

The Ph.D. Program
in
Chemistry and Biochemistry
at
The University of Oklahoma

Fall 2015

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PREFACE

The Ph.D. degree is awarded for excellence in research and scholarship, not merely because a required program of courses has been completed or a given time has been spent in its pursuit. It signifies the acquisition of a thorough and comprehensive understanding of a research area as well as the attainment of a high level of professional independence and competence. The Graduate College of The University of Oklahoma normally grants a Ph.D. degree only to an individual who does not already hold the Ph.D. or a similar degree.

A student should normally expect to spend approximately five years beyond the bachelor's degree in the pursuit of the Ph.D. During this period of time, the student must: (1) successfully complete the appropriate coursework, (2) successfully complete the General Examination, and (3) submit and successfully defend the results of the original research that will be presented as a dissertation.

The purpose of this document is to describe the requirements for a student to be awarded the Ph.D. in the Department of Chemistry and Biochemistry. Individual topics will be discussed here in the approximate order that students will encounter them. Thus, the initial requirements will apply to every student, while later requirements will differ for the disciplinary Programs of Study within the Department.

It should be noted that the student must also completely and independently satisfy the requirements prescribed by the Graduate College at The University of Oklahoma. These requirements are given in the Graduate College Bulletin, which can be obtained from the Graduate College.

I. PLACEMENT EXAMINATIONS

The purpose of the placement examinations is to establish the proficiency level of new students in the core areas of Analytical Chemistry, Biochemistry, Inorganic Chemistry, Organic Chemistry, and Physical Chemistry. Because the results of these examinations will provide the basis upon which the Departmental Graduate Committee will advise the student with regard to initial graduate course work, the examination should specifically assess the new student's potential to succeed in the Introductory (5XYZ, Y = 0-2) courses that are offered that semester. It is important that the student recognizes the importance of these examinations and therefore prepares for them, so that the Graduate Committee has an accurate assessment of the strength of the student's background in various areas and hence can advise the student properly. A thorough preparation for these exams has the additional advantage of serving as a review of past coursework and therefore as a means to maximize one's ability to begin his/her graduate studies on a positive note. To this end, students will be given guidance for the placement examinations upon the department's receipt of their acceptance into our program.

II. ENGLISH LANGUAGE REQUIREMENTS

A. According to the Graduate College Bulletin, any graduate student for whom English is not the native language must be certified as proficient in English before s/he may assume teaching duties that require contact with students. The English Assessment Program administers certification tests in oral and written English.

B. All students for whom English is not the native language are required by the Department of Chemistry and Biochemistry to demonstrate a suitable level of English proficiency. This means that a student must reach the minimum level of "Certified to Support" in the English tests administered by the English Assessment Program of the university. Fulfilling this "Certified to Support" requirement is a prerequisite to the General Examination that should be satisfied by the end of the first semester. The "Certified to Instruct" level is required to qualify for regular teaching assistant duties.

III. COURSE REQUIREMENTS

A. Course Nomenclature

Graduate courses that are part of Programs of Study in the Department of Chemistry and Biochemistry are denoted as CHEM G5XYZ, where X is the program of study, Y is the sequence number within that Program of Study (for Y = 0-9), and Z is the number of credit hours as follows:

X = 0 Departmental Requirements

1 Analytical

2 Biochemistry

3 Inorganic

4 Organic

5 Physical

6 Chemical Education

7 Structural Biology

8 Unused at present

9 Interdisciplinary or custom program of study

Y = 0-2 Introductory Instruction (no graduate prerequisite)

3-5 Advanced Instruction (regularly-offered course(s), beyond the introduction, for majors)

6-7 Special Topics or Electives (one-time or irregularly offered courses}

8 Practicum

9 Seminar

Z = 0-4 Credit Hours (modules)

Within this numbering scheme, Graduate College-reserved course numbers are:

