee. He/she is required to submit the following documents to each member of the Thesis Advisory Committee at least 2 weeks in advanced of the scheduled meeting:

- an abstract of the pre-defense talk
- a one-page thesis completion plan
- a tentative list of the chapter titles of the thesis
- a current list of the student’s publications

The student should have submitted a manuscript for publication in a peer-reviewed journal to meet the publication requirement stipulated in C.10 as a pre-condition for scheduling the Thesis Pre-Defense. If the Thesis Advisory Committee approves the student’s completion plan, he/she can start writing his/her thesis and organize the defense. If the plan is not approved, the student has to meet his/her committee again at a time determined by the Committee Chair and the thesis advisor.

The Thesis Pre-Defense substitutes for the annual progress report.

9. Thesis and Final Defense

A Ph.D. thesis, the heart of the Ph.D. degree, must be written and correctly formatted by the student, accepted by the Research Advisor, presented to the Ph.D. Final Oral Defense Committee (Form D-4), and defended orally. A copy of the Thesis Style Manual may be downloaded from the Additional Information section of the Drexel Libraries webpage, "[Theses, Dissertations, and Projects](#)." According to university requirements (Form D-4), the presentation and oral defense must be scheduled "at least four (4) weeks prior to the final defense."

Members of the student's Ph.D. Final Oral Defense Committee should be selected in mutual consultation with the student's Research Advisor as the student nears completion of her/his dissertation, but no later than four (4) weeks prior to her/his final defense (Form D-5).

The Committee is normally composed similarly to (and is often the same as) the Dissertation Advisory Committee. The Ph.D. Candidate's Research Advisor, the Graduate Advisor, and the Graduate Studies Office must approve the composition of the Ph.D. Final Oral Defense Committee. Other specific rules governing the composition of the committee are as follows:

- The candidate's Research Advisor may not be a member of the Committee, and many 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 and from an appropriate discipline. The external member should be an expert in the field of the student's research. All members of the committee should be research active. Research active is someone who has published in the primary literature within the last 3 years, or is currently advising graduate students. Ideally a majority (3 out of 5 committee members) should publish in the field of the student's research. In the case that sufficient expertise is not present in the department, a suitable solution is the use of 2 external members that are experts in the field of the student's research. Personality conflict is generally not a valid reason for excluding a faculty member in our department from a committee, especially when that faculty member is an expert in the student's field of research.
- The Committee must include at least one member of the departmental GPC.
- 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.
- The Graduate Advisor has been asked by the faculty to make sure all committees are in line with the above rules. In some ambiguous cases, the Graduate Advisor will consult with the Chair of the GPC prior to making a decision. The Graduate Advisor can refuse to sign if the chosen committee does not meet the above criteria, keeping in mind that committee members that are experts in the field of the student's research should be used unless such experts do not exist in the region.

It is the responsibility of the student, not his/her Research Advisor, to submit an acceptable Ph.D. thesis. However, the final defense is not to be scheduled until (i) the Research Advisor and the

Graduate Advisor have approved the Ph.D. Final Oral Defense Committee, as indicated by their signatures on Graduate Studies Form D-6 (Final Oral Exam); and (ii) the student has published at least one peer-reviewed article in a scientific journal that is part of her/his PhD research (see section II.C.9).

One or more 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. However, a copy of the finished thesis must be received by each member of the examining committee no later than two weeks prior to the final defense. The date, time, location and title of the final defense 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. When scheduling the final defense, once a student has confirmed that *every* member of his/her committee is available on the proposed day and time of his/her defense, he/she should then ask the department office coordinator to reserve a suitable room. The final defense of the Ph.D. thesis consists of two parts:

