

# DEPARTMENT OF CHEMISTRY & BIOCHEMISTRY

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## Degrees Offered

The Department of Chemistry and Biochemistry offers degree programs for a Bachelor of Science in chemistry or biochemistry.

Both the Bachelor of Science degrees in chemistry and in biochemistry are certified by the American Chemical Society Committee on Professional Training (<https://www.acs.org/content/acs/en/about/governance/committees/professional-training.html>)

A minor in chemistry, a minor in Green Chemistry and Engineering and certificates in Analytical Chemistry and in Materials Chemistry are also available.

## Department Mission

The Department of Chemistry and Biochemistry strives (1) to present outstanding teaching and the highest quality education in chemistry and biochemistry to students at all levels and in all disciplines, (2) to develop and maintain leading research programs with national and international reputations, both in support of our teaching programs and to add to scientific and technological base of the State of Ohio and the Nation, (3) to advance the development of teaching and research qualifications of our students and faculty, (4) to continuously improve the high quality undergraduate and graduate programs with emphasis on hands on training, and (5) to serve the University, the Community, and Society through the unique experiences and talents of our students, staff and faculty.

## Advanced Placement

- Students with a score of 3 on the Chemistry Advanced Placement Exam will receive credit for CHEM 1100 and placement into CHEM 1230 and CHEM 1280;
- Students with a score of 4 will receive credit for CHEM 1230 and CHEM 1280;
- Students with a score of 5 will receive credit for CHEM 1230, CHEM 1280, CHEM 1240, and CHEM 1290.

## Experience in Research

The department offers experience in research under faculty guidance at all levels, in CHEM 2910, CHEM 3910 and CHEM 4910. Students are encouraged to talk with faculty members about research participation and to consult with more than one faculty member about appropriate projects. A student who wishes to participate in research should obtain the consent of a faculty member who agrees to guide this work and the

approval of a departmental undergraduate advisor before the first day of the first semester that he/she enrolls for CHEM 2910, CHEM 3910 or CHEM 4910. Students may enroll in the different courses, CHEM 2910, CHEM 3910 and CHEM 4910, with different faculty members.

## Junior Year Studies in England for Chemistry and Biochemistry Majors

The University of Toledo has an exchange program agreement with the University of Salford, England. Selected University of Toledo students spend their junior years at Salford, and students in the Salford three-year chemistry honors program spend their second year at the University of Toledo. Eligibility is based on scholastic standing. Participants in the program pay their instructional and general fees to their home institutions. Information on the program may be obtained from Dr. Brian Ashburner, Director of the UToledo-Salford Exchange Program.

## Degrees Offered

- BS in Biochemistry (<https://catalog.utoledo.edu/undergraduate/natural-sciences-mathematics/chemistry-biochemistry/bs-biochemistry/>)
- BS in Chemistry (<https://catalog.utoledo.edu/undergraduate/natural-sciences-mathematics/chemistry-biochemistry/bs-chemistry/>)
- Minor in Chemistry (<https://catalog.utoledo.edu/undergraduate/natural-sciences-mathematics/chemistry-biochemistry/minor-chemistry/>)
- Minor in Green Chemistry & Engineering (<https://catalog.utoledo.edu/undergraduate/natural-sciences-mathematics/chemistry-biochemistry/minor-green-chemistry-and-engineering/>)
- Certificate in Analytical Chemistry (<https://catalog.utoledo.edu/undergraduate/natural-sciences-mathematics/chemistry-biochemistry/certificate-analytical-chemistry/>)
- Certificate in Materials Chemistry (<https://catalog.utoledo.edu/undergraduate/natural-sciences-mathematics/chemistry-biochemistry/certificate-materials-chemistry/>)

### CHEM 1090 Elementary Chemistry

[3 credit hours]

For students who major in science, engineering or other fields which require chemistry as a prerequisite subject who have not had a previous course in chemistry and whose preparation is not sufficient to begin General Chemistry (CHEM 1230) .

