# CHEMISTRY AND BIOCHEMISTRY

The Department of Chemistry provides graduate students in our MS and PhD programs a unique atmosphere, with state of the art instrumentation, accomplished professors, and motivated researchers. Much of the current research transcends traditional boundaries to include fields such as surface chemistry of organic electronic materials, quantifying physiological processes via synthesis of optical probes, applied information theory to thermodynamic systems, and metal analysis in retina causing cataract development. Weekly seminars and the annual Denkewalter Lecture (https://www.luc.edu/chemistry/events/denkewalterlecture/), which brings the winner of either the American Chemical Society's Pure Chemistry or Eli Lilly awards (https://www.acs.org/content/acs/en/funding/technical-divisions.html) to campus, provide opportunities to learn about recent advances from respected academic and industrial scientists.

## Graduate Programs

- Chemistry (MS) (https://catalog.luc.edu/graduate-professional/graduate-school/arts-sciences/chemistry-biochemistry/chemistry-ms/)
- Chemistry (PhD) (https://catalog.luc.edu/graduate-professional/graduate-school/arts-sciences/chemistry-biochemistry/chemistry-phd/)

## Chemistry (CHEM)

**CHEM 400 Chemistry Seminar (1 Credit Hour)**
This weekly seminar series on current topics in Chemistry is presented by experts from outside Loyola.

**CHEM 401 Chemistry Methodology and Communication (3 Credit Hours)**
*Pre-requisites:* Graduate Standing
This is the common preparatory course providing all chemistry graduate students with the necessary skills to navigate towards their respective degrees and success post-degree. Topics include: notebooks, design of experiment, safety, ethics, effective communication of science, conflict resolution, and professional conduct.
*Outcomes:*
Students are prepared with the soft skills and formal training in research methodology and compliance expectations expected of a graduate student and a professional chemist in a senior role

**CHEM 415 Special Topics in Chemistry (3 Credit Hours)**
Specific titles and contents vary from semester to semester.

**CHEM 420 Advanced Organic Chemistry I: Struct-Stereo (3 Credit Hours)**
Important organic chemical concepts. Includes discussion of the stereochemistry of carbon, organic quantum mechanics, chemical kinetics and related mechanistic concepts, and an introduction to synthetic methodology.

**CHEM 422 Advanced Organic Chemistry III: Mechanism (3 Credit Hours)**
This is an intensive review of the more general types of organic chemical mechanisms, such as electrophilic and nucleophilic additions, substitution reactions, elimination processes, and hemolytic processes. The experimental approach to mechanisms is emphasized.

**CHEM 423 Medicinal Chemistry (3 Credit Hours)**
This course explores how medicinal chemists design and synthesize new drug candidates as well as the hurdles that must be overcome in meeting the FDA requirements of efficacy and safety on the road to market, emphasizing the therapeutic index that underscores the risk/benefit consideration of every drug.
*Outcomes:*
1) Explain risk/benefit of drugs in efficacy vs. toxicity and the therapeutic index/window; 2) Summarize interactions of drugs with receptors, enzymes, or nucleotides; 3) Analyze structure-activity relationships given potency data

**CHEM 424 Molecular Characterization Part A (3 Credit Hours)**
*Pre-requisites:* Graduate Students Only
This course will include a closer look at the theory and applications of several spectroscopic methods used for analysis of organic as well as inorganic compounds, including 1D and 2D methods employing 1H and 13C NMR, in addition to other elements; UV/Vis, combined with mass spectrometry.
*Outcomes:*
Students will be able to identify a compounds molecular structure based of spectroscopic means and understand the working principles behind those spectroscopies

**CHEM 425 Special Topics in Organic Chemistry (3 Credit Hours)**
Specific titles and contents vary from semester to semester. Some courses are: natural products, free radicals, molecular rearrangements, photochemistry, heteronuclear NMR, carbocyclic chemistry, medicinal chemistry, synthetic organic methodology, pericyclic reactions, heterocycles.

**CHEM 429 Research in Organic Chemistry (1-9 Credit Hours)**
Laboratory. Specific content varies on consultation with a faculty sponsor.

**CHEM 430 Physical Chemical Survey (3 Credit Hours)**
*Pre-requisites:* calculus and undergraduate physical chemistry
Covers chemical thermodynamics, molecular structure and spectra, and chemical kinetics. It includes review and survey of some recent research.