- A public 40-60 minute seminar on the thesis research followed by general questions from the audience with the committee in attendance.
- A private (candidate plus committee) question/answer session (Final Oral Exam), convening shortly after the public seminar. This part of the defense will be documented by minutes. The chairperson of the Final PhD Defense Committee will appoint a committee member as the minute taker. The minutes have to be signed by all committee members.
- For the Ph.D. thesis exam, a student needs an Exam Report Form, D-5. The "Adviser" signature is that of the research adviser. The Thesis Approval Form can be brought to the exam for the approving extra-departmental committee members, if it would be inconvenient for them to sign their acceptance at a later date. The signatures of the Chair and the Adviser are to be withheld until any required thesis corrections have been made. After the public seminar and private thesis exam, the Thesis Defense Committee will convene in the absence of the student. The committee will judge the thesis and oral performance separately. For the thesis, the possible outcomes are: (i) accepted, (ii) minor revisions requested, (iii) major revisions requested, or (iv) declined. Minor revisions of the thesis have to be submitted to the committee chair within two weeks after which he or she will decide on the thesis acceptability. If major revisions are requested, the revised thesis has to be sent to all committee members who will sign the D5 form only after they found the revision acceptable. In each case, the final acceptability of the thesis is contingent on the student having carried out the required revision to the satisfaction of the committee chair (for minor revisions) or the committee (for major revisions). If the committee declines the thesis, the student will not be able to graduate with a Ph.D. and will have to leave the program. For the oral exam, the possible results are pass or fail. If the student fails, the oral exam can be repeated within three months after the thesis defense. Generally, students should be encouraged to minimize the time between the two exams. Extension of the three-month period requires the approval of the Graduate Program Committee and will be granted only under exceptional circumstances. If the student fails the second oral exam, the student will not be able to graduate with a Ph.D. and will have to leave the program.

10. Publication Requirement

The publication of scientific articles in discipline-appropriate, peer-reviewed journals is the primary method for disseminating research results to the broader scientific community. Given that the dissemination of such results is essential for the advancement of science as well as an essential

skill for the individual scientist, every Ph.D. Candidate must submit to the Graduate Advisor, at the same time that the PhD. Thesis Pre-Defense is scheduled, evidence of at least one (1) peer-reviewed publication in a scientific journal that is part of her/his PhD research and on which he/she is the first author, which documents that he/she contributed the majority of the experimental and/or theoretical results. Acceptable evidence is either (i) an electronic copy (pdf) of the published article or (ii) a DOI number that enables the access to a copy of the paper or (iii) a letter (or email) from the journal editor confirming that the article has been accepted. Importantly, the submission of a manuscript for publication in a peer-reviewed journal without its subsequent acceptance does not fulfill the publication requirement. In cases where the fulfillment of the requirement is ambiguous for whatever reason, the issue will be adjudicated by the GPC. Students shall be advised that this paragraph stipulates a minimal requirement. The Research Advisor has the right to expect a higher productivity for graduation. Without his/her approval, no student can generally move towards his/her final defense.

II. Use of a Scientific Article as a Chapter or Portion of a Chapter in a Dissertation

When a given chapter in a dissertation is based in whole or in part on a scientific journal article (published, in press, or submitted), the full bibliographic citation of the article should be listed on the title page of the chapter, along with an estimate and brief description of the relative contributions of all authors.

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 Chair of the GPC.

In the case of some irresolvable disagreement between the student and the Research Advisor, the student should consult with the Graduate Advisor and the Department Head. The next four levels of appeal are (i) the Associate Dean for Graduate Studies in the College of Arts & Sciences (CoAS), (ii) the Dean of CoAS, (iii) the Vice-Provost for Graduate Studies, and (iv) the Provost of the University, the latter being the final arbiter. Please check the Graduate College's and/or Provost's website(s) for a formal appeals procedure.

IV. Graduate Support

Financial aid is typically available in the form of a teaching assistantship (TA), research fellowship (RF), and/or tuition remission. Exceptional applicants will also be nominated for a supplemental Dean's Fellowship (\$3,000/year) or Provost's Fellowship (\$5,000/year). Teaching assistantships and tuition remission are available from the department on a competitive basis and are therefore not automatically given to every student who is admitted into our graduate program. Both incoming and resident graduate students are considered by request for a departmental TA/tuition remission. RFs are available from individual faculty members via their research grant funds. Please note that the university does not allow a student to hold any other employment in addition to a full teaching or research assistantship.

New and full-time M.S. & Ph.D. students who are self-supporting (don't have a TA) and have GPA's of 3.5 or greater are eligible to apply for a one-time \$3,000 Dean's Fellowship offered by

the Vice-President of Enrollment Management. This Fellowship is applied as an offset against the student's tuition bill.

A. Teaching Assistantship (TA)

The current standard Teaching Assistantship (TA) is a 12-month, October-September appointment. Teaching Assistants are required to teach for three out of the four quarters (normally Fall-Winter-Spring); the possibility of not teaching during a quarter other than Summer is dependent on Departmental teaching needs. Students with TAs and RFs usually also receive tuition remission for the (substantial) costs of graduate tuition. M.S. students are not eligible for TA support at Drexel, and tuition remission is normally not awarded without an accompanying TA or RF appointment.

