CHEMISTRY AND BIOCHEMISTRY

Office: F.W. Olin Hall, Room 202
Mail Code: 2190 E. Iliff Ave., Denver, CO 80208
Phone: 303-871-2436
Email: cheminfo@du.edu
Web Site: http://www.chemistry.du.edu

Why study chemistry at the University of Denver?
Consider the advantages:

• Excellent, research-active faculty
• Small classes, personal attention
• First-rate teaching facilities
• Modern, state-of-the-art equipment

At the University of Denver, we offer the training and amenities to energize your graduate experience and help you develop into a professional scientist.

The Department of Chemistry and Biochemistry at the University of Denver offers programs leading to MA, MS or PhD degree in chemistry.

Our faculty members actively involve students in research programs supported with more than $1.5 million in annual funding from federal agencies, state governments and private industries. In our programs, you will enjoy the benefits of a friendly, personalized learning environment that offers nationally competitive and extremely productive research opportunities.

The Department of Chemistry and Biochemistry has much to offer a graduate student: close and frequent student-faculty interaction; an integrated program of courses; and excellent equipment and facilities including 500 MHz NMR, single-crystal X-ray diffraction, multiple EPR spectrometers, ICP-mass spectrometer, photon counting lifetime fluorescence, nanosecond laser flash photolysis, aerosol particle monitoring spectrometer, and fluorescence microscopy.

Faculty research interests encompass biophysical, organic, analytical and environmental chemistry and biochemistry. The department’s relatively small size allows a broader, more interdisciplinary approach than in large departments. Our instructional format merges traditional disciplines into interdisciplinary courses that more closely reflect current trends in chemistry.

Master of Science in Chemistry, Doctor of philosophy in chemistry
Following are the simple steps to apply for graduate study in Chemistry and Biochemistry at the University of Denver. If you have any questions about the process, please contact the Office of Graduate Studies (http://www.du.edu/learn/graduates).

Apply Online / Application Deadlines
• Applications for graduate study in Chemistry and Biochemistry at the University of Denver must be submitted online. Apply online (https://gradadmissions.du.edu/apply).
• All online materials must be received, and all supplemental materials including transcripts must be on file in the Office of Graduate Studies, by the program’s stated deadline: March 1. The programs admit for fall quarter only. After the March 1 deadline, applications may be considered on a rolling basis for fall admission until positions are filled.
• A $65 non-refundable application fee is required for an application to be processed. Application fee waivers are available for McNair Scholars.

Course and Degree Prerequisites and Requirements
• Applicants must earn and submit proof of earning the equivalent of a baccalaureate degree in chemistry, biochemistry or a related field from a regionally accredited institution prior to beginning graduate coursework at DU.

Transcripts (http://bulletin.du.edu/graduate/admissions/admissionprocessandstandardsforallapplicants/#text)
• Applicants are required to submit an official transcript from each post-secondary institution they have attended, or are presently attending, where two quarter hours (or one semester hour) or more were completed including study abroad and college coursework completed in high school.
• The applicant is responsible for obtaining all transcripts. Applicants who have earned a degree outside the U.S. must submit transcripts accompanied by certified English translations, if not normally issued in English. DU students and alumni do not need to provide DU transcripts.
• Official study abroad transcripts are required unless the course titles, grades and credit earned abroad appear on another transcript. Transcripts from outside of the U.S. are evaluated by the Office of International Student Admission. This process can take three to four weeks and must be complete by the program’s stated deadline. Therefore, applicants with a degree from outside of the U.S. are encouraged to apply early. Applicants educated outside the U.S. are encouraged to contact the Office of Graduate Studies for assistance regarding transcript-related materials.
• The University of Denver will consider electronic transcripts official from a domestic institution provided by the following approved agencies: Army/American Council on Education Registry Transcript System (AARTS); Docufide/Parchment; National Student Clearinghouse; Naviance; Royall and Company; and, Scrip-Safe.
• Mail official transcripts to
  University of Denver
  Office of Graduate Studies
  Mary Reed Building, Room 5
  2199 S. University Blvd.
  Denver, CO 80208-4802

  Electronic transcripts should be sent to gradinfo@du.edu.

