

# CHEMISTRY AND BIOCHEMISTRY

Department Website (<http://www.chem.sc.edu/>)

The Department of Chemistry and Biochemistry offers programs leading to the Ph.D. degree, with concentrations in analytical, biological, inorganic, organic, and physical chemistry. The Ph.D. program is flexible and is designed to maximize research opportunities and to encourage interdisciplinary research. Master of Science degrees in the same areas of concentration are awarded. The Master of Arts in Teaching in Science (Chemistry and Biochemistry Option) and the Interdisciplinary Master of Arts in Science (Chemistry and Biochemistry Option) are offered in cooperation with the College of Education.

On average, the Ph.D. degree is earned in less than five years. Thirty tenure-track and research faculty teach and supervise the research of the department's approximately 130 graduate students and 30 postdoctoral fellows. Each year, around 30 new students are added to the program. Generally, 15-20 Ph.D. and four M.S. degrees are awarded per year.

The Ph.D. and M.S. degree programs prepare students for careers in industry, government, and academic settings.

## Admission

An applicant must have a baccalaureate degree or its equivalent from an accredited college or university. The applicant's academic record must indicate adequate preparation for graduate study in the Department of Chemistry and Biochemistry. Generally, to be considered for admission, a student should have a minimum grade point average of 3.00 in the sciences on a 4.00 scale and score at or above the 50th percentile on the GRE. However, these guidelines are flexible, and slight deficiencies in one area can be compensated by strengths in another. In addition, applicants whose native language is not English must obtain a minimum score of 600 (250 computer-based score) on the TOEFL exam or 7 on the IELTS exam.

## Programs

- Chemistry, M.S. (<https://academicbulletins.sc.edu/graduate/arts-sciences/chemistry-biochemistry/chemistry-ms/>)
- Chemistry, Ph.D. (<https://academicbulletins.sc.edu/graduate/arts-sciences/chemistry-biochemistry/chemistry-phd/>)

## Courses

### CHEM 511 - Inorganic Chemistry (3 Credits)

Consideration of atomic structure, valence, complex compounds, and systematic study of the periodic table.

**Prerequisites:** C or higher in CHEM 334, PHYS 212, and MATH 241.

### CHEM 541L - Physical Chemistry Laboratory (2 Credits)

Applications of physical chemical techniques. Five laboratory hours and one recitation hour per week.

**Prerequisites:** C or higher in CHEM 321L or in CHEM 322L or in CHEM 142.

**Corequisite:** CHEM 541 (unless grade of C or higher in CHEM 541 earned previously).

### CHEM 542 - Physical Chemistry (3 Credits)

Spectroscopy, statistical mechanics, and chemical applications of quantum mechanics.

**Prerequisites:** C or higher in CHEM 112 or in CHEM 142, MATH 241 and PHYS 212.

### CHEM 542L - Physical Chemistry Laboratory (2 Credits)

Applications of physical chemical techniques. Five laboratory hours and one recitation hour per week.

**Prerequisites:** C or higher in CHEM 321L or in CHEM 142.

**Corequisite:** CHEM 542 (unless grade of C or higher in CHEM 542 earned previously).

### CHEM 545 - Physical Biochemistry (3 Credits)

A survey of physical methods essential for studies of biomacromolecules. Three lecture hours per week.

**Prerequisites:** C or higher in CHEM 541 and in CHEM 550 or CHEM 555.

### CHEM 550 - Biochemistry (3 Credits)

Description of biological macromolecules and major metabolic pathways. Three lecture hours per week.

**Prerequisites:** C or higher in CHEM 334.

**Cross-listed course:** BIOL 541

### CHEM 550L - Biochemistry Laboratory (1 Credit)

Experiments and demonstrations illustrating the principles of biochemistry. Three laboratory hours per week.

**Prerequisite or Corequisite:** C or higher in CHEM 550 or BIOL 541 or CHEM 555 or BIOL 545.

**Cross-listed course:** BIOL 541L

### CHEM 555 - Biochemistry/Molecular Biology I (3 Credits)

Essentials of modern biochemistry. First semester of a two-semester course. Three lecture hours per week.