In return for departmental support (TA and tuition remission), the chemistry department expects each teaching assistant to carry out his or her duties conscientiously and responsibly. Failure to do so (*e.g.*, not enforcing the eye protection or other safety requirements in lab classes) can result in the loss of the assistantship. If, because of some emergency (such as illness or getting snowed-in during winter), the TA is unable to attend a class, he/she has to make sure that he/she has 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, the TA should therefore consult with the faculty member who is in charge of the course to determine what a student's duties will be for the coming quarter.

The types of activities in which one will find oneself involved include: running labs and recitations; grading of students' lab reports, recitation quizzes and exams; and helping faculty to develop and prepare materials for labs and exams. This translates into an average of 6-8 hours per week of classroom activity (22 quarter contact hours per year), plus 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 meetings is mandatory unless the instructor in charge specifies otherwise.

B. Tuition Remission

Remission of graduate tuition is generally awarded only in conjunction with graduate teaching or research fellowships. It covers the flat tuition rate to be paid for a full-time student as set by the College of Arts and Sciences. The respective amount is currently \$ 5,000, but it will increase over the next few years. Contingent on his/her performance in teaching and research, a PhD-level student can generally expect TF support or a combination of TF and RF support (*vide infra*) for a period of not more than five years. After these five years, the respective mentor of a student can keep him or her on RF support until the seven-year limit stipulated by the Drexel University rules is reached. In the absence of such support, students can apply for an extension of their TF support

on a quarterly basis. Applications should include a short summary of a student's progress, a research plan for the upcoming quarter and a reasonable prediction of the time at which the student will have his/her thesis defense. A letter from the research advisor has to accompany the application. Applications have to be sent to the Graduate Program Committee which recommends a course of action to the Department Head. The committee's recommendation depends on the student's productivity, the number of conference presentations, the results of his/her annual evaluations and his/her performance as teaching assistant. If an extension of the TF-support is granted, the student will receive 100% tuition remission for the quarter covered by the TF support. If a student is not receiving TF or RF support, he/she has to pay the tuition for one credit per term and the respective enrollment fees. Under no circumstances will the TF support be extended for a seventh year. Decisions about TF-support beyond a student's fifth year in the program do not depend on whether the student has received RF support (*vide infra*) during the five-year period.

C. Research Fellowship (RF)

A Research Fellowship (RF) may be arranged with the Research Advisor if sufficient grant funds are available; the stipend is determined by the Research Advisor. 100% tuition remission is generally included in the student's support. 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 RA. When one becomes interested in doing research work with a given faculty member, one may want to inquire about the possibility of a Research Assistantship. M.S. students are eligible for RA support at Drexel.

D. Financial Support for Attending Scientific Meetings

Departmental resources are available to support Ph.D.-level graduate students who want to attend a national or international meeting in his/her field of research. Any request for departmental support should be coupled to attempts to secure funding from the Teck-Kah Lim Graduate Student Travel Subsidy of the Graduate College (for national meetings) or from the Office of International Programs (for international meetings). If the research advisor of the student has extramural funding, he/she is expected to partially support the student. A request for departmental support should be submitted to the Department Head at least two months in advance of the event. Requests can be submitted prior to the acceptance of an abstract, but the availability of the money is contingent on the acceptance of the abstract and the documented participation of the student. The expectation is for third year students and beyond to be supported for one conference per year. The decision about the request and the level of support will depend on the department's financial situation.

E. Satisfactory Progress

Continuation of any of the above forms of financial aid is contingent on satisfactory academic and research performance. Performance is evaluated annually by the Graduate Program Committee and based upon the student's academic transcript and research progress reports (see section II.C.6). The department generally supports Ph.D. students (via stipend and/or tuition remission) for no more than 20 quarters of graduate work from the date in which they entered the graduate program, except in the case of a department-approved leave of absence. Support beyond the first 20 quarters is strictly at the discretion of the department and/or the Research Advisor if the latter has funds to support a graduate student. M.S. students are not eligible for teaching assistantships (section IV.A) but may receive financial aid from the university for their first 8 quarters of graduate study. M.S.

students may also apply for a one-time Dean's Fellowship of \$3000 (see section IV. Graduate Support) if their GPA is 3.5 or higher.

