

**SUMMARY OF PROCEDURES
AND REQUIREMENTS
FOR GRADUATE DEGREES**

Department of Chemistry
The Ohio State University

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SUMMARY OF PROCEDURES AND REQUIREMENTS FOR GRADUATE DEGREES IN THE CHEMISTRY DEPARTMENT

INTRODUCTION

The requirements for advanced degrees at The Ohio State University are summarized in the Graduate School Handbook, which is available for download from the Graduate School website at: <http://www.gradsch.ohio-state.edu/Depo/PDF/Handbook/Handbook.pdf>. All incoming students should obtain a copy of this Handbook upon entering OSU and keep it for reference during the tenure of his or her degree program.

This document summarizes specific requirements for graduate degrees in Chemistry, as well as additional comments and instructions for students in our program. A graduate student in Chemistry who seeks the M.S. or Ph.D. degree is expected to expend a major effort on the research problem that culminates in a thesis or dissertation. To reach this goal, the candidate will conduct independent research under the guidance of a faculty advisor, prepare and present a thesis on the study, and demonstrate that it adds significant new knowledge to some area of chemistry. The course requirements are designed to prepare the student for this major challenge of graduate education. Do not become preoccupied with these rules, but be guided by them to an increasingly productive and rewarding experience.

ADMISSION TO GRADUATE PROGRAMS IN CHEMISTRY

Admission requires demonstration of an acceptable B.S. or B.A. degree, and a reasonable expectation of success in the Ph.D. program. The student should have a minimum overall undergraduate point-hour ratio of at least 3.2 (on a 4.0 basis), suitable performance on the graduate record examination (GRE), or satisfactory completion of such specific additional requirements as may be stipulated in special cases. The Graduate Admissions Committee reviews and makes recommendations on each application for admission to the program. The Vice Chair for Graduate Studies has final approval on all offers of admission.

TRANSFER STUDENTS

At the time of admission, the Admissions Committee may recommend that certain transfer students be exempted from the first-year exams (see section II.A below). This decision will be based on the student's academic record and level of research experience. If no recommendation is made, transfer students will be required to take the first-year exam.

Transfer students may petition to allow courses they took at a prior institution to stand in place of courses required here. The student will submit previous course materials – syllabi, notes, homework, and exams – which will be evaluated by appropriate faculty in our department. Credits from other institutions cannot be transferred.

ACADEMIC STANDARDS FOR GRADUATE PROGRAMS

A graduate student doing acceptable work toward a graduate degree is expected to maintain a point-hour ratio of B (3.00) or better in all graduate-credit courses. If at any time after 15 hours of graduate credit, a student's cumulative point hour ratio (CPHR) falls below the 3.00 requirement, the student is automatically placed on probation by the Graduate School. Although the student is expected to raise the CPHR above 3.00 the next term, continued enrollment is permitted on a term-by-term basis, as determined by the Vice Chair for Graduate Studies and the Graduate School.

THE DURATION OF GRADUATE PROGRAMS IN CHEMISTRY

Normally, an M.S. student will spend two years in residence. The student who proceeds toward the Ph.D. without the M.S. degree will probably spend between 4-6 years, depending on the student's own initiative and research success. The student who has previously received a M.S. degree probably will spend four years in the Ph.D. program. The shorter time-periods apply to those students who enter with a strong undergraduate preparation, take a full course load, and are efficient and productive researchers.

PLACEMENT EXAMINATIONS

At the time students enroll in the Graduate School, the department will administer a series of written examinations that are used to gauge competence at the undergraduate level in analytical, biological, inorganic, organic, and physical chemistry. The purpose of these examinations is to aid the student and faculty advisors in planning a suitable progression of course work leading to the advanced degree. Students who are considered "not proficient" in a given area will be provided with advice on how to strengthen competency in that area. Such advice may include suggested course work and/or a course of independent study.

SAFETY SEMINAR PROGRAM (CHEM 685)

Every graduate student is required to attend a complete series of Safety Seminars during the winter quarter of the first year. The purpose of the series is to maintain high safety standards in the departmental teaching and research laboratories. The series of lectures, given weekly by the departmental safety coordinator, covers topics ranging from the handling of corrosive and toxic chemicals to fire fighting. Failure to attend any of these lectures will constitute an unsatisfactory performance as a Graduate Associate and may result in loss of departmental support during the summer of the first year. In addition to the Safety Seminars, each student must become familiar with the department's Chemical Hygiene Plan and the Standard Operating Procedures associated with their work.

FINANCIAL SUPPORT FOR GRADUATE STUDENTS

Most graduate students receive financial support as Graduate Associates, either Teaching Associates (GTA) or Research Associates (GRA), or as Fellows during their tenure in the department. Graduate students supported by any of these appointments may not hold additional employment of any kind without express permission of the Vice Chair for Graduate Studies. Fellowship stipends may be supplemented up to the current GTA stipend; any stipends above that level must have prior approval by the Vice Chair for Graduate Studies. The Graduate School sets minimum requirements of eligibility for GA appointments to students who are in a degree program. Until passing the candidacy exam (section II.B) students must register for at least nine (9) credit hours during autumn, winter and spring quarters and at least seven (7) credit hours during the summer term. After entering Ph.D. candidacy, the minimum number of credit hours per term is three (3). Students who hold fellowships must register for 15 credit hours during each term the appointment is held prior to entering Ph.D. candidacy, when they must register for a minimum of three (3) credit hours. International students who are not holding a GA appointment (an exceedingly rare occurrence) must register for ten (10) credit hours per term. Each of these registration requirements qualifies the student to be considered "full-time" for purposes such as visas, health insurance, etc.

There are further requirements imposed by the Graduate School. A student must be enrolled for at least three (3) credit hours during the term in which they graduate. A Master's degree

requires at least 45 graduate credit hours, and the Ph.D. requires at least 120 graduate credit hours. Audited courses do not count toward these minima.

Departmental policies coincide with these guidelines for the most part:

- (1) Students with a GPA below 3.00 lose their right to a fourth quarter Graduate Research Associate appointment from the department (dGRA), and may lose future support as a TA.
- (2) Students must advance to candidacy by the end of their third year in order to maintain support either in the form of an RA, TA, or fellowship appointment. Students failing to advance to candidacy by the end of the third year must petition the Vice Chair for Graduate Studies for continuation of support.
- (3) Students required to obtain an M.S. degree prior to moving onto the Ph.D. track are still expected to advance to candidacy by the end of their third year to maintain support either in the form of an RA or TA appointment. Students failing to advance to candidacy by the end of their third year must petition the Vice Chair for Graduate Studies for continuation of support.
- (4) Students required to take a terminal M.S. degree are expected to defend their thesis by the end of their third year. Students failing to defend their M.S. thesis by the end of their third year must petition the Vice Chair for Graduate Studies for continuation of support.
- (5) Students who are entering their sixth year of graduate training must petition the Vice Chair for Graduate Studies to receive support during all or part of their sixth year, and must have the approval of their advisor. Approval of such petitions will require the demonstration of a reasonable prospect that the degree program can be completed within one year.
- (6) Department policies specify that, except in unusual cases, students who have been enrolled for more than six years may not receive support as a GTA, GRA, or Fellow, from Research Foundation, departmental, or other funding sources. Only in exceptional instances will the Vice Chair for Graduate Studies will consider a petition for support beyond six years.
- (7) Every faculty member is required to evaluate their Graduate Teaching Assistants each term with ratings of Excellent (E), Satisfactory (S+, S, or S-), or Unsatisfactory (U). Evaluations are based primarily on overall performance as a teaching associate, but also include punctuality, attendance of staff meetings, and attitude toward students. Students receiving an unsatisfactory (U) teaching evaluation will be suspended from their teaching appointment for one term and must petition the Vice Chair for Graduate Studies for subsequent reinstatement. No TA support will be available during such a suspension. Petitions to be supported as a TA can be made after three quarters or two semesters from the time the U rating was received. Two S- ratings are regarded as equivalent to one U rating. Any subsequent U will lead to dismissal from the teaching program. No further TA support will be available. A further S- rating will result either in complete dismissal from the teaching program or a one-term suspension, as appropriate.
- (8) Every faculty member is required to grade the performance of students taking research credits under his or her supervision each term with ratings of Satisfactory (S) or Unsatisfactory (U). Evaluations are based primarily on overall progress in research, but also include time spent in the lab, attendance of group meetings, and handing in reports required by the advisor in a timely manner. Students receiving an unsatisfactory (U)

grade will meet with the advisor and the Vice Chair for Graduate Studies to devise a plan to ensure future success. Any subsequent U grades in research will lead to the student not being in good standing in the department and can result in dismissal from the program.