**Prerequisites:** C or higher in CHEM 334.

**Cross-listed course:** BIOL 545

### CHEM 556 - Biochemistry/Molecular Biology II (3 Credits)

Essentials of modern biochemistry and molecular biology. Three lecture hours per week.

**Prerequisites:** C or higher in BIOL 302.

**Cross-listed course:** BIOL 546

### CHEM 619 - Special Topics in Inorganic Chemistry (1-3 Credits)

Current developments in inorganic chemistry. Readings and research on selected topics. Course content varies by title and will be announced in the schedule of classes. May be repeated for credit.

### CHEM 621 - Instrumental Analysis (3 Credits)

Chemical instrumentation including electronics, signal processing, statistical analysis, molecular/atomic spectroscopy, electrochemical methods, chromatography, and mass spectrometry. Three lecture hours per week.

**Prerequisites:** C or higher in CHEM 321 or CHEM 322.

### CHEM 621L - Instrumental Analysis Lab (1 Credit)

Methods, principles and strategies for chemical instrumentation in analysis. Chemical instrumentation laboratory with environmental, forensic, and biotechnology applications. Three laboratory hours per week.

**Corequisite:** CHEM 621.

**CHEM 622 - Forensic Analytical Chemistry (4 Credits)**

Analytical chemical methods in forensic science, including gathering of evidence, toxicology, drug identification, analysis of trace evidence, arson analysis, and DNA/serology. Three lecture hours and three laboratory hours per week.

**Prerequisites:** C or higher in CHEM 321 and CHEM 321L or CHEM 322 and CHEM 322L; C or higher in CHEM 334; C or higher in CHEM 332L or CHEM 334L.

**CHEM 623 - Introductory Environmental Chemistry (3 Credits)**

Study of the chemical reactions and processes that affect the fate and transport of organic chemicals in the environment. Three lecture hours per week.

**Prerequisites:** C or higher in CHEM 321, in CHEM 333, and in MATH 142.

**CHEM 624 - Aquatic Chemistry (3 Credits)**

Study of the chemical reactions and processes affecting the distribution of chemical species in natural systems. Three lecture hours per week.

**Prerequisite or Corequisite:** CHEM 321, MATH 142.

**Cross-listed course:** MSCI 624

**CHEM 629 - Special Topics in Analytical Chemistry (1-3 Credits)**

Current developments in inorganic chemistry. Readings and research on selected topics. Course content varies by title and will be announced in the schedule of classes. May be repeated for credit.

**CHEM 633 - Introduction to Polymer Synthesis (3 Credits)**

Special emphasis on the modern synthesis of polymeric materials. Definitions, characterization, and applications of polymers will be briefly presented.

**Prerequisites:** C or higher in CHEM 334.

**CHEM 639 - Special Topics in Organic Chemistry (3 Credits)**

Current developments in organic chemistry. Readings and research on selected topics. May be repeated as content varies by title.

**CHEM 643 - Computational Chemistry (3 Credits)**

This course is designed to familiarize students with theory and use of modern electronic structure codes, as well as to develop critical thinking and problem-solving skills and to improve computer literacy.

**Prerequisites:** C or higher in CHEM 541 or CHEM 542.

**CHEM 644 - Materials Chemistry (3 Credits)**

Introduction to materials science; structural and electronic description of inorganic-based solids; experimental techniques in materials chemistry; interfacial energetics and optoelectronic processes at metal and semiconductor surfaces.

**Corequisite:** CHEM 542 (unless a grade of C or higher earned previously).

**CHEM 649 - Special Topics in Physical Chemistry (1-3 Credits)**

Current developments in physical chemistry. Readings and research on selected topics. Course content varies by title and will be announced in the schedule of classes. May be repeated for credit.

**CHEM 655 - Metabolic Biochemistry of Human Disease (3 Credits)**

Core concepts of biochemistry as applied to human health and disease.

**Prerequisites:** C or higher in CHEM 555/BIOL 545 or CHEM 550/BIOL 541.

**Cross-listed course:** BIOL 668

**CHEM 659 - Special Topics in Biochemistry (3 Credits)**

Selected topics in the field of biochemistry. May be repeated as content varies by title.