**Prerequisites:** MATH 1200 with a minimum grade of C or MATH 1320 with a minimum grade of C or MATH 1340 with a minimum grade of C or MATH 1750 with a minimum grade of C or MATH 1830 with a minimum grade of C or MATH 1850 with a minimum grade of C or ACT Math with a score of 20 or Aleks Math Placement Test with a score of 046 or Math - Coll Algebra Placement with a score of 10 or SAT Mathematics with a score of 480 or MATH SECTION SCORE with a score of 510

**Term Offered:** Spring, Summer, Fall

**CHEM 1100 Chemistry And Society**

[3 credit hours]

An introduction to basic chemistry and a survey of the impact that chemistry has on society. Topics include: power, energy, and fuels; water and pollution; soaps and detergents; nutrition; poisons and toxins; plastics and polymers; drugs.

**Term Offered:** Spring, Summer, Fall

Core Natural Sciences, OT36 Natural Science

**CHEM 1110 Elementary Chemistry for the Health Sciences**

[3 credit hours]

The study of chemistry for students that are studying nursing or other allied health related fields who have not had a previous course in chemistry or whose preparation in chemistry is not sufficient to begin Chemistry for the Health Sciences (CHEM 1120).

**Prerequisites:** ACT Math with a score of 20 or MATH SECTION SCORE with a score of 520 or Aleks Math Placement Test with a score of 046 or Math - Coll Algebra Placement with a score of 10 or MATH 1200 with a minimum grade of C or MATH 1320 with a minimum grade of C or MATH 1340 with a minimum grade of C or MATH 1750 with a minimum grade of C or MATH 1830 with a minimum grade of C or MATH 1850 with a minimum grade of C

**Term Offered:** Spring, Fall**CHEM 1120 Chemistry For Health Sciences**

[4 credit hours]

The study of chemistry for students majoring in nursing and other health-related fields. This course includes general, organic and biochemical topics in condensed form. The impact of chemistry in health fields will be emphasized.

**Prerequisites:** CHEM 1110 with a minimum grade of C or Aleks Health Science Placement with a score of 39 or Aleks Health Science Retest with a score of 39

**Term Offered:** Spring, Summer, Fall

Core Natural Sciences, OT36 Natural Science

**CHEM 1150 Chemistry And Society Laboratory**

[1 credit hour]

Laboratory introduction to the concepts of chemistry to accompany Chemistry 1100. Demonstrations by laboratory experiments of lessons developed in the accompanying lecture course. Two hours of laboratory per week.

**Term Offered:** Spring, Fall

Core Natural Sciences, OT36 Natural Science

**CHEM 1200 Problem Solving In General Chemistry**

[1 credit hour]

Problem solving and skill development for students enrolled in CHEM 1230 who obtained a satisfactory score on the chemistry placement test but need additional assistance in selected topics. May be taken only as P/NC. Pre-requisites: CHEM 1090 with a minimum grade of C or better OR pass placement exam.

**Prerequisites:** CHEM 1090 with a minimum grade of C or Aleks Chem Placement Highest with a score of 50 or Chemistry Placement with a score of 17

**Term Offered:** Spring, Fall**CHEM 1230 General Chemistry I**

[4 credit hours]

An introduction to atomic structure, chemical bonding, kinetic-molecular theory, energy relationships and structural concepts. This sequence is for students who major in science, engineering or other fields which require chemistry as a prerequisite subject. Three hours lecture and one hour discussion per week.

**Prerequisites:** CHEM 1090 with a minimum grade of C or Chemistry Placement with a score of 17 or Aleks Chem Placement Highest with a score of 50

**Term Offered:** Spring, Summer, Fall

Core Natural Sciences, OT36 Natural Science

**CHEM 1240 General Chemistry II**

[4 credit hours]

An introduction to solutions, equilibrium, acid-base theory, energy relationships and structural concepts. This sequence is for students who major in science, engineering or other fields which require chemistry as a prerequisite subject. Three hours lecture and one hour discussion per week.