GRIEVANCE PROCEDURES

Discussion with the Vice Chair for Graduate Studies usually leads to resolution of a grievance. If discussion with the Vice Chair proves unsatisfactory, the Graduate Council has established grievance procedures, copies of which are available in the Graduate School.

ENGLISH REQUIREMENTS – International Students

A student whose native language is not English must demonstrate a satisfactory proficiency in English at the beginning of the graduate program. Courses in written and oral English may be required for students who show a deficiency that might prove to be a handicap to graduate work. Students who hold a TA will be required to demonstrate proficiency in Spoken English, either by passing the SPEAK TEST or a Mock Teaching Test, both of which are administered by the English as a Second Language Program. Students must be certified to teach by the end of the spring quarter of their first year. International students may also be required to take written English courses (106, 107, 108.2) after taking English entrance examinations. Chemistry students are required to complete all spoken English courses by the end of their third quarter at OSU.

INITIATION OF RESEARCH AND ADVISOR SELECTION

Dissertation research is initiated when a student has selected a research adviser, and has been admitted into a research group. The selection of an advisor is a major step in a student's program. The process involves a formal system of interviews. To initiate the procedure, the student will obtain a "Selection of Research Advisor Form" from the Graduate Office and designate a minimum of four (4) faculty members that he/she wishes to interview. Students are encouraged to interview as many faculty as they feel may provide research programs of interest. The Vice Chair will assign additional faculty members for Graduate Studies in accordance with departmental and divisional guidelines, and provide the student with an "Interview Record Sheet." All faculty members on the "Interview Record Sheet" must sign the sheet after they have been interviewed. Students then submit a rank-ordered list of their top three choices for advisor ("Choice of Preceptor" form) to the Graduate Office by a date that is announced at the start of autumn quarter, typically during the first week of classes in January. The Graduate Studies Office provides the list of student advisor preferences to the division secretaries and faculty. Following any formal discussion between faculty that may be required by a division, the faculty member listed as the first choice must decide whether or not to serve as advisor to the student. The faculty member notifies the division secretary and Graduate Studies Office of his/her decision. If a faculty decides not to serve as advisor, the faculty member who is the second choice makes a similar decision. This process is repeated until the student has an advisor. In the event a student is not accepted by one of their top three choices, the Vice Chair for Graduate Studies becomes active in helping the student find an advisor, in a manner left to the discretion of the Vice Chair. Once the list of advisor preferences has been distributed, it is a goal of the department to place students in research groups within a two-week period. The process of selecting an advisor must be completed by the end of the third quarter in order to qualify for a fourth term RA appointment.

A student may complete their Ph.D. research under the supervision of a faculty member in the Department of Chemistry. This may be done in collaboration with faculty outside the

department, including those affiliated with the department. The direct supervision of the Ph.D. research of chemistry graduate students by faculty outside the chemistry department is not permitted. Any other advising arrangement is subject to approval by the Vice Chair for Graduate Studies, who will request a description of the proposed research and consider whether it is suitable for a Ph.D. thesis in Chemistry.

After selection of an advisor and in consultation with the student and their advisor, the Vice Chair for Graduate Studies will appoint an advisory committee for each student. The purpose of the advisory committee is to provide each student with support and guidance during their graduate career. Students should meet with their advisory committee during the autumn term of each year to discuss their progress in course work, examinations and research. In addition, students are free to meet with any committee member at any time during the year. The department hopes that this process will provide a mechanism for forging closer ties between students and faculty, both before and after graduation.

If a student leaves a group, or the faculty advisor resigns his/her position as preceptor, the student will have until the end of that term to find a new advisor. If less than two weeks remain in the term including final examination week, then the student will have until the fifth week of the following term to find a new advisor. After this time, support will be withdrawn (at the end of the term of enrollment) and the student will no longer be in good standing in the department.

FACULTY RESEARCH PRESENTATIONS

Students are required to attend a series of weekly Faculty Research Presentations during the autumn of their first year in the program (CHEM 693). The purpose of these presentations is to provide students with an overview of the types of research being conducted in various research groups, and to help students identify the four faculty members that he/she wishes to interview. The point of attending presentations in the areas of interest to the student is obvious. The Department also hopes that attending presentations from other disciplines will provide students with points of reference, should they need help during the course of their graduate studies, for topics in which their advisor is not an expert.

GRADUATE PROGRAMS

I. DEGREES GRANTED, RESIDENCE AND CREDIT HOUR REQUIREMENTS

A. MASTERS PROGRAM

The student must have a minimum residence of three quarters at The Ohio State University with completion of at least 45 quarter hours of graduate work. The student's course program should be decided in conjunction with the Advisor. Course work must be at the 600-900 level, and the courses in related fields must be acceptable to the Vice Chair for Graduate Studies, the student's advisor, and the student's division. Divisional course requirements for the M.S. degree can be found under the section titled "Course and Examination Requirements for the Sub-disciplines" of this document.

Students will carry out a research program that will culminate with the writing of a thesis. The research program should be initiated upon joining a research group. See Initiation of Research under Ph.D. requirements, and Graduate Examinations for various sub-disciplines, for more specific procedures.

A student must submit an "Application to Graduate" form to the Graduate School no later than the second Friday of the term in which graduation is expected. At least two weeks prior to the date proposed for conferring the M.S. degree, the candidate must pass an oral examination before a committee composed of at least two Chemistry Department faculty members, including their research advisor. Should the graduate record of the candidate be wholly satisfactory to the examining committee, the scope of the examination will be confined to the candidate's field of specialization.

Students working toward an M.S. degree will not receive financial support from the department (GRA, GTA, GAA) after completion of three years in the program.

The Department of Chemistry does not award a non-thesis M.S. degree and does not award M.S. degrees on the basis of satisfactorily completing the doctoral candidacy examination.

B. DOCTORAL PROGRAM

The Graduate School requirements for the Ph.D. degree are stated in Part V of the Graduate School Handbook. The Chemistry Department has several additional requirements and procedures as outlined below. The student may follow either of two paths. The first involves proceeding directly to the Ph.D. degree. The second involves completion of an M.S. degree followed by continuation toward a Ph.D. degree. In either program, the candidate must satisfy the course requirements of one of the divisions of the chemistry department, or a designed multidisciplinary course of study, in addition to all departmental requirements.

The purpose of course work in the Ph.D. program is to prepare the student to take the Candidacy Examination for the Ph.D. degree and to undertake work on a significant original investigation in chemistry that culminates in the doctoral dissertation. With the approval of the advisor, a student may elect to meet specific degree requirements in any of the areas of chemistry in the department, normally the one in which the student's major research effort is planned.

Students initiating graduate studies at The Ohio State University after having received an M.S. degree at another institution can petition to have specific course requirements waived. The student will submit evidence (e.g., syllabi, course notes, and examinations) to the appropriate Division Secretary of having taken a course equivalent to one required by this program. The evidence is evaluated by appropriate faculty, who recommend whether or not the course satisfies requirements in the division of the student's specialization. The recommendation is submitted by the evaluator for approval to the Secretary of the Division and the Vice Chair for Graduate Studies.

The Ph.D. degree is a research degree, and thus most course work is taken during the first year; usually only selected advanced subjects are taken in the second and subsequent year. Those courses indicated as electives may include those required in other areas by the Division (both inside and outside the Chemistry Department) and, in some cases, additional courses in the major field. Advanced subjects are usually in the major field. Students who elect to take courses outside of chemistry, must obtain required permission from the student's research advisor before registration. If the student does not have a research advisor at the time of enrollment, permission from the Vice Chair for Graduate Studies is required. Students may enroll in research as early as winter quarter of their first year, and they must do so by the summer term following their first year in graduate school.