**Prerequisites:** C or higher in CHEM 555/BIOL 545 or CHEM 550/BIOL 541.

**CHEM 700 - Methods of Solving Problems in Chemistry (3 Credits)**

Various approaches to solving problems in gas laws, solution chemistry, and equilibrium. Comparison of the pedagogical merits of the different approaches. For teachers of chemistry, M.A. Students. Three lectures per week.

**CHEM 701 - Seminar (1 Credit)**

Required of all graduate students. Fall or Spring limit of 2 credits.

**CHEM 701A - Seminar (1 Credit)**

A survey of chemical research at the University of South Carolina.

Required of all first-year degree candidates in chemistry.

**CHEM 702 - Structure and Bonding in Covalent Molecules (4 Credits)**

Covalent bonding in compounds of the first short period elements, with emphasis on those of boron, carbon, and nitrogen. Structure of molecules, some important functional groups, resonance in unsaturated compounds, stereochemistry, and organometallic compounds. For teachers of chemistry, M.A.T., or M.Ed. students. Three lectures and one discussion period per week.

**CHEM 703 - Molecular Reactions (4 Credits)**

General types of organic reactions, including those of biochemistry. Industrial preparations of both organic and inorganic compounds of major importance. For teachers of chemistry, M.A.T., or M.Ed. students. Three lectures and one discussion period per week.

**CHEM 704 - Energy, Equilibrium, and Chemical Change (4 Credits)**

The basic laws of chemical thermodynamics, chemical kinetics, and equilibrium, with emphasis on the practical and theoretical importance of the interconversion of chemical energy with other forms of energy. For teachers of chemistry, M.A.T., or M.Ed. students. Three lectures and one discussion period per week.

**CHEM 705 - Modern Instrumental Methods in Chemistry (4 Credits)**

A survey of the applications of modern instrumental techniques to the solution of chemical problems, with emphasis on development of a basic understanding of the experiment and on interpretation of data. For teachers of chemistry, M.A.T., or M.Ed. students. Three lectures and one discussion period per week.

**CHEM 706 - Chemistry in Living Systems (4 Credits)**

The structures and functions of proteins, nucleic acids, lipids, enzymes, and other biologically important molecules; the role of these molecules in the major metabolic pathways. For teachers of chemistry, M.A.T., or M.Ed. students. Three lectures and one discussion period per week.

**CHEM 709 - Special Topics in Chemical Education (1-6 Credits)**

Selected chemical topics with emphasis on modern chemical concepts. For teachers of chemistry, M.A.T., I.M.A. and M.Ed. students. Lectures, discussion, laboratories, depending on credit offered.

**CHEM 711 - Physical-Inorganic Chemistry (3 Credits)**

The use and interpretation of modern physical measurements of particular application to inorganic chemistry, including X-ray, ESR, magnetic measurements, Mössbauer spectra, ligand field theory, and reaction mechanisms.

**CHEM 712 - The Chemistry of Transition Elements (3 Credits)**

Systematic study of the reactions and bonding of the d and f transition elements.

**CHEM 713 - The Chemistry of the Representative Elements (3 Credits)**

Systematic study of the structure and bonding of the inorganic compounds of main group elements.

**CHEM 719 - Special Topics in Inorganic Chemistry (3 Credits)**

May be repeated as content varies by title.

**CHEM 721 - Electroanalytical Chemistry (3 Credits)**

Theory and application of classical and modern electrochemical techniques.

**CHEM 722 - Spectrochemical Methods of Analysis (3 Credits)**

A comprehensive study of the theory, instrumentation, methodology, and analytical applications of modern atomic and quantitative molecular spectrometry.

**CHEM 723 - Separation and Detection Methods in Analytical Chemistry (3 Credits)**

Theory and application of modern techniques for analytical separation and detection. Three lecture hours per week.

**CHEM 729 - Special Topics in Analytical Chemistry (3 Credits)**

May be repeated as content varies by title.