F. 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 remission is usually not taxed.

V. Course Selection

A. Core Courses

1. Analytical Chemistry

CHEM 530, Spectroscopic Methods, Fall: Introduction to optics, interaction of electromagnetic radiation with matter, design of optical instruments, survey of spectroscopic methods of analysis.

CHEM 531, Chromatographic Methods, Winter: Principles of separation, resolution theory, pressure- and voltage-driven flow, separative and dispersive transport, survey of chromatographic instrumentation (pumps, injectors, columns, detectors), survey of chromatographic separation modes and applications

CHEM 755, 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

CHEM 521, Inorganic Chemistry I, Fall: Review of electron-counting rules (including 18-e Rule) & their correlation with structure. Molecular symmetry. Coordination complexes: structure, constitution, isomerism & chirality; complexation in solution, the chelate effect; HSAB concept. X-Ray diffraction applied to inorganic molecules: utilization of CIF files; Bond Valence Sum; lattice types. Qualitative MO approach for homonuclear systems.

CHEM 522, Inorganic Chemistry II, Winter: 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. Spectroscopy/structure relationships for inorganic molecules (first part).

CHEM 523, Inorganic Chemistry III, Spring: Redox potentials and basic electrochemical methods; inorganic spectroscopy and structure (continued); reaction kinetics; metalloprotein examples.

CHEM 771, Organometallic Chemistry: Structures, reactivity, mechanisms of important organometallic complexes and reactions. Applications in organic synthesis and polymer chemistry.

CHEM 772, Bioinorganic Chemistry: Metal transport and storage in biological systems, structure and function of metalloenzymes, reaction mechanisms, synthetic systems for metalloenzyme modeling.

3. Organic Chemistry

CHEM 543, Organic Chemistry III, Fall: 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.

CHEM 542, 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.

CHEM 541, Organic Chemistry I, Spring: 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).

4. Physical Chemistry

CHEM 557, Physical Chemistry I: Spectroscopy, Winter, every other year, alternating with Chem.558: Schrödinger's equation and particle-wave duality, atomic structure and spectra, optical spectroscopy on molecules (rotational, vibrational and electronic spectra) molecular symmetry, emission and absorption of light, time independent and time dependent perturbation theory, magnetic resonance spectroscopy.

CHEM 555, Quantum Chemistry of Molecules I, Fall: Covers general properties of operators; Schrödinger's equation and its solutions for a particle in a box; harmonic oscillator, tunneling problems, rigid rotor, and the hydrogen atom; approximation methods; and absorption of radiation and selection rules.

CHEM 558, Physical Chemistry II: Statistical Thermodynamics, Winter, every other year, alternating with Chem.557: Covers statistical mechanics of distinguishable and indistinguishable particle systems, statistical definition of entropy, canonical and grand canonical ensembles, Fermi-Dirac and Bose-Einstein statistics, physics of phase transitions, ideal and non-ideal mixtures, physical chemistry of polymers and thermodynamic functions for both systems and chemical equilibrium, diffusion and friction.

CHEM 752, Biophysical Chemistry, Spring (depending on demand): Peptide conformation, protein structure, peptide and protein folding, intrinsically disordered proteins, heme proteins, electron transfer proteins, enzyme kinetics, membrane biophysics, biophysical techniques (X-ray, NMR, fluorescence, vibrational spectroscopy)

CHEM 554, Chemical Kinetics, Spring, generally every other year: Focuses on experimental and theoretical considerations of chemical reaction rates

5. Polymer Chemistry

CHEM 561, 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.

CHEM 562, 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.

CHEM 563, 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 'permanent' graduate courses listed in the Graduate Catalog, each quarter the graduate faculty offer a variety of special topics courses (CHEM 680-0XX & other CHEM 700-CHEM 800 level courses) worth 3 credits each. A listing of both permanent elective and special topics elective courses 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 elective courses are seminar-style courses in the various areas of Chemistry. Not all courses are offered every year, so if a student is interested in a particular course he/she 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); students should consult the Graduate Advisor regarding this issue. This also applies to CHEM 865 (Chemical Research Seminar), credit for which can be counted once toward the M.S. degree.