Students in good standing in the graduate school will enroll for Research in Chemistry (CHEM 999) when they begin their degree research. Each student should enroll every term for one hour of CHEM 885 (Colloquium in Chemistry), unless doing so violates the credit hour limits. This course requires regular attendance at departmental and/or divisional seminars.

The broadly defined contents of the Ph.D. curriculum in Chemistry are illustrated in the "Suggested Ph.D. Curriculum" that follows. More specific sample curricula are presented on a divisional basis on following pages.

C. SUGGESTED Ph.D CURRICULUM

| <u>First Year, AU</u> | <u>Hours</u> | <u>Second Year, AU</u> | <u>Hours</u> |
|---|--------------|------------------------|--------------|
| Major Subjects | 6 | Advanced Subject | 3 |
| Electives | 3 | Research (999) | 5 |
| Colloquium (885) | 1 | Colloquium (885) | 1 |
| Faculty Research Presentations (693) | 1 | | |

| <u>First Year, WI</u> | | <u>Second Year, SP</u> | |
|-----------------------|---|------------------------|---|
| Major Subjects | 6 | Advanced Subject | 3 |
| Electives | 3 | Research (999) | 5 |
| Colloquium (885) | 1 | Colloquium (885) | 1 |
| Safety Seminar (685) | 2 | | |

| <u>First Year, SP</u> | | <u>Second Year, SU</u> | |
|-----------------------|---|------------------------|---|
| Major Subject | 3 | Research (999) | 7 |
| Elective | 3 | | |
| Research (999) | 2 | | |
| Colloquium (885) | 1 | | |

| <u>First Year, SU</u> | |
|-----------------------|---|
| Research (999) | 7 |

| <u>Subsequent Terms</u> | <u>Hours</u> |
|-------------------------|--------------|
| Research (999) | 8(2) |
| Colloquium (885) | 1(1) |

Students holding a TA/RA appointment must register for at least nine (9) credits each term (7 in the summer). Fellowship students must register for at least 15 credits each term. CHEM 999 should be used to fill a schedule to the required number of hours. Numbers in parentheses (throughout) refer to registration for post-Candidacy students.

II. DEPARTMENTAL REQUIREMENTS FOR THE Ph.D. DEGREE

A. FIRST-YEAR ORAL EXAMINATION

All students pursuing either an M.S. degree or Ph.D. degree must take an oral examination near the end of their first year of study. The focal point of this examination is a paper selected jointly by the student and advisor that is related to the student's research topic. The purpose of this exam is to evaluate the student's progress within the context of an activity that is relevant to their research interests, and to determine whether the student is ready to proceed with further requirements of the Ph.D. program. The administration of the first-year oral examination is outlined below.

1. By the end of the first week of spring quarter, the Secretary of each division announces to students:
 - (a) dates for administration of the first-year oral examination;
 - (b) possible outcomes of the exam (e.g., proceed to the Ph.D. Candidacy Examination, take a series of written examinations prior to proceeding to the Candidacy Examination, etc.);
 - (c) a three-member committee, or set of three-member committees to give the oral exams.

A single three-member committee of faculty members is typical because all students in a division will be judged by a common standard. However, it may not be practical for a single committee to examine all students in each division.

2. The examination committees attend a brief orientation with the Vice Chair for Graduate Studies to make sure that examinations are conducted consistently within the department.
3. The student and advisor are jointly responsible for selection of a journal article – related to the student's research topic – that will form the basis of the exam. The article may or may not be one published with the advisor as a co-author. In some cases, prior approval of the article by the committee may be required (as defined in Section III of this document). It is a good strategy to choose an article that covers substantial scientific issues, that is not overly difficult. An article that is, for example, a brief communication of measurements will give the examination committee little inspiration for exam questions. In that case, the line of questioning will be less predictable, which will put the student at a disadvantage. The student and advisor are jointly responsible for delivering a copy of the article to the each examination committee member two weeks in advance of the exam period.
4. The Graduate Studies Office, in consultation with committee members and students, will be responsible for scheduling the individual exams. All exams must take place within the specified period unless the student has a valid excuse. Significant life events (e.g., wedding), documented medical excuses, or important scientific activities (e.g., conference) constitute valid excuses.
5. The format of the exam will include a short presentation by the student of no more than 5-10 minutes, followed by approximately one hour of questioning. The student may use the chalkboard, overheads, or computers as part of this presentation (refer to divisional requirements in Section III of this document). The presentation and paper will serve as the starting point for questioning. Students will be expected discuss the content of the paper and respond to questions about larger concepts underlying research described in the paper. The advisor, if not a member of the committee, can sit in on the exam. The advisor may formu-

late questions with the permission of the committee, but may not assist the student with answers.

6. After the exam, the student is excused. The exam committee and the advisor will have a brief (5-10 minute) meeting to exchange impressions on the exam. This is very useful for getting a more accurate view of the student's performance and preventing later misunderstandings.
7. Within two working days of the last exam,* all examination committees of each division will meet, and based on the student's overall performance on the oral exam and first-year course work, determine whether each student should proceed directly with the Ph.D. program, undergo further evaluation (as defined by each division in Section III of this document), or proceed to a terminal M.S. degree. Forms for communication of the results will be furnished by the Graduate Studies Office.
8. Within three working days of the last exam,* the results of the exams must be communicated to the division secretaries and the Graduate Studies Office.
9. Within four working days of the last exam,* the results of the exams will be reported to the students by the Graduate Studies Office.

*excluding delayed exams

Repeat exams or extra chances at cumulative exams will only be given in exceptional cases. The student must clearly state the grievance and proposed redress in a petition to the Graduate Studies Committee, who will act on the petition in consultation, and based on the recommendation, of the division(s) administering the exam.

B. CANDIDACY EXAMINATION

The precise timing of the Candidacy Examination should be determined collectively by the advisor and the student using the following guidelines. Students who have passed the First-Year Oral Examination should initiate the Candidacy Examination no earlier than the spring of their second year and no later than the autumn of their third year. Students requiring further evaluation via cumulative exams should initiate their Candidacy Examination within 6 months of completing cumulative exams. Students requiring further evaluation via completion of an M.S. degree should initiate their Candidacy Examination within six (6) months of completing their M.S. degree. In all circumstances, students must complete their Candidacy Examination by the end of their third year in the program.

The Candidacy Examination offered by the different divisions in the Department of Chemistry vary somewhat in format, as described in sections that follow, but in each case this examination includes both written and oral portions. The examination is a comprehensive test administered by a committee of faculty, and is based on the fundamentals of the broad area of chemistry in which the student is specializing. The student's progress in research may be evaluated by the exam committee (consult Section III). Satisfactory performance in this examination or series of examinations admits the student to candidacy for the doctoral degree at the end of the term in which the exam is passed, or the series concluded.

The written portion of the Candidacy Examination for the Ph.D. takes the form of an original research proposal written by the candidate. The purpose of this written exam is to examine the creative potential of the candidate and their knowledge of relevant literature surrounding the proposed research. The Candidacy Examination committee must indicate approval of the proposal by signing a form (available from the Graduate Studies Office) and a copy of the

approved proposal must be filed with the Graduate Studies Office). The details of this examination are delineated in Section III of this document.

The oral portion of the Candidacy Examination for the Ph.D. consists of general questions that may be initiated by the defense of the original written proposal that constitutes the written portion of the Candidacy Examination. The written portion of the Candidacy Exam must be approved by the examination committee three weeks prior to the oral exam. A final draft of the student's written examination must be available to all members of the oral examination committee, including a possible university representative appointed by the Graduate School (see next section), at least two weeks prior to the examination. The candidate shall be judged on the oral examination by his/her performance on the general questions and the defense of his/her research proposal, and research progress, depending on Divisional requirements.

Procedures for Selection of Candidacy Examination Committee

The Vice Chair for Graduate Studies, with advice from the student's advisor, will assign faculty to the student's committee according to the following procedures.