CHEM G5960 Directed Readings

CHEM G5980 Research for the Masters Thesis

CHEM G5990 Independent Studies

CHEM G6980 Research for the Doctoral Dissertation

B. Departmental Requirements

Every graduate student in their first semester are required to complete the S/U-graded Fundamentals Seminar (CHEM 5011), two credits of letter-graded Laboratory Rotations (CHEM 5080), and two letter-graded two-credit Introductory courses (CHEM 5XY0, Y = 0-2). With the permission of the Departmental Graduate Committee, well-prepared students may enroll in a third 5XY0 course (Y = 0-2) or through a petition process enroll immediately in advanced coursework. Graduate students in their second semester are required to complete the letter-graded Fundamentals Seminar (CHEM 5021). All graduate students must enroll and participate in the Departmental Colloquium (CHEM 5090) throughout the entire period of graduate study (excluding summers). In the first semester, graduate students are required to attend ten (10) seminars while enrolled in CHEM 5090. These seminars can be any combination of General Examination, Final Examination, CHEM 5X9Z (X ≠ 0 Program seminars), departmental, Karcher/Barton seminars, research group meetings or literature club discussions. All graduate students are required to attend all of the Karcher/Barton seminars.

Entering graduate students who show no Physical Chemistry on their transcript must take and pass a one credit hour Physical Chemistry course offered at the beginning of the fall term. Entering graduate students who have not taken one year of Organic Chemistry must take and pass one of CHEM

3053, CHEM 3153, and/or an Organic Chemistry proficiency exam. Undergraduate courses cannot be used to satisfy either the 16-hour requirements described above or the 90-hour total required for the doctoral degree.

C. Lecture Course Requirements

Every student must complete a minimum of sixteen (16) credit hours in letter-graded courses at the CHEM 5XYZ level (X = 1-9 and Y = 0-8). The coursework requirements for each of the Programs of Study are given in section XI. Not all of the coursework may be taken in one discipline (X = 1-7). At least four credit hours of graded coursework must be outside a major discipline (i.e., courses must be taken with at least two different X's). If more than three credit hours of lecture coursework are to be taken outside the Department of Chemistry and Biochemistry, prior approval must be given by both the student's Advisory Committee (see below) and the Departmental Graduate Committee. A minimum grade average of 3.0 (on a 4.0 scale) must be achieved for all approved coursework (X = 1-9 and Y = 0-8), with not more than four credit hours with a letter grade below B allowed. Failure to meet these requirements will result in the student being discontinued from the graduate program in Chemistry and Biochemistry.

D. Transfer Credit

Graduate lecture course credits obtained in other institutions may be transferred to fulfill some of the above requirements or the 90-hour total requirement (see Section F below). As a first step, the student should consult the regulations in the Graduate College Catalog that govern the acceptability of a course for transfer. To receive credit for each such course, the student should submit a written petition first to the faculty of the appropriate Program(s) of Study [X = 1-9; i.e., the one which reflects the nature of the course(s) being transferred], then to the Departmental Curriculum Committee, and finally to the Ph.D. Advisory Committee (see below). This should be done prior to the first Advisory Conference meeting (see Section V.A.). The faculty of the Program of Study and/or Advisory Committee also typically examines the textbook(s) and copies of exams taken by the student in the course in question in order to evaluate which OU course is equivalent to the course being transferred. If acceptable, each of these committees will in turn signify by placing a written and signed memo to that effect in the student's file in the Departmental office. Whenever possible, the corresponding University of Oklahoma course numbers should be clearly identified. The Advisory Committee and the Graduate Committee will recommend accepting course equivalency to replace some of the 16 required credits of graded lecture courses or to count the transferred credit against the 90 credit hours for graduation. The course(s) to be transferred should be incorporated into the Report of the Advisory Conference for final approval by the Graduate Dean.

E. Research Hours

Once enrolled in CHEM 6980 (Research for the Doctoral Dissertation), continuous enrollment (at least 2 hours per semester) is required. Also, a maximum of 9 hours of CHEM 5990 (Independent Studies) can be applied towards the 90-hour total (next section).

F. Total Number of Hours

A minimum of 90 total graduate-level, post-baccalaureate credit hours is required for the Ph.D. degree.

G. Petitions

A student with special circumstances may petition to receive an exception to any Ph. D. degree requirement(s) itemized in this document. Such a petition, submitted in writing, must be successively approved by the student's Ph.D. Advisory Committee (if appointed), the Graduate Committee of the Department, and, if appropriate, the Graduate College. The petition must clearly specify the exception requested, with detailed justification, and the modified requirement that will substitute for the original (e.g., different timetables or courses).