Course	Course Title	Usual Instructor	Notes
CHEM 571	Chemistry of Biomolecules	Xo	
CHEM 680	Special Topics (general)		
CHEM 751	Magnetic Resonance in Chemistry		
CHEM 752	Biophysical Chemistry	Schweitzer-Stenner	1
CHEM 753	Chemical Instrumentation Lab	Owens	1,3
CHEM 767	Chemical Information Retrieval	Sohlberg	1
CHEM 772	Inorganic Biochemistry		1
CHEM 774	Electrochemistry for Chemists		1
CHEM 780	Experimental NMR Lab		2
CHEM 788	Atmospheric Chemistry	Wood	
CHEM 789	Experimental Design & Statistics in Chemistry	Owens	1
CHEM 792	Advanced Organic Synthesis I	n.a.	1
CHEM 793	Advanced Organic Synthesis II	n.a.	1
CHEM 794	Organic Reaction Mechanisms	n.a.	
CHEM 862	Topics in Inorganic Chemistry. Most recently, "Magnetism & Paramagnetic Resonance"		1
CHEM 865	Chemistry Research Seminar	Ji	4
CHEM 866	Topics in Polymer Chemistry		

CHEM 868	Topics in Analytical Chemistry Examples: Modern Liquid Chromatography, Chromatographic Data Acquisition & Interpretation, Capillary Electrophoresis	Foley	1
CHEM 997	Research		
CHEM 898	M.S. Thesis		5
CHEM 998	Ph.D. Dissertation		6

Notes:

- (1) These courses have been offered 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 almost weekly during the fall, winter, and spring quarters. All full-time graduate students are expected to attend department seminars every term unless they have a teaching or class conflict.
- (5) For M.S.- thesis option candidates only.
- (6) Enrollment for “Ph.D. Candidates” only.

VI. Selection of Research Advisor

All graduate students wishing to engage in research are required 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.

It is expected that incoming students have already selected their research advisor after their interview. In cases that this had not happened, 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 (see Departmental C-2 form) that he/she interviews at least six faculty members about research. After their arrival or after having conducted the above interviews, incoming students must submit the Departmental C-2 form for formally requesting the approval of their choice of Research Advisor. Incoming students who have not already been assigned to a research advisor after their interview, must list their top three choices for Research Advisor in order of preference; the department will place him/her with the first eligible faculty member after confirming her/his interest in serving as Research Advisor and the presence of an available TF or RF position in that group. The student and his/her Research Advisor will then jointly designate the area(s) in which he/she will do his/her cumulative exams.

All full- and part-time Ph.D. students must choose their Research Advisor no later than the end of the first quarter of the first year. When talking to faculty members about their research, 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 the student and the faculty member reach agreement regarding the general area of research to be done for the Ph.D. thesis, the student

should fill out Graduate Studies Form D-1. Thus, a student is expected to start research not later than at the beginning of his/her second quarter of residence at Drexel. If a student intends to obtain a thesis-option M.S. degree, it's advisable to commence that research as soon as possible as well.

All C-2 forms will be processed by the graduate faculty after the fall term concludes and the ***firm deadline*** for submitting the C-2 form will be the last business day of final exams week for the fall term.

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, and the new C-2 form must be submitted to the Graduate Advisor within 4 weeks after leaving the original Research Advisor's group. Except under exceptional circumstances approved by the GPC and Department Head, switching Research Advisors for a ***second*** time is ***not*** permitted.

VII. Appendices

A. Department Directory

1. Chemistry Department Personnel

Head of Department

Dr. Joe Foley

Associate Head of Department

Dr. Reinhard Schweitzer-Stenner

Graduate Advisor

Dr. Karl Sohlberg

Departmental Advisory Committee

Dr. Joe Foley (chair)