1. The student's adviser will recommend three faculty members to the Vice Chair, in addition to himself/herself, to serve on the oral committee. Faculty members will normally be from the student's division.
2. The Vice Chair may select two of the three nominees, or may suggest another faculty member, if inequities exist in the distribution of committee assignments.
3. When required by division rules, the Vice Chair will also assign a committee member from outside the division. The university representative will sometimes be assigned by the Dean of the Graduate School.
4. The Vice Chair will notify the adviser of those individuals who will serve on the committee, and the adviser (not the student) will arrange a time and location for the exam in consultation with his/her colleagues, and the Vice Chair's office. The appropriate form (Doctoral Notification of Candidacy Examination form) will be prepared by the Vice Chair's office and the advisor/student must file this form with the Graduate School at least two weeks prior to the examination date.

C. DISSERTATION

The dissertation resulting from the student's graduate research must represent significant contribution to knowledge in chemistry. Its importance should be sufficient to warrant the acceptance for publication of a paper based upon it by one of the respected journals of chemistry or a related scientific area. A reading committee composed of the adviser and at least two graduate faculty members (often members of the student's Advisory Committee) will consider the merit of the dissertation in detail. The student's advisor selects this committee.

D. FINAL ORAL EXAMINATION

On approval of the dissertation by the advisor and the reading committee, a final oral examination, based largely on the dissertation work, will be held in accord with the Graduate School guidelines. The examination committee will consist of the members of the dissertation reading committee, and a graduate faculty member nominated by the Dean of the Graduate School from a department other than Chemistry. A unanimous vote of all committee members is required for a satisfactory decision.

III. COURSE AND EXAMINATION REQUIREMENTS FOR THE SUBDISCIPLINES

With the approval of his/her adviser, a student may elect to satisfy the specific graduate degree requirements in any one of the areas of chemistry (i.e., division) in the department. Alternatively, the student and advisor may jointly propose a multidisciplinary program of student by submitting an application for the "Multidisciplinary Track" for evaluation and approval by the Vice Chair for Graduate Studies.

The examination procedures employed by the different divisions are defined in the following sections. Each of the procedures allows an early delineation of the final study plan and the nature of the degree to which the student's effort will lead. Divisional requirements, such as satisfactory performance on a qualifying examination or presentation of seminars, are supplemental to the departmental requirements.

A. ANALYTICAL CHEMISTRY

A Ph.D. candidate is required to take, in addition to those graduate analytical courses recommended by his/her adviser, Chemistry 721, three of the five 82x series courses (821, 822, 823, 824 and 825) and at least three courses numbered 700 or above in areas other than analytical chemistry. The choice among alternatives will be made in consultation with the student's adviser and in view of the major interest areas of the candidate. When appropriate, courses with numbers below 700 may be substituted by petition to the analytical division faculty. Acceptable courses in areas outside analytical include, but are not limited to, the following: Biochemistry 733, 734; Inorganic Chemistry 751, 752, 753, 851; Organic Chemistry 731, 831; Physical Chemistry 861, 862, 863, 775, 880, 876.

Sample Analytical Chemistry Ph.D. Curriculum

| <u>First Year, AU</u> | <u>Hours</u> | <u>Second Year, AU</u> | <u>Hours</u> |
|-------------------------------|--------------|--------------------------|--------------|
| 721, 82x Analytical Chemistry | 3 | 82x Analytical Chemistry | 3 |
| 775 or 861 Physical | 3 | 999 Research | 8 |
| Elective A | 3 | 885 Colloquium | 1 |
| 885 Colloquium | 1 | | |
| 693 Faculty Presentations | 1 | | |

| <u>First Year, WI</u> | <u>Hours</u> | <u>Second Year, SP</u> | <u>Hours</u> |
|--------------------------|--------------|------------------------|--------------|
| 82x Analytical Chemistry | 3 | 999 Research | 8 |
| 862 Physical | 3 | 885 Colloquium | 1 |
| Elective B | 3 | | |
| 885 Colloquium | 1 | | |
| 685 Safety Seminar | 2 | | |

| <u>First Year, SP</u> | <u>Hours</u> | <u>Second Year, SU</u> | <u>Hours</u> |
|--------------------------|--------------|------------------------|--------------|
| 82x Analytical Chemistry | 3 | 999 Research | 7 |
| Elective C | 3 | | |
| 999 Research | 2 | | |
| 885 Colloquium | 1 | | |

| <u>First Year, SU</u> | <u>Hours</u> |
|--------------------------|--------------|
| 999 Research | 4 |
| 720 Analytical Chemistry | 3 |

All Subsequent Terms

| | |
|----------------|------|
| 999 Research | 8(2) |
| 885 Colloquium | 1(1) |

- A. Usual electives are 751, 731 or 733
- B. Usual electives are 752, 832
- C. Usual electives are 753, 833

82x Series Courses

Students are required to take three of the following courses. The courses will be rotated as follows:

School year ending with an even number

| | | |
|--------|-----|--------------------|
| Autumn | 821 | Electrochemistry |
| Winter | 822 | Separation Science |
| Spring | 833 | Spectroscopy |

School year ending with an odd number

| | | |
|--------|-----|----------------------------|
| Autumn | 824 | Nuclear Magnetic Resonance |
| Winter | 825 | Mass Spectrometry |
| Spring | | Special Topics Course |

The degree programs available to students in Analytical Chemistry are M.S. and Ph.D.

M.S. Degree

Students who intend to terminate graduate studies after the M.S. degree follow this degree program. It is also followed by students whose early graduate performance indicates that completion of a thesis problem and writing of a M.S. thesis would be of considerable help in advancing their academic program and students who cannot complete a given requirement of the Ph.D. program. For example, students who do not pass the Candidacy Examination portion of the Ph.D. program often complete the thesis M.S. degree program. The minimum course requirements for the M.S. Degree are completion of Chem 720 and Chem 721. Other courses may be required by the advisor as required for the student to gain expertise aligned with the thesis project. The student must also write an M.S. thesis and defend this thesis (oral examination) as delineated on page 7 of this document.

Ph.D. Degree

To proceed toward a Ph.D. degree without obtaining the M.S. degree students must make satisfactory progress as follows:

- The student must be enrolled in the Graduate School and maintain a 3.0 GPA at the end of the third quarter of the first academic year and all terms thereafter.
- The student must have selected a research advisor by the end of the third quarter of the first academic year and must remain in a research group thereafter.
- During the summer following the first academic year, the student must present a poster on his/her research carried out during the first academic year.
- The student must complete 21 hours of lecture courses (graded A thru E) during the autumn, winter and spring quarters of the first academic year. A minimum of 15 of these credits must be at the 700 level or above (Chem 661.01, 661.02, and 694 will be treated as 700 level courses for this purpose).

- The student must pass the First-Year Oral Examination (see below).

First Year Research Project

Each student seeking to earn the Ph.D. degree is expected to begin research upon joining a research group. The choice of such a project will be made in consultation with the student's advisor. A poster session will be held at the end of the summer term in which the first year students will have the opportunity to report on their progress and to discuss their research with other students and faculty. All first year students must present a poster. A brief written description of the poster presentation shall be provided, in advance, to the analytical division secretary.

Student Seminars

Students seeking to earn a Ph.D. degree are expected to present seminars to the analytical division during their second and final years in the program, as part of the requirement for Chemistry 885. The second year seminar will generally be 30 minutes long on a topic determined by the student and his advisor, and will be evaluated by both faculty and students in attendance.

First-Year Oral Examination

The first-year oral examination will typically occur one week after finals week for spring quarter, and will last approximately one hour. The structure of this examination will involve the student choosing (in consultation with their advisor) a published paper to present orally and evaluate critically. The chosen paper must receive prior approval by the examination committee. The examination committee will consist of three analytical faculty members with one alternate (the research advisor is not to be among the 3 person committee). The student may make a five-minute presentation and may use chalk and the chalkboard for the remainder of the exam.

Based on the exam performance, course grades, and early research progress, three exam outcomes are possible: (1) proceed directly to the Ph.D.; (2) completion of a M.S. degree before proceeding to the Ph.D.; or (3) stop graduate studies after completion of a terminal M.S. degree. The exam outcomes will not be decided until all students have taken the examination. All students who take the oral exam will be provided feedback on the results of their examination.