**CHEM 431 Chemical Thermodynamics (3 Credit Hours)**
*Pre-requisites:* calculus and undergraduate physical chemistry
An extended study of the principles of the thermodynamic laws followed by applications to real and ideal systems of gases, liquids, and solids; partial molal properties; principles and applications of quantum statistical thermodynamics to gaseous equilibria

**CHEM 433 Chemical Kinetics (3 Credit Hours)**
*Pre-requisites:* calculus and undergraduate physical chemistry
Description of rates of chemical reactions and interpretations thereof; principal theories of bimolecular and unimolecular processes; chain reactions; development of absolute reaction rate theory and application to a number of chemical systems; potential energy surfaces; includes heterogeneous kinetics, solution phenomena, isotopic effects, flow systems, empirical kinetic relations.

**CHEM 435 Special Topics in Physical Chemistry (3 Credit Hours)**
Specific titles and contents vary from semester to semester. Some courses are NMR spectroscopy, photophysical processes, molecular spectroscopy, computational chemistry, molecular modeling, and spectroscopy of surfaces.

**CHEM 436 Statistical Thermo Dynamics (3 Credit Hours)**
Methods of classical and quantum statistical mechanics applied to thermodynamic problems; calculation of thermodynamic quantities from spectral data; properties of real gases; selected problems in the solid sate.

**CHEM 437 Quantum Mechanics I (3 Credit Hours)**
*Pre-requisites:* CHEM 302 or equivalent; strong courses in calculus and modern physical chemistry, and some knowledge of computer programming
A thorough introduction to elementary quantum chemistry: angular momentum, quantum mechanical operators, interaction of radiation with matter, the many-electron atom, introduction to matrix mechanics, approximate methods, SCF calculations, electronic structure of polyatomic molecules, recent molecular orbital calculations.

**CHEM 438 Quantum Mechanics II (3 Credit Hours)**
*Pre-requisites:* CHEM 437
This course is a continuation of CHEM 437, which is a thorough introduction to elementary quantum chemistry: angular momentum, quantum mechanical operators, interaction of radiation with matter, the many-electron atom, introduction to matrix mechanics, approximate methods, SCF calculations, electronic structure of polyatomic molecules, recent molecular orbital calculations.

**CHEM 439 Research in Physical Chemistry (1-9 Credit Hours)**
Laboratory. Specific content varies on consultation with a faculty sponsor.

**CHEM 441 Advanced Inorganic Chemistry (3 Credit Hours)**
The important topics in inorganic and organometallic chemistry are surveyed.

**CHEM 445 Special Topics in Inorganic Chemistry (3 Credit Hours)**
Specific titles and contents vary from semester to semester. Some courses are organometallic chemistry and catalysis, bioinorganic chemistry, physical methods in inorganic chemistry, inorganic reaction mechanisms, non-metal chemistry, transition metal clusters and X-ray crystallography.

**CHEM 449 Research in Inorganic Chemistry (1-9 Credit Hours)**
Laboratory. Specific content varies on consultation with a faculty sponsor.

**CHEM 451 Chemical Methods of Analysis (3 Credit Hours)**
Topics covered include the statistical evaluation of analytical results and sources of errors, sampling and significance of proper samples, optimization of experiments, review of acid-base theory, chelometry and its applications, theory of precipitation, oxidation and reduction reactions and applications.

**CHEM 452 Electrochemistry (3 Credit Hours)**
Fundamentals of electrochemistry, the application of electrochemical techniques and current literature.

**CHEM 454 Analytical Separations (3 Credit Hours)**
Topics include aspects of chromatography, partition, thin layer, gas and liquid chromatography, mass spectroscopy and other techniques.

**CHEM 455 Special Topics in Analytical Chemistry (3 Credit Hours)**
Specific titles and contents vary from semester to semester. This course may involve a lab. Some courses are analytical absorption and emission spectroscopy, electroanalytical methods, environmental chemistry, lasers in analytical spectroscopy, and mass spectroscopy.

**CHEM 456 Analytical Spectroscopy (3 Credit Hours)**
We will discuss photometric instrumentation, absorption, emission and fluorescence spectroscopy and types of analytical laser spectroscopy.

**CHEM 459 Research in Analytical Chemistry (1-9 Credit Hours)**
Laboratory. Specific content varies on consultation with a faculty sponsor.

**CHEM 460 Biophysical Chemistry (3 Credit Hours)**
This class will cover the role of molecular interactions in determining the structure and reactivity of complex biological molecules. Modern experimental techniques are used in studying these interactions in biological systems.