Language Proficiency (http://bulletin.du.edu/graduate/admissions/additionalstandardsfornonnativeenglishspeakers)
  • Official scores from the Test of English as a Foreign Language (TOEFL) or International English Language Testing System (IELTS) are required of all graduate applicants, regardless of citizenship status, whose native language is not English or who have been educated in countries where English is not the native language. Applications will not be processed until the required TOEFL or IELTS score is received. The TOEFL and IELTS scores are valid for two years from the test date. The minimum TOEFL score accepted by the University is 80 (iBT) or 550 (paper-based). The institution code for the University of Denver is 4842. The minimum IELTS score accepted by the University is 6.0. Graduate Teaching Assistants (GTAs) must demonstrate fluency in spoken English by scoring a 26 on the TOEFL speaking section or 8.0 on the IELTS speaking section. Please see the Graduate Policy Manual for complete English language proficiency requirements.
  • Applicants may be exempted from English proficiency test requirements if by the time of matriculation they have earned a post-secondary degree from a formally-recognized/accredited university where the language of instruction and examination is English. Such applicants may be exempt from the TOEFL/IELTS requirement but not from other standardized graduate entrance examinations. There are no exemptions for graduate teaching assistants.
  • Students whose native language is not English and who are required to submit TOEFL/IELTS scores will be assessed by the University of Denver English Language Center (ELC) prior to matriculation.

Test Scores
  • The Graduate Record Examination (GRE) is required. Scores must be received directly from the appropriate testing agency by the program’s stated deadline. The institution code for the University of Denver is 4842.

Personal Statement
  • A personal statement of at least 300 words is required. The statement should include information concerning your life, education, practical experience, special interests and specific purpose for applying to the University of Denver. Describe your goals for attending graduate school. What areas of chemistry or biochemistry are you most interested in? What do you hope to do after you complete your graduate studies? Why do you enjoy chemistry or biochemistry? Describe any research or teaching experience you have had. Have you been involved in an undergraduate research project during the academic year or in the summer? Have you had a summer job or internship in a commercial lab? Have you had experience in teaching as a grader, a lab teaching assistant or a lab preparatory assistant? Share anything in your personal statement that you believe will help evaluate your application. The statement should be submitted via upload through the online application process.

Resume / C.V.
  • A resume or C.V. is required. This should include work experience, research, and/or volunteer work. This should be submitted via upload through the online application process.

Recommendation Letters
  • Three letters of recommendation are required. Letters should be solicited and uploaded by recommenders through the online application system. Requests for letters should be sent to recommenders well in advance so the letters are on file by the application deadline.

Financial Support
  • To be considered for financial support, domestic applicants should apply early and submit the Free Application for Federal Student Aid (FAFSA) by the priority deadline; February 15. Information about financial aid can be found on the Office of Financial Aid Website (http://www.du.edu/financialaid/graduate). International students are not eligible for federal financial aid.
  • Chemistry and biochemistry students are provided financial support as teaching assistants or research assistants. Assistantship positions provide a full tuition waiver and a 12-month stipend of $23,333 for new master’s students and $26,600 for doctoral students for the 2016-2017 academic year. Non-native English speakers must demonstrate fluency in spoken English by scoring a 26 on the TOEFL speaking section or 8.0 on the IELTS speaking section to receive a graduate teaching assistantship.

Application Status
  • We encourage you to be actively engaged in the admission process. You can check your application status online (https://gradadmissions.du.edu/apply). Applicants will receive login information post application submission.
Contact Information

- Mail official transcripts and any supplemental admission materials not submitted with the online application to:
  University of Denver
  Office of Graduate Studies
  Mary Reed Building, Room 5
  2199 S. University Blvd.
  Denver, CO 80208-4802

- Electronic transcripts should be sent to gradinfo@du.edu.
- For more information call (303) 871-2706.