Candidacy Examination

The student will write and defend an original research proposal that will be followed by a general question period by the examination committee.

The ongoing and contemplated research problems in the advisor's group cannot be used for proposed topics. However, this does not necessarily exclude proposals in the broad area of the advisor's research program. At least one month before the oral exam, the student will submit an abstract to the committee members in the Chemistry Department for approval of the research topic. At least three weeks prior to the examination the student is to submit to the committee a detailed description of the proposed research. This should include Objective (½ page), Background (1½ pages), Project Description and Data Analysis (14 pages) and References (1 page). This document must be approved by the committee prior to scheduling the oral defense of the proposal. The document describing the proposed research will constitute the written portion of the candidacy exam for analytical students. The defense of this proposal will constitute the oral portion of the candidacy exam.

B. BIOLOGICAL CHEMISTRY

The minimum course requirements consist of: (1) Sixteen credit hours of Biochemistry from courses listed in the Chemistry Department's offerings, with a minimum of six credit hours in Chemistry 990 (Chemistry 752 and Biochemistry 770 can be counted as part of the 990 requirement). Other 700 level or higher courses offered by other divisions or departments may be substituted with the approval of the division faculty. (2) Three hours of credit in Organic Chemistry at the 700-900 level, preferably Chemistry 731. (3) Three credit hours of Physical Chemistry at the 700-900 level, preferably Chemistry 775. The individual course program will be selected from the courses listed below, as well as other pertinent courses.

Sample Biological Chemistry Ph.D. Curriculum*

| <u>First Year, AU</u> | <u>Hours</u> | <u>Second Year, AU</u> | <u>Hours</u> |
|--|--------------|----------------------------|--------------|
| 731 Physical Organic I | 3 | 752 Bioinorganic Chemistry | 3 |
| 761 Proteins | 3 | 775 Intro. Thermo/Kinetics | 3 |
| Elective (MG 701) | 3 | 885 Colloquium | 1 |
| 885 Colloquium | 1 | 999 Research | 2 |
| 693 Faculty Presentations (alternative: 752, 775) | 1 | | |

| <u>First Year, WI</u> | <u>Hours</u> | <u>Second Year, SP</u> | <u>Hours</u> |
|---|--------------|------------------------------------|--------------|
| 685 Safety Seminar | 2 | 885 Colloquium | 1 |
| 766 Nucleic Acids | 3 | 999 Research/Elective [‡] | 8 |
| 885 Colloquium | 1 | | |
| 999 Research [†] or Elective [‡] (alternative: MG 702) | 3 | | |

| <u>First Year, SP</u> | <u>Hours</u> | <u>Second Year, SU</u> | <u>Hours</u> |
|------------------------------------|--------------|------------------------|--------------|
| 762 Enzymes | 3 | 999 Research | 7 |
| 763 Biochemistry | 2 | | |
| 885 Colloquium | 1 | | |
| 999 Research/Elective [‡] | 3 | | |

| <u>First Year, SU</u> | <u>Hours</u> |
|-----------------------|--------------|
| 999 Research | 7 |

Year two: Journal Club Literature Presentations; Complete Written Cumulative Exams if assigned; Complete General Exam; Thesis Research.

Year three and four: Complete General Exam; Thesis Research and Journal Club Presentation (Research-In-Progress).

[†] Students should select an adviser at the beginning of winter quarter.

[‡] Students should complete their electives in your second year. Consult with your adviser.

*Note: This is a sample program only. The particular program to be followed must be decided on in consultation with the faculty adviser and must conform to the Divisional guidelines given above. Students who have not had an undergraduate biochemistry course are advised to enroll in Biochemistry 511 during their first year, unless they pass the Biological Chemistry placement test. All other students should take 761 (Proteins) and one elective, preferably Mol Gen 701 (DNA Transactions).

The degree programs available to students in Biological Chemistry are M.S. and Ph.D.

M.S. Degree

This program is followed by students who intend to terminate graduate studies after the M.S. degree, by students whose early graduate performance indicates that completion of a thesis problem and writing of a M.S. thesis would be of considerable help in advancing their academic program, and by students who cannot complete a given requirement of the Ph.D. program. For example, students who do not pass the Candidacy Examination portion of the Ph.D. program often complete the thesis M.S. degree program. The course requirements for the M.S. degree are 23 hours of course work in Chemistry (600-level and above) including the following biochemistry courses: 761, 762, and 763. At least 22 additional credits at the graduate level are required. These courses may consist of research courses or other graduate level courses required by the student's research advisor. The student must also write an M.S. thesis describing original research and defend this thesis in front of a committee consisting of their advisor and one other faculty member from the biological chemistry division.

Ph.D. Degree

Students who qualify to proceed to the Ph.D. degree must fulfill the requirements detailed in this section of the document, starting on page 17.

Course Requirements

As stated at the top of page 17. Students working toward the Ph.D. degree must address placement exam performance as outlined on page 3 of this document and must maintain an overall grade point average of 3.00 and a grade point average of 3.00 or better in biochemistry courses taken as a graduate student at Ohio State.

Seminar Presentation

The student is required to present, before all the members of the division, two one-hour seminars, reviewing a specific topic of current interest. The topic of the first presentation will be assigned and the student will choose the topic of the second presentation. Generally, both of these presentations will be scheduled in the second year. In addition, students in the fourth year and beyond will be asked to present a brief Research-In-Progress talk to the division.

First-Year Oral Examination

This exam will take place during the first two weeks of summer term. The exam will last for approximately one hour. The student, in consultation with the adviser, will choose a published paper related to his/her research. The chosen paper must be approved by the committee two weeks before the exam. The student will present the paper in 5-10 minutes using only chalk and the chalkboard; no overheads or computerized slides may be used. The student will be asked questions on the paper and background pertaining to the subject area of the paper. The committee members will evaluate the performance. The examination committee will consist of three faculty designated by the Biological Division. The advisor may attend the examination, and help the committee formulate the questions for the student, but cannot assist the student in any manner. After the examination, the committee and the student's advisor will have a brief meeting to exchange impressions on the examination. The committee will assign 1 to 5 points based on a combination of the student's overall performance on the oral exam, course work during the first year and other factors. A score of 5 points will be required for the student to go directly to Candidacy Exam.

Based on this performance, a recommendation will be made by the committee on whether the student can proceed directly to Candidacy Exam, complete a terminal Master's degree, or be further evaluated by taking cumulative examinations. Feedback will be provided to the students as delineated on page 10 of this document.

To make up deficient points, the students needing further evaluation will take a series of cumulative examinations. These "cumes" will be offered on an announced date in October, November, January, February, April, and May. Students will be awarded 0, 0.5, or 1 point on each exam. The student will have six (6) chances to achieve five (5) points (including points awarded by the first-year oral examination committee). Students who fail to obtain the five points by the end of the spring term of the second year will be asked to complete a terminal M.S. degree, except in rare cases when the division faculty determine that further graduate work would be fruitful and in the student's best interest.

Candidacy Examination

In the general examination, the student presents and defends an original research proposal in an area other than that of the student's thesis work before the members of an examining committee set up for each student. The Vice Chair selects the members of the committee based on the recommendation of the adviser, according to the procedures specified in section II.B. Two of the committee members must be from the biological division; the third member must be a faculty member of the chemistry department; and the fourth member may be from the chemistry department or another unit on campus. Students are encouraged to take this part of the general examination within one term of passing their final cumulative examination. Before preparing the written proposal, the student is required to (1) submit to each member of the examination committee a proposal outline (maximum of 300 words) and (2) obtain approval from each committee member for the proposed study. The actual written proposal should follow the NIH postdoctoral grant format, which can be obtained from the NIH website (<http://grants.nih.gov/grants/funding/416/phs416-1.pdf>). The proposal (including figures, schemes, charts, and other illustrations) is limited to 10 single-spaced pages. The font should be 11-point Arial or 12-point Times. The margin should be at least 0.5" on each side. The references, which should be in the *Biochemistry* journal style and include the full title of the article, are not counted toward the 10-page limit. The document describing the proposed research will constitute the written portion of the Candidacy Exam. Members of the exam committee will provide a critique of the proposal to the student within two weeks of receiving the proposal. The candidacy committee must approve this document prior to scheduling the oral portion of the Candidacy Examination, and a final draft of the document must be available to all members of the committee (including the university representative appointed by the Graduate School, if applicable) two weeks prior to the oral examination. The adviser and student are responsible for arranging a time and location for the oral exam. In the oral portion of the candidacy exam, the committee will ask general questions to evaluate the research proposal and the student's knowledge of the entire area of biochemistry plus any areas related to the student's research. Students may bring up to five slides in any format, but preferably as printed handouts, to aid in the discussion of the proposal; however, the entire exam will consist of questions from the committee.