**CHEM 735 - Structural and Mechanistic Organic Chemistry (3 Credits)**

Basic concepts of structure, bonding, stereochemistry, and reaction mechanisms as applied to organic compounds and synthetic transformations.

**CHEM 736 - Mechanistic and Synthetic Organic Chemistry (3 Credits)**

A continuation of CHEM 735 with special emphasis on organic synthesis.

**Prerequisites:** CHEM 735.

**CHEM 739 - Special Topics in Organic Chemistry (3 Credits)**

May be repeated as content varies by title.

**CHEM 741 - Chemical Thermodynamics (3 Credits)**

A development of classical thermodynamics and its application to chemical changes.

**Prerequisites:** CHEM 542.

**CHEM 742 - Surface Science (3 Credits)**

The principles of surface processes – structure and electronic properties, adsorption and reactions, surface characterization using spectroscopy and microscopy.

**CHEM 743 - Quantum Chemistry (3 Credits)**

An introduction to the application of quantum mechanics to problems in chemistry.

**Prerequisites:** CHEM 542; differential equations.

**CHEM 744 - Statistical Mechanics (3 Credits)**

Calculations of the thermodynamic properties of chemical systems from molecular properties. Theory and applications.

**Prerequisites:** CHEM 542; differential equations.

**CHEM 745 - Introductory Crystallography (3 Credits)**

Point and space groups. Matrix representation and the derivation of the space groups. Significance of general and special positions. Powder and single crystal methods. Limitation imposed upon molecules by space group considerations. Introduction to structure analysis. Patterson and electron density functions. Refinement techniques.

**CHEM 747 - Spectroscopy and Molecular Structure (3 Credits)**

Study of the rotational, vibrational, and electronic spectra of polyatomic molecules for the elucidation of molecular structures.

**CHEM 749 - Special Topics in Physical Chemistry (3 Credits)**

May be repeated as content varies by title.

**CHEM 751 - Biosynthesis of Macromolecules (3 Credits)**

A detailed consideration of the enzymological basis for the synthesis of DNA, RNA, and protein including mechanisms for the regulation of these processes. Focus will be on eucaryotic mechanisms though procaryotic systems will be covered as necessary for background.

**CHEM 752 - Regulation and Integration of Metabolism (3 Credits)**

Biochemical organization of the cell. Regulation and integration of metabolism. Membrane structure and function. Energy transduction processes.

**CHEM 753 - Enzymology and Protein Chemistry (3 Credits)**

An analysis of the isolation, composition, structure, and function of enzymes emphasizing their kinetic, mechanistic, and regulatory features. Protein chemistry: amino acid and protein sequence analysis; chemical modification methodologies; analysis of higher order structures of proteins.

**CHEM 754 - Biomedical Biochemistry I (4 Credits)**

First of a two-semester sequence covering the major areas of biochemistry in a biomedical context. Chemistry of amino acids and proteins, enzymology, metabolism of carbohydrates and lipids. Emphasis is on biomedical research applications. Four lecture hours per week.

**CHEM 755 - Biomedical Biochemistry II (4 Credits)**

A continuation of CHEM 754. Topics include nucleic acids and protein biosynthesis, blood chemistry, respiration, acid-base chemistry, metabolism, and nutrition. Four lecture hours per week.

**Prerequisites:** CHEM 754.

**CHEM 759 - Special Topics in Molecular Biochemistry (3 Credits)**

May be repeated as content varies by title.

**CHEM 790 - Introduction to Research (3 Credits)**

A laboratory and introduction to modern research techniques. Six hours of laboratory per week and individual consultation with instructor.

**CHEM 791 - Introduction to Research (1-3 Credits)**

A continuation of CHEM 790. Six hours of laboratory per week and individual consultation with instructor.

**Prerequisites:** CHEM 790.

**CHEM 798 - Research in Chemistry I (1-12 Credits)**

Directed laboratory research and readings in chemistry.

**CHEM 799 - Thesis Preparation (1-12 Credits)****CHEM 898 - Research in Chemistry II (1-12 Credits)**

A continuation of CHEM 798 for Ph.D. candidates.

**CHEM 899 - Dissertation Preparation (1-12 Credits)**