**Prerequisites:** CHEM 1230 with a minimum grade of C

**Term Offered:** Spring, Summer, Fall

Core Natural Sciences, OT36 Natural Science

**CHEM 1280 General Chemistry Lab I**

[1 credit hour]

Experiments over topics covered in CHEM 1230 lectures. Approved chemistry safety goggles meeting the American National Standard Z87.1-1968 must be worn by every student during every laboratory class meeting. Three hours of laboratory per week.

**Prerequisites:** CHEM 1230 (may be taken concurrently) with a minimum grade of C

**Term Offered:** Spring, Summer, Fall

Core Natural Sciences, OT36 Natural Science

**CHEM 1290 General Chemistry Lab II**

[1 credit hour]

Experiments over topics covered in CHEM 1240 lectures. Approved chemistry safety goggles meeting the American National Standard Z87.1-1968 must be worn by every student during every laboratory class meeting. Three hours of laboratory per week.

**Prerequisites:** CHEM 1240 (may be taken concurrently) with a minimum grade of C and CHEM 1280 with a minimum grade of C

**Term Offered:** Spring, Summer, Fall

Core Natural Sciences, OT36 Natural Science

**CHEM 1300 Principles of General Chemistry**

[2 credit hours]

This is an accelerated course with selected topics from general chemistry including matter, units, ionic compounds, molecular compounds, aqueous solutions, precipitation reactions, acid-base reactions, oxidation-reduction reactions, concentration, enthalpy, calorimetry, polarity, Lewis structures, dipole moment, and intermolecular forces. This course is for students who major in science, engineering or other fields which require CHEM1240. Students who earned a C-/D+/D-/D- in CHEM1230 may take this course in place of the prerequisite grade of C in CHEM1230 such that they are eligible to advance to CHEM1240 without having to retake CHEM1230. Students can also take this course to improve preparation and performance in CHEM1240. This is a DL course with a 2 hour meeting on campus for a final exam.

**Prerequisites:** CHEM 1230 with a minimum grade of D-

**CHEM 1910 Survey Of Research**

[1 credit hour]

Survey of current research areas at the frontiers of chemistry, including topics that cross the boundaries with other disciplines. May be taken only as P/NC.

**Term Offered:** Spring**CHEM 2410 Organic Chemistry I**

[3 credit hours]

Study of structure and reactions of organic compounds. Three hours lecture per week.

**Prerequisites:** CHEM 1240 with a minimum grade of C-**Term Offered:** Spring, Summer, Fall**CHEM 2420 Organic Chemistry II**

[3 credit hours]

Study of structure and reactions of organic compounds. Three hours lecture per week.

**Prerequisites:** CHEM 2410 with a minimum grade of C-**Term Offered:** Spring, Summer, Fall**CHEM 2430 Recitation For Organic Chemistry I**

[1 credit hour]

Optional recitation sections that discuss concepts and solve practice questions in CHEM2410.

**Prerequisites:** CHEM 1240 with a minimum grade of C-**Term Offered:** Spring, Fall**CHEM 2440 Recitation For Organic Chemistry II**

[1 credit hour]

Optional recitation sections that discuss concepts and solve practice questions in CHEM2420.

**Prerequisites:** CHEM 2410 with a minimum grade of C-**Term Offered:** Spring, Fall**CHEM 2460 Organic Chemistry Laboratory I for Non-Majors**

[1 credit hour]

Practice of organic laboratory techniques. Four hours of laboratory per week. Approved chemical safety goggles meeting the American National Standard Z87.1-1968 must be worn by every student during every laboratory class meeting. This course is for students in majors other than chemistry or biochemistry. Chemistry (BS, BA) or biochemistry majors (BS) should take CHEM 2480.

**Prerequisites:** (CHEM 1240 with a minimum grade of C- and CHEM 1290 with a minimum grade of C-) and CHEM 2410 (may be taken concurrently) with a minimum grade of C-**Term Offered:** Spring, Summer, Fall**CHEM 2470 Organic Chemistry Laboratory II for Non-Majors**

[1 credit hour]

Practice of organic laboratory techniques. Four hours of laboratory per week. Approved chemical safety goggles meeting the American National Standard Z87.1-1968 must be worn by every student during every laboratory class meeting. This course is for students in majors other than chemistry or biochemistry. Chemistry (BS, BA) or biochemistry majors (BS) should take CHEM 2490.