International Applicants

- For complete international applicant information, please visit the Office of Graduate Studies International Student Application Information (http://www.du.edu/learn/graduates/internationalapplicants.html). International applicants are strongly encouraged to have their applications complete, with all materials on file in the admission office, at least eight weeks prior to the program’s application deadline.

The Graduate Policies and Procedures provides complete details regarding admission requirements.

Doctor of Philosophy in Chemistry

The PhD is the highest degree awarded and is intended for students seeking a career in scientific research. The ultimate aim of this degree is to train a scientist who can independently pursue a research project. To facilitate the educational process, each student has an advisory committee that functions to both advise the student and monitor the student’s progress.

Degree Requirements

Coursework Requirements

Required Courses

<table>
<thead>
<tr>
<th>Chemical systems (three-quarter sequence)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 3110 Chemical Systems I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 3120 Chemical Systems II</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 3130 Chemical Systems III</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Molecular structure and energetics (two-quarter sequence)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 3310 Structure and Energetics I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 3320 Structure and Energetics II</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Biochemistry (two-quarter sequence)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 3811 Biochemistry-Proteins</td>
<td>3</td>
</tr>
<tr>
<td>or CHEM 3831 Advanced Protein Biochemistry</td>
<td></td>
</tr>
<tr>
<td>CHEM 3812 Biochemistry-Membranes/Metabolism</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analytical</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 3220 Advanced Analytical Chemistry</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Seminar</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 4900 Chemistry Seminar</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Independent research (repeats allowed)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 4995 Independent Research</td>
<td>1-10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Additional Coursework</th>
<th>55-64</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced topics</td>
<td></td>
</tr>
<tr>
<td>CHEM 4XXX or others if pre-approved by the graduate committee</td>
<td></td>
</tr>
</tbody>
</table>

Total Credits 90

Minimum credits required for degree: 90

A total of 90 quarter hours (of which a minimum of 75 hours must be earned at the University of Denver). Because a PhD in chemistry is primarily a degree in which competence in research is learned and demonstrated, a large percentage of these hours are earned as credit for research (CHEM 4995 Independent Research). A minimum of 70 graduate level quarter hours must be in CHEM courses; a maximum of 20 quarter hours may be outside of CHEM courses, but must remain within natural sciences (e.g., courses with BIOL, MATH, GEOG and/or PHYS prefixes). The formal or classroom course requirements are the same as those for the MS degree.

The graduate core curriculum must be completed with a GPA of 3.0 or better.
Non-coursework Requirements

• Qualifying Examinations

All students in the PhD program are required to take a qualifying examination at the end of the spring quarter in their first academic year. This examination covers the material presented in the core curriculum, with each course contributing 100 points. To qualify for continuance in the program, the student must score at least 500 (out of 800 points). The faculty will meet to discuss exam results and decide whether the candidate will continue in the PhD program.

• Cumulative Examinations

The PhD candidate must complete the cumulative examination requirement by the seventh quarter in residence. These examinations are prepared from topics appearing in the current literature and fundamental materials found in review articles.

• Proposition Oral Examination

By the end of the eighth quarter in residence, the student should give an oral presentation of an original research proposal in an area of his/her choice. This proposal will usually focus on the student’s chosen sub-discipline and should not be too closely related to any ongoing research in the department. After the public presentation, the student will defend the proposal before a committee of five faculty members (the advisory committee and two additional members).

• Dissertation

A dissertation of publishable quality based on the student’s original research must be completed. A summary of the dissertation is presented in a public seminar and later defended in a private oral examination. The dissertation examination committee will consist of the three members of the student’s advisory committee, one additional member of the chemistry faculty to be selected by the advisory committee and an outside chair.

• Seminars

All students in the PhD program are expected to present a departmental “non-thesis” seminar (CHEM 4900 Chemistry Seminar). This seminar should be presented fairly early in the degree program. In addition, the student must present public seminars as part of the proposition oral exam and final thesis defense.

