Chemistry (M.S.)

About The Program:

The Chemistry graduate program is designed to provide a solid background in the chosen area of specialization. It emphasizes the acquisition of skills that enable students to gain further knowledge in their research and professional careers. For this reason, the Chemistry graduate degree program is research oriented, and seminar attendance and familiarization with the chemical literature are considered integral. The course requirements are comparatively light, although a wide variety of intermediate and advanced courses in related areas are offered. Students are encouraged to take courses in related areas, such as Biology, Computer Science, and Physics, according to their research interests.

Career Options: The majority of students find employment in the chemical industry. Some go on to academic positions or positions in government laboratories.

Prerequisites for Admission: Background in Chemistry, Biochemistry, or a related field.

Areas of Specialization: The Department of Chemistry offers programs leading to the M.S. and Ph.D. degrees in Analytical Chemistry, Biochemistry, Inorganic Chemistry, Organic Chemistry, and Physical Chemistry. Areas of specialization include environmental chemistry, materials and polymers, medicinal, nanoscience, photonics, and surface science. For the master's program, two options are offered:

- Thesis Track, which is designed for students who are not full-time. Students cannot receive financial support from the Chemistry Department when completing this option. Any student wanting to pursue this option must receive prior approval from the Graduate Committee.
- Coursework Track, which is designed for students who already have extensive experience in the laboratory and are currently employed in the local chemical industry. Students must obtain permission from the Graduate Committee to pursue this option.

Requirements of Programs:

- **Total Credit Hours**: 30
- **Culminating Events**:
  Thesis:
  The M.S. thesis is the culminating event for the Thesis Track. The thesis should be an original piece of research. Often, but not always, the research described in the M.S. thesis can be published in a peer-reviewed journal. The student coordinates the time for the defense with her/his Graduate Advisory Committee, which is responsible for evaluating the thesis and its defense. No thesis should go to defense unless it is ready for public scrutiny.
  Master's Examination:
  The master's examination is usually the last requirement to be fulfilled by students in the Coursework Track. Its purpose is to demonstrate a breadth and depth of knowledge in the core concepts of Chemistry. The exam is based on the student's major track in Chemistry. Faculty

members in the student's track write the questions for the master's exam. The faculty members who write the questions grade the exam. Students schedule the exam though the Graduate Secretary.

Required Courses (Thesis Track)

Six formal lecture courses (18 credits)

Literature seminar (2 credits)

An approved graduate course and/or research course (4 credits)

Master's Thesis Research – Course for master's thesis research. Only intended for students in thesis bearing master's programs. A minimum of one credit is required. This course will confer full-time status at the minimum credit hour registration limit of one credit.

Required Courses (Coursework Track)

Ten formal lecture courses (Worth 30 Credits)

In consultation with an academic advisor, students select coursework from the following approved courses:

Advanced Inorganic Chemistry I – Group theory and its applications to chemical systems. Molecular orbital theory and spectroscopy. Descriptive chemistry of transition metal and organometallic compounds.

Data Analysis and Evidence – Forensic chemistry involves the forensic application of analytical chemistry theories, techniques and instrumentation to the analysis of controlled substances, fire debris evidence, explosives, and other trace evidence/chemical unknown materials. This course will cover those concepts relevant to the field of forensic chemistry including chain of custody, the theory and practical applications of the uncertainty of measurement and propagation of error. Students will also learn the classifications and unique physical and chemical characteristics of forensic chemistry evidence and investigate the physical and chemical characteristics of this evidence through the use of chemical, microscopic and instrumental techniques. The chemical characteristics of explosive materials as well as the analytical techniques used to analyze these samples will also be covered.

Advanced Instrumental Methods – Recent developments in electrochemical and electroanalytical techniques, including voltammetric and potentiostatic procedures and the basics of instrumental design. Applications to organic chemistry, trace analysis, chromatographic detectors, and electrokinetics discussed.

Drug Analysis

Investigative Chemistry

Physical Methods in Organic Chemistry – Principles and applications of important physical and spectroscopic methods; IR, UV, NMR, MS, ESR, ORD, and CD in structure determination.

Organic Reaction Mechanisms – This course is an introductory overview of organic structure and most common organic reaction mechanisms.

Organic Syntheses – Scope and limitations of modern synthetic methods, including silicon reagents, organometallic and radical chemistry.

Quantum Chemistry – Introduction to quantum mechanics and its application to chemical systems.

Statistical Thermodynamics – The basic concept of statistical mechanical ensembles and their application.

Nanomaterials Chemistry and Physics – This course will cover the key chemical/physical properties of nanomaterials as well as nanomaterials characterization and synthesis for graduate students. The goal of this class is to help students get familiar to the important concepts associated with the confined dimensionality in nanomaterials and apply these concepts to understand unique electronic/optical properties of nanomaterials and the thermodynamics/kinetics of forming nanomaterials. The course is organized with four modules: 1) Introduction to Nanoscience - Physical and Chemical Concepts, 2) Characterization of Materials at Nanoscale, 3) Fabrication of Nanostructures and Nanomaterials, and 4) Case Study of Specific Nanomaterials.

Chemical Kinetics – A study of the dynamics of chemical reactions.