Dr. Reinhard Schweitzer-Stenner

Dr. Kevin Owens

Dr. Craig McClure

Graduate Program Committee

Dr. Reinhard Schweitzer-Stenner, Chair

Dr. Karl Sohlberg

Dr. Jeremiah Scepaniak

Dr. Ezra Wood

Mr. Louis Mueller, Graduate Student Representative

Safety Committee

Dr. Kevin Owens, Chair

Dr. Anthony Wambsgans

Undergraduate Affairs Committee

Dr. Daniel King, Chair

Dr. Monica Ilies

Dr. Kevin Owens

Dr. Jun Xi

Information current as of 2021/5/29

2. Chemistry Department Faculty

Name	Office	Office phone	Lab phone	Title	Area
Dr. Tony Addison	12-418	895-2646	895-1697	Professor Emeritus	Inorganic
Dr. Jason Cross	12-506	895-2641		Assistant Teaching Professor	
Dr. Reza Farasat	12-223			Assistant Teaching Professor	
Dr. Fraser Fleming	5-410	895-2644		Professor	Organic
Dr. Joe Foley	12-212	895-6218	895-1702	Professor and Head	Analytical
Dr. Lee Hoffman	12-403	895-1784		Assistant Teaching Professor	
Dr. Monica Ilies	12-224	895-2642		Associate Teaching Professor	
Dr. Haifeng (Frank) Ji	12-221	895-2562	571-3648	Professor	Materials/Analytical
Dr. Daniel King	12-509	895-0571	895-0571	Associate Professor	Chemical Education
Dr. Jamie Ludwig	5-414			Assistant Teaching Professor	
Dr. Dionicio Martinez Solorio	5-413	895-3561		Assistant Professor	Organic
Dr. Craig McClure	5-412	571-3197		Teaching Professor	
Dr. Kevin Owens	5-415	895-2621	895-6276	Associate Professor	Analytical
Dr. Susan Rutkowsky	5-412	895-1509		Associate Teaching Professor	
Dr. Jeremiah Scepaniak	12-506	895-2666		Assistant Professor	
Dr. Reinhard Schweitzer-Stenner	12-606	895-2268	895-2654	Professor	Physical/Biophysical

Dr. Karl Sohlberg	12-222	895-2653	895-6951	Associate Professor	Computational/ Physical
Dr. Peter Wade	12-508	895-2652	895-1699	Associate Professor Emeritus	Organic
Dr. Ezra Wood	12-223	895-1681	895-2661	Associate Professor	Atmospheric and Environmental
Dr. Anthony Wambsgans	5-409	895-1585		Associate Teaching Professor	
Dr. Jun Xi	12-218	895-2648	895-2655	Associate Teaching Professor	Organic/Biochem.

3. Associated Research Faculty (courtesy appointments in Chemistry)

Name	Office	Office phone	Lab phone	Title	Area
Dr. Aaron Fafarman	CAT 486	895-5818		Assistant Professor	Materials/Physical
Dr. Jian-Min Yuan	12-819B	895-2722		Professor	Physics

4. Chemistry Department Staff and College level Support Staff

Name	Office	Phone	Title
Dr. Vaidy Mathrubootham	PISB 501	571-4204	Laboratory Manager
TBA	12-316	895-1331	Laboratory Specialist
Ms. Laura D'Angelo	12-816		Graduate Program Administrator
Mr. Kari Lindsey	12-305	895- 2638/2639	Office Services Coordinator
Dr. Jacob Powell	12-412	895-2967	NMR Specialist
Dr. Joshua Williams	5-405	895-1980	Instrumentation Specialist
Ms. Sue Tang	12-314	895-2660	Operations Manager
TBA	5-406	895-1576	Electronic Instrumentation Specialist

5. College and University Personnel

Name	Office	Phone	Title
Dr. Norma Bouchard	McAlister-4020	895-2620	Dean, College of Arts & Sciences
Mr. Tsz Kwok	Main-301	895-0366	Associate Director, Graduate College

Notes:

All telephone numbers are in area code 215.

Building Information: 1 - Main Building, 5 - Stratton Hall, 9b - MacAlister Hall, 12 - Disque Hall, PISB – Papadakis Integrated Science Building

B. Timeline Checklist

Attendant to several of the items documented in this handbook there are formalities that must be observed. A student may obtain the necessary forms online from the chemistry department's website (<http://www.drexel.edu/coas/chemistry/>) and the Provost's website at <http://www.drexel.edu/provost/graduatestudies/forms.html>; these forms should be filed at the appropriate times. **It is very important for a student to attend to the timely filing of each form since he/she will be held responsible for meeting various deadlines (see table below).** For full-time students who typically enter our program in the fall quarter, the second quarter on this checklist will be the winter quarter. For some requirements (e.g., the Thesis Proposal Seminar) it is understood that part-time students are expected to progress at a slower rate than full-time students. A student is considered to be full-time in the program if he/she is registered as a full-time student or receives any stipend from the University while enrolled in any graduate courses.