Doctor of Philosophy in Molecular and Cellular Biophysics

Molecular and Cellular Biophysics is an interdepartmental PhD degree program at the University of Denver.

See the molecular and cellular biophysics bulletin (http://bulletin.du.edu/graduate/schoolscollegesanddivisions/divisionofnaturalscienceandmathematics/naturalsciencesgeneral/#programofstudytext) for more specific details.

MASTER OF ARTS IN CHEMISTRY

The MA degree is intended primarily to meet the needs of students, such as those working full time in local industry or secondary education, who are seeking an advance degree with only a small research component. The primary difference between the MA degree and the MS degree is that a research thesis is required for the MS degree. The research required for the MS degree is often not feasible for students who work full time or is not of interest to those preparing for a career, for example, in secondary education. To facilitate the educational process, each student has an advisory committee that functions to both advise the student and monitor the student’s progress.

Degree Requirements

Coursework Requirements

<table>
<thead>
<tr>
<th>Coursework Requirements</th>
<th>Required Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical systems (three-quarter sequence)</td>
<td>CHEM 3110 Chemical Systems I 3</td>
</tr>
<tr>
<td></td>
<td>CHEM 3120 Chemical Systems II 3</td>
</tr>
<tr>
<td></td>
<td>CHEM 3130 Chemical Systems III 3</td>
</tr>
<tr>
<td>Molecular structure and energetics (two-quarter sequence)</td>
<td>CHEM 3310 Structure and Energetics I 3</td>
</tr>
<tr>
<td></td>
<td>CHEM 3320 Structure and Energetics II 3</td>
</tr>
<tr>
<td>Biochemistry (two-quarter sequence)</td>
<td>CHEM 3811 Biochemistry-Proteins 3</td>
</tr>
<tr>
<td></td>
<td>or CHEM 3831 Advanced Protein Biochemistry</td>
</tr>
<tr>
<td></td>
<td>CHEM 3812 Biochemistry-Membranes/Metabolism 3</td>
</tr>
<tr>
<td>Analytical</td>
<td></td>
</tr>
</tbody>
</table>
### Chemistry and Biochemistry

**CHEM 3220**  
Advanced Analytical Chemistry  
3

**Seminar**  
CHEM 4900  
Chemistry Seminar  
1

**Independent study or independent research (repeats allowed)**  
CHEM 4991  
Independent Study  
6

**CHEM 4995**  
Independent Research  
6

**Additional Coursework**  
One advanced topic course or additional research credits  
14

**CHEM 4XXX or others if pre-approved by the graduate committee**  
Total Credits  
45

**Minimum credits required for degree:** 45 (of which a minimum of 35 credit hours must be earned at the University of Denver)

The graduate core curriculum must be completed with a GPA of 3.0 or better. If it is appropriate, and approved by the graduate committee, other graduate courses may be substituted for part of the graduate core curriculum.

**Independent Study and/or Research**

A minimum of six credit hours of independent study and/or independent research approved by the student’s advisory committee must be completed.

**Courses in Other Departments**

A minimum of 35 credit hours must be taken in courses offered by the Department of Chemistry and Biochemistry. As many as 10 credit hours may be taken in science-related 3000- to 4000- graduate level courses approved by the student’s advisory committee.

### Seminars

All students in the MA degree program must present a technical seminar (CHEM 4900 Chemistry Seminar).

### MASTER OF SCIENCE IN CHEMISTRY

The MS degree is intended for students who wish an advanced degree in chemistry primarily for the purpose of better preparation to conduct research work in chemistry or biochemistry. To facilitate the educational process, each student has an advisory committee that functions to both advise the student and monitor the student’s progress. In general, students serve as teaching assistants during their first year. For subsequent years, they are supported as either teaching assistants or research assistants, depending on the circumstances. Tuition charges are waived for all graduate teaching and research assistants.