**Prerequisites:** CHEM 2460 with a minimum grade of C- and CHEM 2420 (may be taken concurrently) with a minimum grade of C-**Term Offered:** Spring, Summer, Fall**CHEM 2480 Organic Chemistry Laboratory I for Majors: Separations and Elementary Synthesis**

[0-2 credit hours]

For Chemistry/Biochemistry majors. Introduction to theory and laboratory practice in modern methods of physical separation techniques, and introduction to organic synthetic methods. Special emphasis is made on spectroscopic techniques used in the organic laboratory. Approved chemistry safety goggles meeting the American National Standard Z87.1-1968 must be worn by every student during every laboratory class meeting.

**Prerequisites:** CHEM 1240 with a minimum grade of C- and CHEM 1290 with a minimum grade of C- and CHEM 2410 (may be taken concurrently) with a minimum grade of C-**Term Offered:** Fall**CHEM 2490 Organic Chemistry Laboratory II for Majors: Synthesis and Identification**

[2 credit hours]

For Chemistry/Biochemistry majors. Application of synthetic methods to elementary organic synthesis with special emphasis on instrumental approaches to problem solving in organic chemistry. Approved chemistry safety goggles meeting the American National Standard Z87.1-1968 must be worn by every student during every laboratory class meeting.

**Prerequisites:** (CHEM 2410 with a minimum grade of C- and CHEM 2480 with a minimum grade of C-) and CHEM 2420 (may be taken concurrently) with a minimum grade of C-**Term Offered:** Spring**CHEM 2500 Instrumental Methods For Organic Chemistry**

[0-2 credit hours]

A bridge course for students wishing to major in chemistry or biochemistry at the B.S. level after taking the organic non-major lab sequence. Introduction to major instrumental methods employed in the organic laboratory. Approved chemical safety goggles meeting the American National Standard Z87.1-1968 must be worn by every student during every laboratory class meeting.

**Prerequisites:** (CHEM 2420 with a minimum grade of C- and CHEM 2470 with a minimum grade of C-)**Term Offered:** Spring, Summer, Fall**CHEM 2910 Undergraduate Research I**

[1-3 credit hours]

An introduction to research under the guidance of a faculty member. May be repeated. A maximum accumulated credit of 4 hours in 2910 and total of 10 hours in 2910, 3910, 4910 may be applied toward a degree. May be taken only as P/NC.

**Prerequisites:** CHEM 1240 (may be taken concurrently) with a minimum grade of C-**Term Offered:** Spring, Summer, Fall**CHEM 2920 Readings In Chemistry**

[1-2 credit hours]

Readings from the literature of chemistry. May be taken only as P/NC.

**Term Offered:** Spring, Summer, Fall

**CHEM 3100 Fundamentals of Scientific Glassblowing**

[1 credit hour]

An introduction to flame working techniques for the manipulation of glass for chemistry and biochemistry majors. Hands-on techniques for developing skills for artistic and scientific glass design, creation and repair. May be taken only as P/NC.

**Prerequisites:** CHEM 2480 (may be taken concurrently) with a minimum grade of C-

**Term Offered:** Spring, Fall

**CHEM 3310 Analytical Chemistry**

[2 credit hours]

Theory and applications of chemical equilibria to gravimetric, volumetric and separation techniques. Emphasis on the quantitative aspects of analytical chemistry. Two hours lecture per week.

**Prerequisites:** CHEM 1240 with a minimum grade of C-

**Term Offered:** Fall

**CHEM 3360 Analytical Chemistry Laboratory**

[2 credit hours]

Practice of quantitative analytical methods of analysis. Six hours laboratory per week. Approved chemical safety goggles meeting the American National Standard Z87.1-1968 must be worn by every student during every laboratory class meeting.

**Prerequisites:** (CHEM 3310 with a minimum grade of C- and CHEM 1290 with a minimum grade of C-)

**Term Offered:** Spring

**CHEM 3510 Biochemistry I**

[3 credit hours]

The chemistry of living systems, beginning with the structures and molecular and biological functions of proteins, nucleic acids, carbohydrates and lipids. Other topics include enzyme kinetics and mechanism, biological membranes and membrane transport, and signal transduction.