C. INORGANIC CHEMISTRY

In addition to all the requirements of the Graduate School and the Department of Chemistry, the Ph.D. aspirant in Inorganic Chemistry must fulfill the following: Credit must be obtained for the major courses 751, 752, 753, 754, 755, 851 and 995. Three courses must be taken in chemical areas other than Inorganic, at least two of which should be in the same field (e.g. biological, physical, etc.). The courses should be chosen from approved 600, 700, 800, or 900 level courses in Chemistry. Other courses outside of the Department will be considered upon petition.

Sample Inorganic Chemistry Ph.D. Curriculum

| <u>First Year, AU</u> | <u>Hours</u> | <u>Second Year, AU</u> | <u>Hours</u> |
|------------------------------|--------------|------------------------|--------------|
| 751 Organometallic Chemistry | 3 | | |
| 752 Inorganic Biochemistry | 3 | 999 Research | 8 |
| Elective | 3 | 885 Colloquium | 1 |
| 885 Colloquium | 1 | | |
| 693 Faculty Presentations | 1 | | |

| <u>First Year, WI</u> | <u>Hours</u> | <u>Second Year, SP</u> | <u>Hours</u> |
|-----------------------------|--------------|------------------------|--------------|
| 753 Inorg/Cluster Chemistry | 3 | 999 Research | 8 |
| 851 Theoretical Inorg Chem | 3 | 885 Colloquium | 1 |
| Elective | 3 | | |
| 885 Colloquium | 1 | | |
| 685 Safety Seminar | 2 | | |

| <u>First Year, SP</u> | <u>Hours</u> | <u>Second Year, SU</u> | <u>Hours</u> |
|-----------------------------|--------------|------------------------|--------------|
| 754 Solid State Chemistry | 3 | | |
| 755 Inorganic Chemistry Lab | 3 | 999 Research | 7 |
| 885 Colloquium | 1 | | |
| Elective | 3 | | |
| 999 Research | 1-2 | | |

| <u>First Year, SU</u> | <u>Hours</u> |
|-----------------------|--------------|
| 999 Research | 7 |

All Subsequent Terms

| | |
|------------------------|------|
| 999 Research | 8(2) |
| 885 Colloquium in Chem | 1(1) |

*Not offered on a regular basis.

The degree programs available to students in Inorganic Chemistry are M.S. and Ph.D.

M.S. Degree

In the M.S. program, the candidate must conduct independent research under the guidance of an advisor, prepare and present his/her thesis and demonstrate that it adds new knowledge to some area of chemistry. The candidate would select 27 hours of course work in chemistry (600-level and above) including the following Inorganic courses: Chemistry 751, 752, 753, 754, 755, and 851. Part of the 27 hours of course work may be in related fields if they are acceptable to the Graduate Committee of the Department of Chemistry. Thesis work will require a minimum of 15 additional credit hours in Chemistry 999. The total credit hours must be a minimum of 45 hours. Students not continuing on to the Ph.D. degree are expected to pursue this M.S. program. The student must also write an M.S. thesis describing original research and defend this thesis in front of a committee consisting of their advisor and one other faculty member.

Ph.D. Degree

First Year Oral Examination

The examination of all inorganic first-year students will occur early in the Summer Term. This will be an oral examination and will last approximately one hour. The structure of this examination requires a student to select a published paper that has been approved by the student's advisor. The student will give an oral presentation and critical evaluation of the content of the paper. The student will be asked questions by the committee on the contents of the paper as well as general background material pertaining to the subject matter of the paper. The Vice Chair selects the members of the committee based on the recommendation of the adviser, according to the procedures specified in section II.B. Based on the performance on the oral exam and course grades during the student's first year in graduate school, a recommendation will be made by the committee on whether the student proceed directly to candidacy, or complete an M.S. degree first, or complete a terminal M.S. degree. All students who take the oral exam will be provided feedback on the results of their examination. Students who are required to complete an M.S. degree first must defend their thesis by the end of summer term of their second year.

Candidacy Examination

Following a satisfactory evaluation in the first- year oral examination, or completion of an M.S. thesis (if required), a student may proceed to the Ph.D. Candidacy Examination. The decision on who may proceed to the Ph.D. will be predicated on the successful completion of the Ph.D. Candidacy Examination. The rules on candidacy will be the same for students who complete an M.S. thesis and for those who proceed directly to candidacy. The candidacy exam must be successfully completed by the end of the student's third year.

The Candidacy Examination is initiated according to the guidelines on page 11, Section I of this document and consists of two parts. The first part is the completion of an original written research proposal that has been approved by the student's candidacy committee. The second part is an oral examination that will probe the student's grasp of concepts in your written proposal as well as their understanding of general topics in chemistry, including progress in thesis research.

Prior to setting the date of the examination, the student must submit an original research proposal for review and approval by the examination committee. Appropriate responses from faculty members on the committee will be made to the candidate within one week. The response may consist of evaluation, criticism, and/or suggestions. The candidate must obtain the

approval of the committee, by signature of an approval form, at least three weeks prior to the exam and this will constitute passing the written part of the exam. The student is reminded that Graduate School rules require these exams to be scheduled at least two weeks in advance.

When the proposal is approved, the student has passed the written portion of the Candidacy Examination and their advisor may then set a date for the oral examination. The student must also prepare a research summary and provide it to their committee at least one week prior to the date of the oral examination. The examination session will run for no more than two hours and is mainly concerned with testing the fundamental knowledge and preparation of the student in his/her chosen discipline. The first 40-60 minutes of the oral examination may involve questions relating to and discussion of the research proposal submitted by the candidate in order to gain admission to the oral examination. Thereafter, questions will be of a more general nature, ranging over fundamental chemical subjects and detailed aspects of inorganic chemistry and the student's progress in research. Students should be able to describe their research project briefly on the board.

The student should expect to be interrupted during their presentation by questions related to the proposal as well as general organic chemistry and questions that probe understanding of their own research project, including ideas for future directions and solutions to current problems in the lab. The student is free to consult with peers and with those members of the faculty who will not be serving on the student's examination committee in preparation for this exam.

The Ph.D. Candidacy Examination is evaluated based on academic and research ability. Defense of the proposal, performance with general questions, and demonstration of an understanding of the research project and research achievements will all be considered in the oral examination. Students may pass only part of the oral examination, and in certain situations, may be asked to repeat part of or the entire exam. For example, if the student has suitably defended the proposal but has not made sufficient research progress or does not possess sufficient general knowledge, that student may be asked to repeat the research report and evaluation section of the oral portion of the Candidacy Examination after additional time spent in the lab. The timetable for reevaluation will be determined by the examination committee on a case-by-case basis, but should not extend beyond three months from the date of the original exam.

Dissertation Defense and Inorganic Seminar

By the time you reach this stage, you will be the expert in some area of modern inorganic chemistry. After writing your dissertation in conjunction with your major professor, you will defend the dissertation and discuss your research before a dissertation committee that will be composed of the adviser and at least two graduate faculty members (often members of the student's Advisory Committee) who will consider the merit of the dissertation in detail. The student's advisor selects this committee.

In addition, you are required to present a seminar before the inorganic students, postdoctoral fellows, and faculty so that we can learn about your contributions to our knowledge of chemistry.

D. ORGANIC CHEMISTRY

The mission of the organic chemistry program is to develop independent creative scientists and teachers. Its culmination is the Ph.D. dissertation, an original and significant contribution to chemical science. Although the main activity in graduate school is research, the student also fulfills the more formal requirements listed below.