IV. RESEARCH

The demonstrated ability to perform original independent research is the single most important aspect of a graduate education in Chemistry and Biochemistry. This includes designing and conducting studies, evaluating the data collected/obtained, considering previously published work, and formulating and presenting valid conclusions. The Dissertation (see X below) represents the essential demonstration of this ability.

A. Choice of Laboratory Rotation Supervisor

To ensure that new students are fully informed about the research opportunities available in the Department, all graduate students entering in the fall semester are required to attend a series of short talks at the beginning of the semester in which each faculty member describes research projects that are under investigation in his/her lab. Attendance at these brief talks is mandatory, and attendance will be taken. In addition to the talks, a list of available laboratory rotation projects will be distributed. Students are encouraged to speak with prospective Laboratory Rotation Supervisors before submitting a prioritized list of selected projects to the Graduate Committee. The Graduate Committee will forward a recommendation to the Department Chair who will approve placement of each graduate student in two different rotation laboratories.

B. Choice of Major Research Advisor

Graduate students in our doctoral program should make an appointment with at least three prospective Major Research Advisors to discuss in more detail the nature of their research and the specific dissertation projects that are available. The faculty who are willing to serve as Major Research Advisors may or may not have participated in the Laboratory Rotations. Students are encouraged to have these individual meetings as soon as possible, since they must be completed well before the end of the first semester in Graduate School. At the conclusion of each meeting, the student should obtain the professor's signature on the form shown in Appendix A (updated annually to reflect current list of faculty). After obtaining a minimum of three signatures, the student must indicate his/her selected Program of Study and three preferences for a Major Research Advisor. It should be noted that the selected professors do not have to be formally affiliated with the chosen Program of Study or one of their Laboratory Rotation Supervisors. The list will be reviewed by the Graduate Committee, which will forward its recommendation to the Department Chair. Subject to the consent of the faculty member, the Department Chair (in consultations with Committee A) will make the assignment of the student to a Major Research Advisor (or co-Advisors) who will also serve as Chair (or co-Chairs) of that student's Graduate Advisory Committee. Major Research co-Advisors may be named when the desired program of study draws heavily on the expertise and guidance of more than one advisor. This process must be completed by the end of the first semester of enrollment. Until this process is finished, a student is not formally registered with a research advisor. Students entering in the spring semester are required to follow the procedures given above except those pertaining to the faculty talks.

C. Expectations.

The Ph. D. degree in Chemistry and Biochemistry is a research-based degree. Entering graduate student begin research work in their first semester while participating in two Laboratory Rotations (CHEM 5080). Intensive activity in the laboratory, including evaluating the relevant scientific literature, will provide a much more realistic context for the lectures and seminars in which the student will participate.

Research productivity is not measured by the total number of hours spent in the lab and/or studying of science, but by the demonstrable (i.e., publishable, or worthy of inclusion in a Dissertation) research accomplishments. This somewhat subtle distinction is sometimes overlooked or forgotten, and students may suddenly become aware that considerable time has gone by with little or no demonstrable progress. Consequently, it is important to recognize from the beginning that the amount of time spent in graduate school is dictated primarily by the student and by how disciplined his/her work habits are. It should also be noted that the time between semesters does not constitute vacation time, but rather an opportunity to make progress in research without the competing time demands of coursework and teaching responsibilities.

The progress in each graduate student's Program of Study is evaluated during each year of his or her enrollment in the graduate program in Chemistry and Biochemistry, including the first year. Such documentation will be incorporated into the Annual Progress Report (see section VI below) that is submitted each year in April.

Graduate students are expected to complete their doctoral degree requirements and dissertation by the end of their fifth year. It is recognized, however, that because of the intrinsic unpredictable nature of research, additional time may be required. The Department does not guarantee teaching assistant support after the first year, as research students are expected to be supported on faculty research grants or individual fellowships beginning their first summer.

D. Alterations in the Student's Major Research Advisor(s) and/or Program of Study

A student may change his or her Program of Study and/or Major Research Advisor(s). This would normally occur when the student's major research or career interests have changed. First, if the student seeks to change his/her Major Research Advisor(s), s/he must petition the departmental Graduate Committee and/or the Department Chair. Subject to the consent of the newly requested Research Advisor(s), the Department Chair, in consultation with Committee A, will make a change in the assignment of the Major Research Advisor(s).