### Degree Requirements

**Coursework Requirements**

**Required Courses**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 3110</td>
<td>Chemical Systems I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 3120</td>
<td>Chemical Systems II</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 3130</td>
<td>Chemical Systems III</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 3310</td>
<td>Molecular structure and energetics I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 3320</td>
<td>Molecular structure and energetics II</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 3811</td>
<td>Biochemistry-Proteins</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 3831</td>
<td>Advanced Protein Biochemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 3812</td>
<td>Biochemistry-Membranes/Metabolism</td>
<td>3</td>
</tr>
</tbody>
</table>

**Biochemistry (two-quarter sequence)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 4900</td>
<td>Chemistry Seminar</td>
<td>1</td>
</tr>
</tbody>
</table>

**Independent research (repeats allowed)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 4995</td>
<td>Independent Research</td>
<td>1-10</td>
</tr>
</tbody>
</table>

**Additional Coursework**

Advanced topics or additional research

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 4XXX</td>
<td>or others if pre-approved by the graduate committee</td>
<td>10-19</td>
</tr>
</tbody>
</table>

**Total Credits**  
45
Minimum credits required for degree: 45 (of which a minimum of 35 credit hours must be earned at the University of Denver)
The graduate core curriculum must be completed with a GPA of 3.0 or better.

Seminars
All students in the MS program must present one departmental “non-thesis” seminar (CHEM 4900 Chemistry Seminar), in addition to the thesis seminar.

Non-coursework Requirements
Thesis- A thesis of publishable quality must be completed. A summary of the thesis is presented in an oral defense. The thesis defense committee will consist of a minimum of two faculty members from the Department of Chemistry and Biochemistry and an outside chair.

Courses
CHEM 3110 Chemical Systems I (3 Credits)
Advanced discussion of modern concepts of organic chemistry; bonding, stereochemistry, reaction mechanisms. Prerequisites: CHEM 2453 and equivalent of one year of physical chemistry.

CHEM 3120 Chemical Systems II (3 Credits)
Interpretation of trends in the chemistry of the elements in terms of orbital interactions. Most examples will be taken from the third row transition metals and the boron and carbon groups. Prerequisites: CHEM 2131, CHEM 3310 and CHEM 3110.

CHEM 3130 Chemical Systems III (3 Credits)
Advanced-level physical biochemistry course intended for advanced-level undergraduates and graduate students. Focuses on kinetic, thermodynamic and dynamic aspects of biopolymers; delineates the relationship of these properties to the mechanism and function of biological macromolecules. Prerequisites: CHEM 3811, CHEM 3812, CHEM 3813, CHEM 3610 or the equivalent.

CHEM 3220 Advanced Analytical Chemistry (3 Credits)
Principles of chemical instrumentation applied to analytical measurements; principles, instrumentation and applications of spectrometric and chromatographic measurements. Prerequisites: CHEM 3210 and CHEM 3621, or the equivalent.

CHEM 3310 Structure and Energetics I (3 Credits)
Fundamentals of quantum chemistry, and introduction to symmetry and molecular structure of small and large systems. Prerequisite: one year of physical chemistry.

CHEM 3320 Structure and Energetics II (3 Credits)
Computational methods in chemistry. Prerequisites: CHEM 3310, one year of physical chemistry.

CHEM 3410 Atmospheric Chemistry (3 Credits)
The concepts of equilibrium thermodynamics, kinetics, and photochemistry will be applied to understanding atmospheric processes. Covers urban air pollution in detail with focus on primary pollutants. Also covers stratospheric chemistry with focus on ozone chemistry and the chemistry of climate change. Prerequisites: CHEM 2270 and CHEM 2453.

CHEM 3411 Aquatic Chemistry (3 Credits)
The circulation of the oceans and their chemical make-up. 'Classical water pollution problems' like biological oxygen demand and turbidity are discussed. Also presented: aquifer structure and flow, ground water chemistry, pollutant partitioning between stationary and mobile phases, heterogeneous surface chemistry, and the detection of trace contaminants. Prerequisites: CHEM 2270 and CHEM 2453.