The degree programs available to students in Organic Chemistry are M.S. and Ph.D.

A student is directed along one of these degree programs as determined by the wishes of the student, the judgment of the preceptor, and the performance of the student on written and oral examinations. In addition to course work and degree research, a student working toward a Ph.D. in the organic division must pass the Candidacy Examination. This Examination consists of both a written and an oral part as described in the Rules of the Graduate School, the details of which are summarized below. After passing the Ph.D. Candidacy Examination, each student must present at least one seminar to the organic division faculty and students, following the guidelines set forth by the division.

M.S. Degree

In the M.S. program, the candidate must conduct independent research under the guidance of an advisor, prepare and present his/her thesis and demonstrate that it adds new knowledge to some area of chemistry. The candidate must complete a minimum of 45 hours of course work in chemistry (600-level and above) including the following organic courses: Chemistry 632, 730, 731, 831 and 832. Thesis work requires a minimum of 20 credit hours in Chemistry 999. Students completing this program must write and defend a thesis according to the guidelines presented on page 7 of this document.

Ph.D. Degree

Placement Examination and Course Requirements

Placement exams are administered to each student upon entry into the Chemistry Graduate Program. Students who pass the organic placement in September of their first year will enroll in CHEM 730 and 731 (autumn), CHEM 632, 831 and 832 (winter), and CHEM 833 (spring). Prior to graduation, each student also will take two of the courses in the CHEM 94x-series from among those offered. CHEM 94x courses are variable special topics courses. For example, Computational Chemistry (CHEM 944) is offered almost every spring quarter, and advanced physical organic, bioorganic, or synthetic organic courses are offered almost every year. Students who enter with a Master's degree, and who pass the organic placement examination, may petition the Division for a waiver of part of the first-year course requirements (see page 2). Doctoral students must also take one chemistry course at the 600-level or above outside the area of organic chemistry. Students are advised to fulfill this requirement during their first year of enrollment.

First-Year Oral Examination

Students will take an oral examination during the first or second week of the summer term of their first year. The examination will last 60 minutes and the focal point of the examination will be a paper selected jointly by the student and his/her advisor. It is expected that the paper will be from organic chemistry literature that is related to the planned thesis research. The student will submit a copy of the paper to the committee (defined below) at least two weeks prior to the examination. The oral examination will start with a short presentation (5-10 minutes) by the

student, highlighting the salient features of the paper. The rest of the examination will be devoted to the student answering questions from the committee members and discussing the broader issues underlying the research described in the paper. The questions will be directed principally toward the topic of the paper, but some general questions may also be asked if the answer to these questions help the student address specific issues related to the paper. The advisor may attend the examination, but may not participate in questioning or assist the student in any manner. After the examination, the committee and the student's advisor will have a brief meeting to exchange impressions on the examination.

Within two working days of the last examination in the division, the committee will meet and assign a point value (1-5) to each student based on his/her overall performance on the oral exam and first-year (graduate) course work. A total of five (5) points will be required to proceed to the Ph.D. Candidacy Examination. The score assigned by the examination committee will determine whether each student should:

- (a) proceed directly to the Ph.D. program;
- (b) take cumulative examinations to make up the deficient points. These examinations will be offered on an announced date during October, November, January, February, April, and May. Students will be awarded 0.0, 0.5, or 1.0 point on each exam. The student will have six (6) chances to collect a total of five (5) points including those awarded by the first-year oral examination committee. Students who fail to obtain the five points by the end of the spring term of the second year will be asked to complete a terminal M.S. degree, except in rare cases when the division Faculty, in consultation with the student's advisor, determines that further graduate work is warranted. In that case, the student may petition the division to proceed to Ph. D., but only after obtaining the M. S. degree;
- (c) proceed to a terminal M.S. degree.

Within three working days of the last of the first-year oral examinations, the results will be communicated to the organic division secretary and the graduate office.

A single committee of current Faculty will administer the examination during a specific academic year. An alternate member will be appointed by the division secretary if the student's advisor is a member of the examination committee.

Candidacy Examination

The Candidacy Examination is initiated according to the guidelines on page 11, Section I of this document. There are two stages to the Candidacy Exam in the Organic Division. The first part is the completion of an original written research proposal that has been approved by the student's thesis committee. The second part is an oral examination that will probe the student's grasp of concepts in your written proposal as well as their understanding of general topics in chemistry, including progress in thesis research.

One of the requirements for admission to Ph.D. candidacy in Organic Chemistry is the successful defense of a research proposal and demonstration of research aptitude through accomplishments in the laboratory. Prior to setting the date of the examination, the student must submit an original research proposal for review and approval by the examination committee. When the proposal is approved, the student has passed the written portion of the Candidacy Examination and their advisor may then set a date for the oral examination. The student must also prepare a research summary and provide it to their committee at least one week prior to the date of the

oral examination. Students will prepare a 20 minute PowerPoint presentation of their proposal and should be able to describe their research project briefly on the board and with a few key slides, if necessary. The student should expect to be interrupted during their presentation by questions related to the proposal as well as general organic chemistry and questions that probe understanding of their own research project, including ideas for future directions and solutions to current problems in the lab. The student is free to consult with peers and with those members of the faculty who will not be serving on the student's examination committee in preparation for this exam.

The Ph.D. Candidacy Examination is evaluated based on academic and research ability. Defense of the proposal, performance with general questions, and demonstration of an understanding of the research project and research achievements will all be considered in the oral examination. Students may pass only part of the oral examination, and in certain situations, may be asked to repeat part of or all the exam. For example, if the student has suitably defended the proposal but has not made sufficient research progress or does not possess sufficient general knowledge, that student may be asked to repeat the research report and evaluation section of the oral portion of the Candidacy Examination after additional time spent in the lab. The timetable for reevaluation will be determined by the examination committee on a case-by-case basis, but should not extend beyond three months from the date of the original exam.

Seminar Presentation

After passing the candidacy exam, each student will present a one-hour seminar to the organic division, following the guidelines established by the division. In planning the seminar and prior to the presentation, the student should consult with the organic division faculty member in charge of student seminars during the term in which the seminar will be presented to obtain approval. This faculty member, in addition to helping the student with the technical aspects of the presentation, should make sure that the guidelines are followed. The responsible faculty member in consultation with other members of the division will assign a grade (S or U) for the seminar. If the performance is judged unsatisfactory, the student will be asked to repeat the presentation to available organic faculty members.

The focus of the seminar will be the student's Ph.D. thesis research project. The talk should last 45-50 minutes and the student may choose any of the standard formats for presentation, including presentation software such as PowerPoint, blackboards, or overheads. The first part of the talk (20-30 minutes) should include a thorough review of the literature with the goal of providing a meaningful context and global perspective for current and future work. The material gathered for this review should be appropriate for and may eventually be used as introductory sections of the student's thesis. For the remaining portion of the talk, a progress report on the student's research accomplishments should be presented. The student should distribute a concise and carefully worded abstract (1-2 pages) before the beginning of the seminar.

Sample Organic Chemistry Ph.D. Curriculum

| <u>First Year, AU</u> | <u>Hours</u> | <u>Second Year, AU</u> | <u>Hours</u> |
|---------------------------|--------------|------------------------|--------------|
| 730 Intermediate Organic | 3 | | |
| 731 Physical Organic I | 3 | 999 Research | 8(5) |
| Elective | 3 | 885 Colloquium | 1 |
| 885 Colloquium | 1 | Special Topics | (3) |
| 693 Faculty Presentations | 1 | | |

| <u>First Year, WI</u> | <u>Hours</u> | <u>Second Year, SP</u> | <u>Hours</u> |
|-------------------------|--------------|-----------------------------|--------------|
| 632 Spectroscopy | 3 | 999 Research | 8(5) |
| 831 Physical Organic II | 3 | 885 Colloquium | 1 |
| 832 Advanced Organic I | 3 | 942 Special Topics | (3) or |
| 885 Colloquium | 1 | 944 Computational Chemistry | (3) |
| 685 Safety Seminar | 2 | | |

| <u>First Year, SP</u> | <u>Hours</u> | <u>Second Year, SU</u> | <u>Hours</u> |
|-------------------------|--------------|------------------------|--------------|
| 833 Advanced Organic II | 3 | | |
| 885 Colloquium | 1 | 999 Research | 7 |
| 999 Research | 5 | | |

| <u>First Year, SU</u> | <u>Hours</u> |
|-----------------------|--------------|
| 999 Research | 7 |

All Subsequent Terms

| | |
|----------------|------|
| 999 Research | 8(2) |
| 885 Colloquium | 1(1) |

YEAR 2

Selected Special Topics: 941, 942, 943, 944 or other advanced courses approved by the Division; Take cumulative exams if needed; complete Candidacy Examination; thesis research; CHEM 885 each term

YEAR 3 & 4

Thesis Research, CHEM 885 each term; complete Candidacy Exam; present seminar.