If the student seeks to change his/her Program of Study, a plan for meeting the candidacy requirements of the new Program of Study must be approved by the student's Advisory Committee and the Departmental Graduate Committee. Documents noting the change and its final approval by the Department Chair, in consultation with Committee A, must be filed with the Graduate Program Assistant in the Department office. All of these steps must be completed before the change is considered official. The Report of the Advisory Conference, if on file in the Graduate College, must also be amended using the appropriate form.

V. THE ADVISORY COMMITTEE

The Advisory Committee consists of at least five graduate faculty members, including at least one member from outside the department. The members are normally selected by the student in consultation with his/her Major Research Advisor(s) who also serve as the Chair (or co-Chairs) of the student's Advisory Committee. There are four primary functions of this committee:

A. The Advisory Conference

Within the second semester of enrollment the student must arrange a meeting with his/her Advisory Committee to plan his/her graduate program. Note that by this time the student must have selected his/her Major Research Advisor(s) (Section IV) and a Program of Study. Prior to attending this meeting, the student should obtain the Report of the Advisory Conference form from the Graduate College, fill it out in consultation with his/her Major Research Advisor(s), and distribute a draft copy to each member of the Advisory Committee. Following the meeting, the Report of the Advisory Conference, amended as necessary, must be signed by all the members of the Advisory Committee and by the department Graduate Liaison. Any subsequent amendments of this report, including a change of committee member(s), require a completed Request for Change in Doctoral Advisory Conference Report form. These forms are also available in the Graduate College. For each form, the completed original must be filed in the Graduate College, and a copy must be filed in the Department Office. In consultation with his/her Advisory Committee, the student is strongly encouraged to develop an Individual Development Plan (IDP); by his/her second semester.

B. Preliminary and General Examination

The Advisory Committee will supervise the student's Preliminary and General Examination (Section VIII, IX).

C. Yearly Evaluation of Student Progress

Each year during the student's graduate career, the Advisory Committee will be responsible for evaluating the progress of the student and recommending appropriate courses of action based upon this progress (Section VI).

D. Preparation and Defense of the Dissertation

Although the Major Research Advisor(s) will be most closely involved in this process, the entire Advisory Committee is responsible for supervising the preparation and conducting the defense of the Ph.D. Dissertation (Section X).

VI. YEARLY EVALUATION OF GRADUATE STUDENTS

The performance of all graduate students will be reviewed annually to ensure that appropriate progress toward the degree is being achieved. The evaluation will initially be performed by the Advisory Committee at an annual meeting, arranged by the student and held prior to the end of the spring semester. The student will supply all the members with a research and general progress report one week prior to his/her advisory meeting. Based upon this material, the Major Research Advisor(s), on behalf of the Advisory Committee, will prepare a written evaluation to be signed by all committee members. If warranted by discussions during the advisory meetings, a modified evaluation will be written by the Major Research Advisor(s) and subsequently signed by all committee members. These documents must then be filed with the Graduate Program Assistant in the Department's main office to allow consideration by the Graduate Committee for continued enrollment in the Graduate Program and financial support (if applicable). In addition to evaluating the performance of the graduate student, the annual meeting is an opportune time to review, and if necessary, update the student's IDP. Based on these documents and any other pertinent information, the Departmental Graduate Committee will evaluate the progress of each student. The results of the evaluation will then be given to each student in writing. The Graduate Committee would normally classify the student's progress in one of the following categories:

1. The student's progress is satisfactory, and the student should continue with the Ph.D.

program.

2. The student's progress is marginal, and specific courses of action will be required to gain satisfactory standing.
3. The student's performance is such that they will be removed from the Ph.D. program.
4. The student's progress is such that they will be required to obtain an M.S. degree as a prerequisite to applying for re-entry into the Ph.D. program.
5. The student's progress is inadequate, and they will not be allowed to continue in the graduate program in the Department of Chemistry and Biochemistry.