Deadline	Form (1)	Action
Weeks 3-10 of first term		Interview prospective Research Advisors for those incoming students who were not already assigned to an advisor.
End of first term	C-2	File <i>Graduate Research Advisor Interview Form</i>
End of first term /Beginning of 2 nd term	D-1	File <i>Plan of Study (2,3)</i> and <i>Supervising Professor Appointment Form</i>
<i>Before thesis research can begin</i>	C-2	<i>Must be submitted to Graduate Advisor and <u>approved</u></i>
Beginning of second term		All full-time PhD level graduate students should have started to conduct research
Start of second year (5 th term) or earlier at student's option—see section II.D.3.a)		Start taking cumulative exams
End of second week of given term		Apply for M.S. degree if appropriate

≥ Four weeks prior to Thesis Proposal	D-3	File <i>Dissertation Advisory Committee Appointment request form</i>
Week 6 of 6th term for <i>full-time</i> students, week 6 of 7th term for <i>part-time</i> students		Schedule and give the <i>Dissertation Proposal Seminar</i> on or preferably earlier than the end of week 6. This is a firm deadline, see section II.C.2 for more information. A student may need to do these earlier, based on the sign-up sheet.
Week 6 of 6th term for <i>full-time</i> students, week 6 of 7th term for <i>part-time</i> students	D-3A	Submission of <i>Dissertation Proposal Form</i> (outcome of oral exam)
After passing Candidacy Exam (4), typically after 6 th term for full-time students	D-2, D-2A	File <i>Doctoral Candidacy Examination Report (D-2) and Member Report (D-2A)</i>
≥ Four weeks prior to Ph.D. exam	D-4	File <i>Final Oral Defense Committee Appointment & Schedule Form</i>
≥ Four weeks prior to Ph.D. exam		The student submits an electronic copy of a peer-reviewed publication on he/she is the first author, to the Graduate Advisor
Four weeks prior to Ph.D. exam		Submit Ph.D. thesis to format checker
≥ Two weeks prior to Ph.D. exam		Deliver printed copy of dissertation to each member of the Final Oral Defense Committee (5)
Day of Ph.D. exam	D-5	Bring <i>Report of Ph.D. Final Oral Defense Committee Form</i> to exam and also <i>Thesis Completion Form</i> .
When thesis corrections finished		File <i>Completion Form</i>
One month prior to commencement		File <i>Application for Ph.D. Degree Form</i>
Before leaving Drexel		Return all keys and other borrowed items

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

- (1) After obtaining the appropriate signatures from his/her Research Advisor and/or committee members, all University forms (D-1 through D-5 and the Completion Form) must be submitted to the Graduate Advisor, who will forward them to the Graduate Studies Office; Department forms (C-2) must be submitted to the Graduate Advisor (with the necessary signatures).
- (2) Ph.D. students & thesis-M.S. students.
- (3) The Graduate Advisor or Chair of the Graduate Program Committee can check over a student's coursework with him/her, although he/she should first consult with his/her Research Advisor.
- (4) Deadline strongly recommended by the chemistry department; **university deadline** is “at least three months prior to the final defense.”

- (5) An electronic copy may be substituted for the printed dissertation if it is acceptable to the committee member.

C. Department Forms

- 1. Graduate Research Advisor Interview Form (Form C-2, revised 12/14/11)**
- 2. Master's Thesis Review Committee Form (Form C-5)**

Form C-2

GRADUATE RESEARCH ADVISOR INTERVIEW FORM

STUDENT NAME: _____

I am interested in starting my _____ M.S. thesis or non-thesis research or _____ Ph.D. thesis research

Interviewed faculty signatures (below)*:

Date:

Having interviewed the above faculty members (at least 3), I submit my choices of faculty advisor as

_____ (first choice)

_____ (second choice)

_____ (third choice)

Based on faculty eligibility and pending his/her agreement, _____ is named as your Research Advisor.

Departmental full-time Graduate Advisor or Department Head signature:

_____ Date: _____

I agree to act as research advisor to the above student. The student's "specialty area" for Ph.D.

Cumulative exams will be: _____.

Research Advisor signature _____ Date: _____

If a co-advisor is also selected, this person is _____

Co- Advisor signature _____ Date: _____

Submit completed form to the Graduate Advisor. Ph.D. students must also submit Drexel forms D1.

* Students who finalized their choice of research advisor as a prospective student should simply enter that faculty member's name on the first line. Otherwise, students should re-interview the faculty member(s) whose research is of interest to them, in addition to any new faculty appointed during the last four years. A complete list of chemistry faculty may be found at <http://drexel.edu/chemistry/contact/facultyDirectory/>.

Form C-5

MASTERS THESIS REVIEW COMMITTEE

STUDENT NAME: _____ Research Advisor: _____

Title of Master's 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

GPC Rev Sept.03