**CHEM 461 Biochemistry (3 Credit Hours)**
The conformation, dynamics and biological activities of macromolecules, generation and storage of metabolic energy, and genetic information and biosynthesis will be discussed.

**CHEM 465 Special Topics in Biochemistry (3 Credit Hours)**
Specific titles and contents vary from semester to semester. Some courses are protein chemistry, sequence and 3D structure, magnetic resonance spectroscopy, protein crystallography, bio-inorganic chemistry, molecular biology, molecular dynamics of proteins, and current developments in biochemistry and related areas.

**CHEM 469 Research in Biochemistry (1-9 Credit Hours)**
Laboratory. Specific content varies on consultation with a faculty sponsor.

**CHEM 470 Biochemistry I (3 Credit Hours)**
*Pre-requisites:* Completion of undergraduate organic chemistry
This is the first part of a two-semester Biochemistry series that emphasizes important biochemical concepts on the structure and function of proteins, enzymes, carbohydrates, lipids and cell membranes as well as on the bioenergetic and regulatory principles behind the central and carbohydrate pathways.
*Course equivalencies:* X- CHEM 370/CHEM 470
*Outcomes:*
Students will be able to demonstrate and understanding of structural-functional relationships in biological molecules and how carbohydrates are metabolized

**CHEM 479 Research in Chemical Education (1-9 Credit Hours)**
*Co-requisites:* RMTD 400 and CIEP 229; This course is restricted to Chemistry Ph.D. students
Prerequisites or This course will count toward the research credits of those students seeking a Ph.D. degree with a focus on Chemical Education. It will examine the effects of numerous variables on the learning and teaching of chemical principles and skills.
*Outcomes:*
Students will be able to: *describe the primary theoretical underpinnings of the chemical education research field; *describe and apply methods for preparing research data collected for publication; *describe and apply methods for analyzing chemical education research projects & manuscripts

**CHEM 480 Chemistry for Teachers I (3 Credit Hours)**
This course focuses on aspects specific to the teaching and learning of chemistry at post- secondary levels. Geared towards graduate students, undergraduate seniors, or current educators who plan on instructing college students, it explores principles surrounding how people learn chemistry and how to align pedagogies and environments to optimize learning opportunities for students. Course activities and assignments are designed to initiate the building of an instructional portfolio to prepare enrolled students for potential academic careers.

**CHEM 491 Laboratory Investigations in Chemistry C (1 Credit Hour)**
A course designed for high school science teachers to help construct and create chemistry laboratories for students in the context of urban high schools. Students must be enrolled in one of the SOE's M.Ed. in science ed cohorts.
*Outcomes:*
Learning how to teach inquiry based science labs; learning how to create labs within the constraints of an urban school district

**CHEM 497 Organic and Bio Chemistry for Teachers (3 Credit Hours)**
*Pre-requisites:* Must be enrolled in M.Ed. in Chem Ed program
A course designed for urban high school teachers to enhance knowledge of chemistry and chemistry teachers.
*Outcomes:*
Increased chemistry content knowledge, ability to teach inquiry based chemistry

**CHEM 500 Graduate Student Seminar (1 Credit Hour)**
This gives students an opportunity to prepare and present a professional chemistry seminar for other professional chemists. The presenter is trained in organizing materials for the 500 Graduate Student Seminar (1)presentation and has the experience of conveying high level technical information to a friendly audience in preparation for subsequent professional presentations in the industrial, academic, and/or scientific meeting arena. The topics of the seminar should not be related to the student's research. The course should be taken at least once by all degree-seeking students.

**CHEM 501 Directed Study (1-6 Credit Hours)**
A special reading project is undertaken by qualified students and directed by a faculty member of the department with chairperson's approval.

**CHEM 509 Doctoral Research (0-9 Credit Hours)**
Laboratory. Specific content varies on consultation with a faculty sponsor.

**CHEM 595 Thesis Supervision (0 Credit Hours)**
The course is for master's degree candidates after completion of course requirements.

**CHEM 600 Dissertation Supervision (0 Credit Hours)**
The course is for Ph.D. degree candidates after completion of courses, cumulative examinations, and research tool requirements.

**CHEM 605 Master's Study (0 Credit Hours)**
This course is for MS students in the (up to two) intervening semesters between completing coursework/research credits and beginning their thesis supervision.

**CHEM 610 Doctoral Study (0 Credit Hours)**
This course is for PhD students in the intervening two semesters (pre-candidacy) between completing coursework/research credits and beginning their dissertation supervision.