VII. ACADEMIC MISCONDUCT

The Student Code specifies the responsibilities and conduct of students at OU, and it is the responsibility of each student to be familiar with the definitions, policies, and procedures concerning academic misconduct. The Student Code document is available from the Office of the Vice President for Student Affairs (<http://www.ou.edu/studentcode/OUStudentCode.pdf>). The definition of academic misconduct is as follows:

Academic misconduct includes (a) cheating (using unauthorized materials, information, or study aids in any academic exercise), plagiarism, falsification of records, unauthorized possession of examinations, intimidation, and any and all other actions that may improperly affect the evaluation of a student's academic performance or achievement; (b) assisting others in any such act; and (c) attempts to engage in such acts.

Of particular note for chemists and biochemists in training is the issue of citation, and it is important that Chemistry and Biochemistry students understand, before they write their research proposition and dissertation, that any facts, conclusions, or ideas that are extracted from another paper or source must be properly referenced back to their source. In addition, verbatim usage of another author's text—even when it is from within the same research group—must be placed in quotes with proper citation. Failure to do so constitutes plagiarism. Simply combining extensive quotes from existing sources without providing original organization and argumentation also constitutes plagiarism. Proper professional ethics demands proper citation in all papers and presentations.

VIII. PRELIMINARY EXAM

1. Purpose of Preliminary Exam: The Preliminary Exam is *not* another General Exam but is meant to assess the student's readiness for the General Exam. It will also aid the student in preparing for the General Exam. The examination will be based on the presentation and analysis of a research paper in the area of the student's research project. The student's Advisory Committee will examine each student on two primary areas:

- a. The student's competence on knowledge of the science in and relevant to the paper (i.e. the general area of their research project).
- b. The student's potential to succeed in the General Exam in the areas of critical thinking and oral communication.

2. Topic Selection, Scheduling and Committee composition: An oral examination will be conducted by faculty of the student's Advisory Committee (see 2c below) no later than the end of the third semester from the time he/she entered the program.

- a. The student and his/her Major Research Advisor(s) will choose two or more papers from which the Advisory Committee will select one on which the student will be examined.
- b. The papers must be submitted to the Advisory Committee no later than the 6th week of the semester (Fall and Spring only). The Advisory Committee will notify the student of their choice within one week.
- c. *At least three* members of the Advisory Committee must be present for the exam to proceed. These members must include the student's Major Research Advisor(s) and two other Chemistry and Biochemistry faculty.
- d. Students are encouraged to submit their papers to their Advisory Committee and schedule their Preliminary Exams early in the semester.

3. Preliminary Exam Format: The exam will comprise of a short (~20 minutes) oral presentation on the paper that summarizes and analyzes key results and identifies its importance to the field, followed by addressing questions posed by the faculty related to, but not limited to, the paper (see #4 below). For scheduling purposes the student should allow at least two (2) hours for the oral presentation and subsequent question /answer period.

4. Preparation for Preliminary Exam: Students should prepare by reading and understanding the paper they present. They should also read relevant papers that are cited in their primary paper (e.g., reviews, important preliminary communications, important papers by competitors, etc.). Students should demonstrate knowledge and a critical understanding of fundamental chemical principles, concepts and methods. The oral presentation should be prepared in the manner of a scientific talk (e.g., PowerPoint, Keynote, etc.). Students should understand and be able to explain all experimental details in the paper (i.e., spectroscopic techniques, synthetic methods, etc.).

5. There will be three possible outcomes of the exam:

- a. **Pass;** advance to the General Exam.
- b. **Deferred;** the student was found deficient in one or more aspect of the exam and will address the deficiency according to a plan of action determined by the Advisory Committee.
- c. **Fail;** the student will leave the Ph.D. program. The student may continue in the Master's program.

If the Advisory Committee vote on the outcome of the exam is tied (Pass/Deferred or Deferred/Fail), the result of the exam shall be a "Deferred" decision.

IX. GENERAL EXAMINATION

The purpose of the general examination is to determine the competence of the student in the following areas:

Knowledge of the fundamental concepts and of the current status of understanding in one

of the Programs of Study in Chemistry and Biochemistry;
Ability to conduct independent, original research;
Ability to learn independently, i.e., to effectively teach oneself;
Ability to think independently, i.e., critically apply acquired knowledge to new chemical and biochemical problems.