**Prerequisites:** CHEM 2420 with a minimum grade of C-

**Term Offered:** Summer, Fall

**CHEM 3520 Biochemistry II**

[3 credit hours]

Continuing study of the chemistry of living systems. Topics include the metabolism of carbohydrates, lipids and amino acids, energy transductions and photosynthesis, mechanisms and regulation of nucleic acid and protein synthesis.

**Prerequisites:** CHEM 3510 with a minimum grade of C-

**Term Offered:** Spring

**CHEM 3560 Biochemistry Laboratory**

[2 credit hours]

Practice of biochemistry laboratory techniques. Six hours of laboratory per week.

**Prerequisites:** CHEM 3510 with a minimum grade of C-

**Term Offered:** Spring

**CHEM 3610 Inorganic Chemistry I**

[3 credit hours]

The application of modern theories to the elements and their inorganic compounds. Physical chemical principles are used throughout.

**Prerequisites:** CHEM 2420 with a minimum grade of C- or CHEE 2230 with a minimum grade of C- and CHEE 2330 with a minimum grade of C-

**Term Offered:** Spring

**CHEM 3710 Physical Chemistry For The Biosciences I**

[3 credit hours]

Physical and mathematical laws applied to chemistry with examples from biologically important processes. No credit given if Chemistry 3730-3740 are taken.

**Prerequisites:** (MATH 1860 with a minimum grade of D- and PHYS 2070 with a minimum grade of D- and PHYS 2075 with a minimum grade of D- and PHYS 2080 with a minimum grade of D- and PHYS 2085 with a minimum grade of D-) or (MATH 1860 with a minimum grade of D- and PHYS 2130 with a minimum grade of D-) or (MATH 1860 with a minimum grade of D- and PHYS 2140 with a minimum grade of D- and PHYS 2145 with a minimum grade of D-)

**Corequisites:** CHEM 3712

**Term Offered:** Fall

**CHEM 3712 Recitation for Chem 3710**

[1 credit hour]

Recitation section that discusses concepts and solves practice questions for CHEM 3710. Must be taken simultaneously with CHEM 3710. Not for major/minor credit.

**Prerequisites:** CHEM 2420 with a minimum grade of D- and CHEM 3710 (may be taken concurrently) with a minimum grade of D-

**Term Offered:** Fall

**CHEM 3720 Physical Chemistry For The Biosciences II**

[3 credit hours]

Physical and mathematical laws applied to chemistry with examples from biologically important processes. No credit given if Chemistry 3730-3740 are taken.

**Prerequisites:** CHEM 3710 with a minimum grade of D-

**Corequisites:** CHEM 3722

**Term Offered:** Spring

**CHEM 3722 Recitation For Chem 3720**

[1 credit hour]

Optional recitation section that discusses concepts and solves practice questions for CHEM 3720. Must be taken simultaneously with CHEM 3720. Not for major/minor credit.

**Prerequisites:** CHEM 3710 with a minimum grade of C- and CHEM 3720 (may be taken concurrently) with a minimum grade of C-

**Term Offered:** Spring

**CHEM 3730 Physical Chemistry I**

[3 credit hours]

Fundamental theories and basic laws of chemistry with emphasis on their mathematical development. Thermodynamics, equilibrium, electrochemistry, classical chemical kinetics.

**Prerequisites:** CHEM 1240 with a minimum grade of C- and PHYS 2140 with a minimum grade of C- and PHYS 2145 with a minimum grade of C- and (MATH 1840 with a minimum grade of C- or MATH 1860 with a minimum grade of C-)

**Term Offered:** Fall

**CHEM 3732 Recitation for Chem 3730**

[1 credit hour]

Optional recitation section that discusses concepts and solves practice questions for CHEM 3730. Must be taken simultaneously with CHEM 3730, Physical Chemistry I. Not for major/minor credit.