E. PHYSICAL CHEMISTRY

The Ph.D. student in physical chemistry will normally take at least 18 hours of physical chemistry courses (775, 861/862/863, 876, and 880) plus at least 12 hours of electives as indicated in the sample curriculum.

Sample Physical Chemistry Ph.D. Curriculum

| <u>First Year, AU</u> | <u>Hours</u> | <u>Second Year, AU</u> | <u>Hours</u> |
|---------------------------|--------------|------------------------|--------------|
| 775 Thermo/Kinetics | 3 | Elective ^a | 3-5 |
| 861 Quantum Chemistry I | 3 | 999 Research | 5-3 |
| Elective ^a | 3 | 885 Colloquium | 1 |
| 885 Colloquium | 1 | | |
| 693 Faculty Presentations | 1 | | |

| <u>First Year, WI</u> | <u>Hours</u> | <u>Second Year, SP</u> | <u>Hours</u> |
|--------------------------|--------------|------------------------|--------------|
| 862 Quantum Chemistry II | 3 | Elective ^a | 0-5 |
| 876 Chemical Dynamics | 3 | 885 Colloquium | 1 |
| Elective ^a | 3 | 999 Research | 8-3 |
| 885 Colloquium | 1 | | |
| 685 Safety Seminar | 2 | | |

| <u>First Year, SP</u> | <u>Hours</u> | <u>Second Year, SU</u> | <u>Hours</u> |
|--------------------------------|--------------|------------------------|--------------|
| 863 Quantum Chemistry III | 3 | 999 Research | 7 |
| 880 Statistical Thermodynamics | 3 | | |
| Elective ^a | 3 | | |
| 885 Colloquium | 1 | | |

| <u>First Year, SU</u> | <u>Hours</u> |
|-----------------------|--------------|
| 999 Research | 7 |

^aUsual alternatives are: MATH 512 (3), 513 (3), 514 (3), 568 (3), 601 (5), 602 (5); CHEM 721, 730, 731, 751, 754, 866; PHYS 555 (4), 656 (4), 657 (5), 664 (4); Special topics courses in physical chemistry or fields related to physical chemistry, sometimes listed as Chemistry 694, may be taken as elective courses.

| <u>Third Year, AU</u> | | <u>Third Year, SP</u> | |
|-----------------------------|---|--------------------------------|---|
| Select Candidacy Exam Topic | | Oral Portion of Candidacy Exam | |
| 999 Research | 8 | 999 Research | 8 |
| 885 Colloquium | 1 | 885 Colloquium | 1 |

All Subsequent Terms

| | |
|----------------|---|
| 999 Research | 2 |
| 885 Colloquium | 1 |

The degree programs available to students in Physical Chemistry are M.S. and Ph.D.

While it is normally anticipated that the entering student will pursue the Ph.D. degree, in cases where the student performance has fallen below that necessary for continuing to the Ph.D., or so elects for personal reasons, the student may terminate his/her studies with the M.S. degree. The Graduate School of The Ohio State University automatically admits the student as a candidate in the M.S. degree program of the department to which the student applied. A student may be requested to obtain an M.S. before the Ph.D. degree, or may proceed directly to the Ph.D., depending on the best educational interests of the student.

M.S. Degree

In the M.S. program with thesis, the candidate must conduct independent research under the guidance of an advisor, prepare and present his/her thesis and demonstrate that it adds new knowledge to some area of chemistry. The candidate would complete 45 hours of course work in chemistry (600-level and above) including the following physical chemistry courses: CHEM 861, 862, 863, 775, and 880. Thesis work requires a minimum of 15 credit hours in CHEM 999. Students completing this program must write and defend a thesis according to the guidelines presented on page 7 of this document.

Ph.D. Degree

A student can qualify for admission to the Ph.D. Candidacy examination administered by the Physical Chemistry Division by satisfactory performance in their course work and on an oral exam offered during the summer term after the first academic year of graduate study.

First-Year Oral Exam

An oral exam will be offered to Physical Chemistry students, normally during weeks 3-6 of the summer term. Details concerning administration of the oral exam can be found starting on page 10 of this document. The topic of the exam is developed jointly by the student and his/her advisor and will be reflected by the choice of a research paper from the Physical Chemistry literature. It is expected that the paper will be related to the thesis research planned for the student. The student should submit a copy of the paper to the Physical division secretary at least two weeks in advance of the exam. The exam will be directed principally toward the topic, but some general physical chemistry questions may also be asked of the student if exploration of the topic touches upon broader issues. The student will receive feedback on his/her performance on the oral exam.

The oral examination committee will recommend one of the following options based on the student's performance in course work, the oral exam, and possible research activity to that point:

- (a) terminate graduate studies with an M.S. degree;
- (b) continue graduate studies by first completing an M.S. degree, followed by the Ph.D.;
- (c) proceed directly to the Ph.D. degree.

The terminal M.S. is invoked when the committee judges that doctoral work is not in the student's best interest. If progress toward the Ph.D. is recommended, the decision on whether to require an M.S. before the Ph.D. is based on all aspects of the student's activity to that point. The decision is made by considering that, for some students, it is helpful to have the smaller goal of an M.S. degree before the Ph.D. It is not exclusively linked to performance on the oral exam.

Candidacy Examination

The examination for admission to Ph.D. candidacy, consisting of written and oral portions, is given on an individual basis. The examination committee of 3 faculty members, at least 2 of which are from the Physical Chemistry Division, will be selected according to the procedures specified on page 11. The written portion is an original research proposition. The student chooses the topic, alone or with the advice of a faculty member. It may not be a research problem currently being pursued by the student or even a variation or modification of the student's current research. The topic may anticipate planned research directions. The topic must receive preliminary approval by the student's advisor and must concern a significant problem in physical chemistry. Subsequent to the advisor's approval, the topic in abstract form must be submitted for approval to the other 3 members of the exam committee, at least two of which are from the Physical Chemistry Division.

The written proposal must clearly define an original research problem and explain why its solution will be significant to the field of physical chemistry. It should be limited to 12 pages. It is suggested that it contain an abstract stating the research problem, 3-5 pages of background and motivation, and 5-6 pages of proposed research and analysis. The proposal must represent independent work of the student, although others, including faculty, may be consulted for technical or bibliographic advice. Following the exam committee's approval of the topic, the student will have 4 weeks to prepare and submit his/her proposal. Each member of the exam committee will submit a written critique of the proposal to the student and other members of the committee within 2 weeks of receiving the proposal. If the committee members judge that revisions of the proposal are necessary, the student must submit a revised version to each committee member within 3 weeks of receiving their critiques. Presentation of a final proposal, which is judged satisfactory by each member of the committee, will constitute successful completion of the written portion of the Candidacy Exam. If a second revision of the proposal is not acceptable to all the committee members, then the committee can declare that the student has failed the written portion of the General Exam, and recommend that the oral portion not be scheduled.

The oral portion of the Candidacy Exam is scheduled by the student and his/her advisor through the Graduate School. The committee will normally consist of the faculty who evaluated the written proposal, but substitutions may be made if necessary. The content of the oral examination will be directed toward the proposal, and to some general issues in the field of physical chemistry. Satisfactory performance will result in admission to candidacy for the Ph.D. degree. Failure may result in a second attempt on recommendation of the Candidacy Examination Committee, possibly requiring a new written proposal, no later than the second term following the first oral exam.