The student's Advisory Committee is responsible for administering the General Examination. The research proposition is common to the General Examination in each Program of Study and offers the Advisory Committee the opportunity to evaluate the student's ability to design an original cogent, creative, and organized research project. Thus, the student must effectively present a scientific rationale in both a written and an oral format. As a consequence, the ability to communicate in unambiguous English is a necessary, but not sufficient, requirement for receiving a passing grade. A secondary objective is to acquaint the student with the appropriate procedures required to apply for federal grant funds or to justify a proposed industrial project. Thus, the written portion of the research proposition must follow the guidelines for a proposal to either the National Institutes of Health (NIH) or the National Science Foundation (NSF).

The semester following completion of the Preliminary Exam the student will submit proposal topic(s) in the form of abstracts to each of the faculty members of his/her Advisory Committee. The abstract(s) should define the objectives, state the significance/importance of the proposed study, briefly outline the plan for solving the problem, and cite key reference. If the topic(s) are not satisfactory to the members of the Advisory Committee, the student will be given a second and final opportunity to submit new/revised topic(s). Following the meeting at which the proposal topic is chosen, the student must within six weeks complete a research proposal following the guidelines for either the U.S. National Institutes of Health (NIH) or the U.S. National Science Foundation (NSF) and arrange a date, time and place to conduct an oral defense of the proposal such that all members of the Advisory Committee can attend. The student must obtain an Application for General Examination form from the Graduate College prior to the oral defense of the Research Proposition. This form must be signed by all members of the Advisory Committee and by the Departmental Graduate Liaison, and then it must be filed in the Graduate College (with a copy filed in the Department Office) at least **two weeks before** the oral defense is to be held. The Advisory Committee Chair should bring a copy of the Report of General Examination, obtained from the Graduate College, to the oral defense. The Advisory Committee Chair will return this Report, filled out and signed, to the Graduate Dean within 72 hours following the oral defense with a copy being sent to the Department Office. According to Graduate College regulations, students who fail their initial General Examination may, with the approval of the Advisory Committee, request a second opportunity to fulfill this requirement the following term. Students requesting a second examination must complete that examination within the first four weeks of the following term.

X. Ph.D. DISSERTATION

Following completion of the General Examination, the student normally concentrates upon original research that will make a contribution to existing knowledge, and, in the process, demonstrates both a mastery of the research methods and tools of the appropriate field and also the ability to address a significant problem and arrive at a successful conclusion. In consultation with the Major Research Professor, this process culminates in the writing of the Ph.D. Dissertation. Instructions for the format of the Dissertation are obtained from the Graduate College. Following preliminary acceptance by the Major Research Professor and at least two weeks before the Dissertation and Final Oral Defense, a reading copy must be submitted, along with a 350-word abstract, to the Advisory Committee members and the Graduate College. At that time, the student also arranges a date, time, and place for the

Dissertation Defense and the Final Oral exam so that all members of the Advisory Committee can attend. The Final Oral Examination will require the candidate to demonstrate the expected depth of critical knowledge of the subject area through a presentation of major portions of the dissertation research in a public seminar followed by questioning by the Advisory Committee and the public. For the Dissertation Defense aspect, the candidate must answer questions that pertain to the key aims and advances of the work described, the methodology used in the work, the critical analysis of the supported conclusions and the structure and organization of the dissertation itself. The Report of the Final Oral Examination, obtained from the Graduate College and brought to the exam by the student, must be completed and returned to the Graduate Dean within 72 hours following the completion of this process. Deadlines for these requirements, which are coupled to the date of graduation, are given in the current class schedule for each semester and summer session. The successful student must deposit one (1) unbound final copy to the Graduate College, and submit the thesis electronically on the SHAREOK website as instructed in the Graduate College Bulletin according to the deadlines of the Graduate College.

In addition to the above, the student must be enrolled in at least two graduate credit hours at OU in the semester that the dissertation is defended. Also, the student must complete the following by the specified deadlines to graduate at the desired time:

1. Pay graduating fee in Bursar's Office (the deadlines are specified in the University Class Schedule).
2. Obtain from the Graduate College a dissertation topic card and a Survey of Earned Doctorate form. Each of these, appropriately filled out, along with the signed library card obtained when the three final copies of the Dissertation are given to the Library, should be filed in the Graduate College as soon as possible following the Final Oral Examination.

