CHEMISTRY PH.D.

All students must meet the Requirements for the Doctor of Philosophy Degree

OVERVIEW

A Ph.D. degree in chemistry prepares students for careers in chemical sciences and related disciplines including biomedical sciences, biotechnology, catalysis, energy, environment, materials science, or nanotechnology. Individuals having earned a Ph.D. in chemistry at UVM have gone on to careers in academics, the chemical industry, and national research laboratories. Graduate study at UVM is research intensive, and a description of research by classic chemical subdivision follows.

Analytical chemistry involves developing and applying instrumentation and chemical methods to solve problems across a range of chemistries and scientific disciplines. One focus is in electroanalytical chemistry studying redox processes of organometallic compounds, including electrocatalysis relevant to the environmental and biological applications. Another area focuses on the development of innovative methods and instruments to study the formation and chemistry of organic aerosols in the atmosphere. This work bridges the gap between analytical chemistry and atmospheric science, contributing to the understanding of the impact of aerosols on global climate through direct scattering of solar radiation and the formation of ice and water clouds. The third area develops mass spectrometry instrumentation and chemistries for addressing current problems in the biomedical sciences. Key foci are development of methods for advancing the rapidly growing field of proteomics and application of stable isotopically labeled tracers to answer questions of metabolism and metabolic diseases in humans.

Inorganic chemistry at UVM involves the study of main-group elements and transition metals in a variety of contexts, with applications in catalysis, energy, environment, and medicine. One example is the synthesis and characterization of inorganic particles, which can be functionalized for broad applications in heterogeneous catalysis, targeted drug delivery, and biological imaging. Another area of interest is spectroscopic and biochemical studies of metalloproteins, with the goal of using a detailed understanding of their structures to explain reaction patterns. Finally, a third example is the design of metal-based catalysts for chemical bond formation, which can be applied to the preparation of useful small molecules and novel polymeric materials.

Current research in organic chemistry includes the development of novel synthetic methodologies to prepare oxygen- and nitrogen-containing heterocyclic compounds, new ring fragmentation reactions and their applications in synthesis, development of efficient and stereoselective tandem/cascade reaction sequences, target-directed total synthesis of medicinally valuable natural products including macrolides, alkaloids, and terpenoids, biomimetic natural product synthesis, mechanistic studies of organic chemical reactions, development of 1,3-diaza-Claisen rearrangements and applications toward the synthesis of guanidine-containing natural products, and studies in bioorganic chemistry.

Physical chemistry research areas include three major areas of focus. The first is thermodynamics/kinetics of hydrogen absorption by metals, alloys, and intermetallic compounds with a view toward storage of hydrogen as a fuel. The second is utilization of TGA, IR, solid-state NMR, and powder X-ray diffraction in determining the structural features of layered zirconium phosphonates containing a mix of chromophores as pendant groups in the interlayer region. Subsequently, photophysics of the interlayer chromophores is explored via UV-vis and fluorescence spectroscopy. Third is the development of Co-59 NMR as a probe of metal tetrapyrrole electronic structure and using NMR/MCD spectroscopies to elucidate tetrapyrrole-containing enzyme binding sites.

SPECIFIC REQUIREMENTS

Requirements for Admission to Graduate Studies for the Degree of Doctor of Philosophy

An undergraduate major in an appropriate field, minimally with course work in the four classic subdisciplines of chemistry (analytical, inorganic, organic, and physical). This is most commonly satisfied with a B.A., B.S., or equivalent degree in chemistry. Applicants with prior research experience are preferred. Satisfactory scores on the Graduate Record Examination general (aptitude) section is required.

Minimum Degree Requirements

In addition to the above requirements a student must:

- Complete a doctoral research project, write an acceptable dissertation, and defend it
- Present a total of 75 hours of credit in course work and dissertation research
- Make an oral and written presentation of an original research proposal, CHEM 488 , typically in the first semester of the third year

Comprehensive Examination

In the Chemistry Department, the Comprehensive Examination for the Doctorate degree consists of completion of the following three parts:

(1) Passing of the (entrance) qualifying-examinations requirement within the first year, and successful completion of the coursework requirement. The qualifying examinations establish a broad knowledge base in all major areas of chemistry, while the latter requirement is constructed to add breadth to the students' knowledge base in specific areas of chemistry not directly related to their research area.

(2) Successful completion of the Advancement to Candidacy exam (CHEM 484). This course consists of the preparation of an end-of-second-year, 15-page dossier of research accomplishments, and an

oral examination on its contents, which serves as a comprehensive review of the student's fundamental understanding of chemistry.

(3) Completion of a total of three (3) credits of Current Topics (CHEM 318). This course consists of a review of one major article from the current literature (and supporting supplementary articles). The oral presentation is followed by an examination of the student's understanding of the crucial information in that paper by faculty in the student's major area.

Requirements for Advancement to Candidacy for the Degree of Doctor of Philosophy

It is expected that a student will ordinarily complete the following requirements for admission to candidacy by the end of the second year of residence:

At least fifteen credits of research (CHEM 491)		15
CHEM 318	Current Topics in Chemistry (Must be taken three times)	1
CHEM 380	Chemical Investigations	1
CHEM 381	Grad Seminar	1
CHEM 484	Advanced Topics in Chemistry (present and defend proposed dissertation topic)	2
Demonstration of basic competence in four fields of chemistry (analytical, inorganic, organic, and physical) through the biannual qualifying examinations or completion of prescribed courses at the University of Vermont		
Three credits of teaching		3
One year of residence		
At least 15 credits of formal course work including:		15
Six credits of graduate level courses in the chemical field of specialization		
Nine credits of graduate-level chemistry courses not in the area of specialization		
Maintenance of an overall grade point average of 3.00		