Cellular/Molecular Neuroscience

Biochemistry I – A survey of the biological macromolecules (proteins, nucleic acids, carbohydrates, and lipids) correlating their structures with their chemical properties and biological functions.

Structural Bioinformatics II – This course provides an introduction to structural bioinformatics, with focus on understanding three dimensional structures of biological macromolecules. Topics covered include: an overview of macromolecular structure determination, introduction to molecular modeling theory and the application of computational modelling in structure based drug design. The course also offers practical training on the application of molecular modelling methods for understanding structural biology and in rational drug discovery.

Advanced Polymer Structure and Properties – Polymers are ubiquitous in many new (scaffolds for tissue engineering, hip replacements) and old (textiles, engineering resins, flocculants) applications, and are often used in composites with inorganic materials. In order to better understand the use and novel developments of polymers, this course will provide the fundamentals of synthesis, polymer structure/property relationships, and characterization methods.

Teaching of Chemistry

Special Topics in Inorganic Chemistry – A survey of a topic chosen by the instructor. Topics could include bioinorganic chemistry, organometallic chemistry, solid state and materials chemistry, and catalysis.

Leadership, Law and Ethics in Forensic Science – This course will provide the students with an introduction to the American criminal justice system, explain the role of the forensic scientist in the

criminal justice system, and discuss theoretical and practical applications of forensic science laboratory management. Students will learn successful leadership styles and discuss topics relating to ethical behavior, quality measures including quality control and quality assurance, communication and privacy issues relating to forensic science as well as resource management. Through discussion and analysis of the U.S. Constitution, the Pennsylvania Constitution, Federal (and State) Rules of Criminal Procedure, and Federal (and State) Rules of Evidence with particular emphasis on case law, students will develop a practical understanding of modern criminal jurisprudence. Special emphasis and consideration will be given to the ethical obligations of criminal justice practitioners, including judges, prosecutors, defense attorneys, law enforcement officers and expert witnesses.

Advanced Forensic Chemistry – Forensic chemistry involves the forensic application of analytical chemistry theories, techniques and instrumentation to the analysis of controlled substances, fire debris evidence, explosives, and other trace evidence/chemical unknown materials. This course will cover those concepts relevant to the field of forensic chemistry including chain of custody, the theory and practical applications of the uncertainty of measurement and propagation of error. Students will also learn the classifications and unique physical and chemical characteristics of forensic chemistry evidence and investigate the physical and chemical characteristics of this evidence through the use of chemical, microscopic and instrumental techniques. The chemical characteristics of explosive materials as well as the analytical techniques used to analyze these samples will also be covered.

Special Topics in Organic Chemistry – Advanced lecture course; subject matter varies from semester to semester.

The Chemistry of Natural Products – Biogenetic classification, classical and modern synthetic approaches to polyketides, steroids, terpenes, and alkaloids.

Heterocyclic Chemistry

Special Topics in Organic Chemistry

Special Topics in Physical Chemistry

Molecular Spectroscopy – Absorption, emission and scattering of light by molecular system. Discussion of basic principles and experimental techniques.

Computational Chemistry

Modern Meth in Exp Chem

Special Topics in Analytical Chemistry

Special Topics in Biochemistry

Bioinorganic Chemistry

High Polymer Chemistry – Introduction to the important theoretical and practical aspects of high polymer chemistry.

Analytical Separations – Theory and practice of modern separation methods with emphasis on chromatographic and electrophoretic techniques.

Teaching in Higher Ed:Phys Sci – Teaching in Higher Education: Physical Sciences. This course focuses on learning theory and the best teaching practices, with the aim of preparing students for effective higher education teaching.

Seminar in Physical Chemistry

Seminar in Forensic Chemistry – Wide-ranging introduction to key areas and "hot topics" in forensic science, as presented by a series of guest lectures by leading practitioners in the field.

Courses:

Click HERE for more information on the courses below.

- Advanced Inorganic Chemistry I
- Organometallic Chemistry
- Data Analysis and Evidence
- Advanced Instrumental Methods
- Drug Analysis
- Investigative Chemistry
- Physical Methods in Organic Chemistry
- Organic Reaction Mechanisms
- Organic Syntheses
- Quantum Chemistry
- Statistical Thermodynamics
- Nanomaterials Chemistry and Physics
- Chemical Kinetics
- Cellular/Molecular Neuroscience
- Biochemistry I
- Chemical Biology
- Structural Bioinformatics II
- Advanced Polymer Structure and Properties
- Teaching of Chemistry
- Responsibility and Ethics in Chemical Research
- Special Topics in Inorganic Chemistry
- Leadership, Law and Ethics in Forensic Science
- Advanced Forensic Chemistry
- Special Topics in Organic Chemistry
- The Chemistry of Natural Products
- Heterocyclic Chemistry
- Special Topics in Organic Chemistry
- Special Topics in Physical Chemistry
- Molecular Spectroscopy
- Computational Chemistry
- Modern Meth in Exp Chem
- Special Topics in Analytical Chemistry
- Special Topics in Biochemistry
- Bioinorganic Chemistry
- High Polymer Chemistry
- Analytical Separations
- Teaching in Higher Ed:Phys Sci
- Seminar in Physical Chemistry
- Seminar in Forensic Chemistry
- Master's Research Projects
- Preliminary Examination Preparation
- Capstone Project
- Master's Thesis Research