XI. PROGRAM REQUIREMENTS

The required coursework for Graduate Programs in the Department of Chemistry and Biochemistry is listed for each discipline. For each Program of Study a minimum of 16 credit hours of graded courses including at least four credit hours of breadth courses is required.

A. ANALYTICAL PROGRAM

1. Course Requirements. In addition to the general requirements of Section IIIB, three core courses (CHEM 5100, 5110 and 5120 for a minimum total of 6 credit hours) and special topics courses (CHEM 5160 and/or 5170) are required for a minimum total of 10 credit hours of CHEM 51Y0 coursework. In addition, at least two breadth courses CHEM 5XY0 ($X \neq 0$ or 1 and $Y = 0-8$) for a minimum total of 4 credit hours are required. A minimum total of 16 credit hours of CHEM 5XY0 ($X \neq 0$ and $Y = 0-8$) are required. Within these parameters, the Advisory Committee for each student will determine the exact distribution of these courses.

2. Seminar Requirement. Continuous enrollment and satisfactory participation in CHEM 5191 during every regular semester following the first semester.

3. Preliminary Examination. See section VIII.

4. General Examination. See section IX.

B. BIOCHEMISTRY PROGRAM

1. Course Requirements. In addition to the general requirements of Section IIIB, three core courses (CHEM 5200, 5210, and 5240 for a minimum of 6 credit hours), approved special topics courses (CHEM 52Y0, Y = 6-7 for a minimum of 6 credit hours), and courses to satisfy the breadth requirement (CHEM 5XY0, X ≠ 0 or 2 and Y = 0-8 for a minimum of 4 credit hours) for a minimum total of 16 credit hours of CHEM 5XY0 (X ≠ 0 and Y = 0-8). For special topics courses, 4 of the 6 credit hours are required to be in biochemistry or a related field. Within these parameters, the Advisory Committee for each student will determine the exact distribution of these courses.

2. Seminar Requirement. Continuous enrollment and satisfactory participation in CHEM 5291 during every regular semester following the first semester.

3. Preliminary Examination. See section VIII.

4. General Examination. See section IX.

C. CHEMICAL EDUCATION PROGRAM

1. Course Requirements

a. *Chemistry:* Sixteen credit hours of graduate level course work in chemistry. The specific course requirements will be the same as that required for one of the disciplinary Programs of Study in Chemistry and Biochemistry. There will also be a minimum of 9 credit hour research requirement in Chemistry.

b. *Science Education, Statistics and History of Science:* There will be a 12 credit hour requirement in science education (EDSC 5513, 5523, 5543 and 3 credit hours of science education in research methods; EDSC 5532, 5533, or readings concentrating on research methods and curriculum development techniques used in science education), a 6 credit hour requirement in psychological statistics (EPT 5023 and 6023, or PSY 5003 and 5013), and a 6 credit hour requirement in the history of science (HSCI 3013 and 3023).

2. Seminar Requirement. The student must meet the seminar requirements of the disciplinary Program of Study in which s/he has chosen to affiliate.

3. Preliminary Examination. See section VIII.

4. General Examination. See section IX.

5. Dissertation Research. For students who did not write a Masters thesis in Chemistry and Biochemistry, the dissertation requirement is met by one of two options. Option I would consist of a report on chemical research and a dissertation in chemical education. Option II would consist of a report of research in chemical education and a dissertation in chemistry. For those who have written a Masters thesis, which meets the approval of the student's committee, the dissertation would focus on chemical education.

D. INORGANIC PROGRAM

1. Course Requirements. In addition to the general requirements of Section IIIB, two core courses (CHEM 5300 and 5330) and a frontiers course (CHEM 5360) are required for a minimum total of 8 credit hours of CHEM 53Y0 (Y = 0-8) coursework. In addition, at least two breadth courses CHEM 5XY0 (X \neq 0 or 3 and Y = 0-8) for a minimum total of 4 credit hours are required. A minimum total of 16 credit hours of CHEM 5XY0 (X \neq 0 and Y = 0-8) are required. Within these parameters, the Advisory Committee for each student will determine the exact distribution of these courses.

2. Seminar Requirement. Continuous enrollment and satisfactory participation in CHEM 5391 during every regular semester following the first semester.