CHEM 3412 Environmental Chemistry & Toxicology (3 Credits)
A survey of environmental toxicology concepts: animal testing, dose-response data, epidemiology, risk assessment. The course includes ecotoxicology, focusing on the alteration of biological and chemical systems beyond the simple response of an individual to an environmental chemical. Prerequisites: CHEM 2270 and CHEM 2453.

CHEM 3610 Physical Chemistry I (3 Credits)
Fundamentals of thermodynamics, including phase and reaction equilibria, properties of solutions, and electrochemistry needed for advanced study in life sciences and for Physical Chemistry II and III. May be taken for graduate credit by nonchemistry majors. Prerequisites: CHEM 2453, calculus and physics.

CHEM 3620 Physical Chemistry II (3 Credits)
Fundamentals of quantum chemistry, including theories of atomic and molecular structure and spectroscopy. May be taken for graduate credit by nonchemistry majors. Prerequisite: CHEM 3610.

CHEM 3621 Physical Chemistry III (3 Credits)
Fundamentals of kinetic theory and statistical mechanics. May be taken for graduate credit by nonchemistry majors. Prerequisite: CHEM 3620.

CHEM 3703 Topics in Organic Chemistry (3 Credits)
May include organic photochemistry, organic synthesis, organic electrochemistry or natural products. May be repeated for credit. Prerequisites: CHEM 2453 or equivalent and others depending on topic.

CHEM 3705 Topics in Biochemistry (3,4 Credits)
May include physical techniques for exploring biological structure, biological catalysis, and selected fields within biochemistry taught from original literature. May be repeated for credit. Prerequisites: CHEM 3811, CHEM 3812, CHEM 3813.
CHEM 3811 Biochemistry-Proteins (3 Credits)
Protein structure and function, starting with the building blocks and forces that drive the formation of protein structure and the basic concepts of protein structure, and continuing with enzyme catalysis, kinetics, and regulation. Prerequisites: CHEM 2453 or instructor permission.

CHEM 3812 Biochemistry-Membranes/Metabolism (3 Credits)
Membranes and membrane mediated cellular processes, energy and signal transduction, and metabolic/biosynthetic pathways. Prerequisite: CHEM 3811.

CHEM 3813 Biochemistry-Nucleic Acids (3 Credits)
Molecular processes underlying heredity, gene expression and gene regulation in prokaryotes and eukaryotes. Prerequisite: CHEM 2453.

CHEM 3831 Advanced Protein Biochemistry (3 Credits)
This course provides fundamental insights into the chemistry and physics of proteins. It investigates how amino acids form proteins with highly complex three-dimensional structures and how these structures mediate function. We examine key research articles and their contribution to our current understanding of proteins. Topics range from protein folding to enzyme kinetics and emphasize basic principles. Prerequisites: CHEM 2453 and instructor permission.

CHEM 3991 Independent Study (1-10 Credits)
May be repeated for credit.

CHEM 3992 Directed Study (1-10 Credits)

CHEM 3995 Research in Chemistry (1-10 Credits)
Research project conducted under guidance of a faculty member. Credit hours and projects arranged on an individual basis. May be repeated for credit.

CHEM 4400 Adv. Topics: Organic Chemistry (3 Credits)
Physical organic chemistry; reaction mechanisms, structure reactivity relationships, kinetics, photochemistry, molecular orbital theory, etc.; current literature. May be taken for credit more than once.

CHEM 4900 Chemistry Seminar (1 Credit)
A weekly presentations of research in progress and of current literature by outside speakers. faculty and graduate students.

CHEM 4991 Independent Study (1-10 Credits)

CHEM 4992 Directed Study (1-10 Credits)

CHEM 4995 Independent Research (1-10 Credits)

CHEM 5991 Independent Study (1-10 Credits)

CHEM 5995 Independent Research (1-10 Credits)