3. Preliminary Examination. See section VIII.

4. General Examination. See section IX.

E. ORGANIC PROGRAM

1. Course Requirements. In addition to the general requirements of Section IIIB, the following coursework is required: Two core organic disciplinary courses (CHEM 5400 and 5430 for a minimum of 2 credits hours each) and elective courses (CHEM 5450, 5460, 5470 and/or 5480) are required for a minimum total of 8 credit hours of CHEM 54Y0 coursework. In addition, at least two breadth courses CHEM 5XY0 (X \neq 0 or 4 and Y = 0-8) for a minimum total of 4 credit hours are required. A minimum total of 16 credit hours of CHEM 5XY0 (X \neq 0 and Y = 0-8) are required. Within these parameters, the Advisory Committee for each student will determine the exact distribution of these courses.

2. Seminar Requirement. Continuous enrollment and satisfactory participation in CHEM 5491 during every regular semester following the first semester.

3. Preliminary Examination. See section VIII.

4. General Examination. See section IX.

F. PHYSICAL PROGRAM

1. Course Requirements. In addition to the general requirements of Section IIIB, two core courses (CHEM 5500 and CHEM 5530 for a total of 6 credit hours) and approved special topics courses (CHEM 5510, 5520, 5540, 5550, 5560, or 5570 for a minimum of 4 credit hours) are required for a minimum total of 10 credit hours of CHEM 55Y0 coursework. Two breadth courses CHEM 5XY0 (X \neq 0 or 5 and Y = 0-8) for a minimum total of 4 credit hours are required. Students entering the program in the fall semester should complete CHEM 5500 in the fall, followed by CHEM 5530 in the spring of the following calendar year. For students entering the program in the spring semester, the two core courses should be completed by the end of the third semester (excluding Summer). A minimum total of 16 credit hours of CHEM 5XY0 (X \neq 0 and Y = 0-8) are required. Within these parameters, the Advisory Committee for each student will determine the exact distribution of these courses.

2. Seminar Requirement. Continuous enrollment and satisfactory participation in CHEM 5591 during every regular semester following the first semester.

3. Preliminary Examination. See section VIII.

4. General Examination. See section IX.

G. STRUCTURAL BIOLOGY PROGRAM

1. Course Requirements. In addition to the general requirements of Section IIIB, CHEM 5210 for 2 credit hours, four core courses (CHEM 5730, 5740, 5750, and 5780 for a minimum of 7 credit hours), approved special topics courses (CHEM 5XY0, $X \neq 0$ and $Y = 6-7$ for a minimum of 3 credit hours), and courses to satisfy the breadth requirement (CHEM 5XY0, $X \neq 0$ or 7 and $Y = 0-7$ for a minimum of 4 credit hours). A minimum total of 16 credit hours of CHEM 5XY0 ($X \neq 0$ and $Y = 0-8$) are required. Within these parameters, the Advisory Committee for each student will determine the exact distribution of these courses.

2. Seminar Requirement. Continuous enrollment and satisfactory participation in CHEM 5X91 ($X = 2$ or 7) during every regular semester following the first semester.

3. Preliminary Examination. See section VIII.

4. General Examination. See section IX.

H. INTER- AND/OR MULTIDISCIPLINARY PROGRAM

1. Course Requirements. In addition to the general requirements of Section IIIB (which includes at least 4 credit hours of Introductory courses CHEM 5XY0 with at least two different $X = 1-9$ and $Y = 0-2$), at least two core courses (CHEM 5XY0, $X \neq 0$ and $Y = 3-5$, for a minimum of 4 credit hours), and approved special topics courses (CHEM 5XY0, $X \neq 0$ and $Y = 6-7$ for a minimum of 4 credit hours). A minimum total of 16 credit hours of CHEM 5XY0 ($X \neq 0$ and $Y = 0-8$) are required. Within these parameters, the Advisory Committee for each student will determine the exact distribution of these courses. Programs of Study and changes to Programs of Study for students in the Multidisciplinary Program must be approved by the Graduate Committee in consultation with the Curriculum Committee.

2. Seminar Requirement. Continuous enrollment and satisfactory participation in one or more seminars (CHEM 5X91) is required during every regular semester following the first semester.

3. Preliminary Examination. See section VIII.

4. General Examination. See section IX.