**Prerequisites:** CHEM 2420 with a minimum grade of C- and CHEM 3730 (may be taken concurrently) with a minimum grade of C-

**Term Offered:** Fall

**CHEM 3740 Physical Chemistry II**

[3 credit hours]

Fundamental theories and basic laws of chemistry with emphasis on their mathematical development. Structure of matter, statistical and quantum mechanics, reaction dynamics, spectroscopy.

**Prerequisites:** CHEM 3730 with a minimum grade of C- or CHEE 2230 with a minimum grade of C- and CHEE 2330 with a minimum grade of C-

**Term Offered:** Spring

**CHEM 3742 Recitation For Chem 3740**

[1 credit hour]

Optional recitation section that discusses concepts and solves practice questions for CHEM 3740. Must be taken simultaneously with CHEM 3740, Physical Chemistry II. Not for major/minor credit.

**Prerequisites:** CHEM 3730 with a minimum grade of C- and CHEM 3740 (may be taken concurrently) with a minimum grade of C-

**Term Offered:** Spring

**CHEM 3810 Chemistry of Sustainable Energy Resources**

[3 credit hours]

Application of the principles of chemistry to understand the issues related to implementing and optimizing a sustainable supply of energy.

**Prerequisites:** CHEM 1240 with a minimum grade of C- and CHEM 1290 with a minimum grade of C- and PHYS 3400 with a minimum grade of C-

**Term Offered:** Spring, Fall

**CHEM 3860 Advanced Laboratory I**

[0-2 credit hours]

Laboratory experiments and techniques relating to subjects developed in CHEM 3710, 3730, or 4570. Three-hour laboratory and one-hour discussion per week. Approved chemical safety goggles meeting the American National Standard Z87.1-1968 must be worn by every student during every laboratory class meeting.

**Prerequisites:** (CHEM 2420 with a minimum grade of C- and CHEM 2470 with a minimum grade of C-) or CHEM 2490 with a minimum grade of C- and (CHEM 3710 (may be taken concurrently) with a minimum grade of C- or CHEM 3730 (may be taken concurrently) with a minimum grade of C- or CHEM 4570 (may be taken concurrently) with a minimum grade of C-)

**Term Offered:** Fall

**CHEM 3870 Advanced Laboratory II**

[2 credit hours]

Laboratory experiments and techniques relating to subjects developed in 3710/3720, 3730/3740. Six hours of laboratory per week. Approved chemical safety goggles meeting the American National Standard Z87.1-1968 must be worn by every student during every laboratory class meeting.

**Prerequisites:** CHEM 3860 with a minimum grade of C- and (CHEM 3740 (may be taken concurrently) with a minimum grade of C- or CHEM 3720 (may be taken concurrently) with a minimum grade of C-)

**Term Offered:** Spring

**CHEM 3910 Undergraduate Research II**

[1-3 credit hours]

Research under the guidance of a faculty member. A written report is required. May be repeated. A maximum accumulated credit of 10 hours in CHEM 2910, 3910 and 4910 may be applied toward a degree. May be taken only as P/NC.

**Prerequisites:** CHEM 2420 (may be taken concurrently) with a minimum grade of C-

**Term Offered:** Spring, Summer, Fall

**CHEM 3920 Readings In Chemistry II**

[1-2 credit hours]

Readings from the literature of chemistry. May be taken only as P/NC.

**Term Offered:** Spring, Summer, Fall

**CHEM 4200 Green Chemistry**

[3 credit hours]

Introduction to the principles and applications of green chemistry, including industrial applications, atom economy, safer solvent substitutions, chemical alternatives assessment, green chemistry metrics, basic life cycle assessment, and an introduction to chemical toxicology. Students need CHEM 2420 or permission of instructor.

**Prerequisites:** CHEM 2420 with a minimum grade of D-

**CHEM 4210 Environmental Chemistry**

[3 credit hours]

This course will focus on the chemistry of air, water, and soil with specific emphasis on the effects of human made chemical products and byproducts on the environment. Connections with green chemistry will be highlighted. Students need CHEM 2420 or permission of instructor.

**Prerequisites:** CHEM 2420 with a minimum grade of D-

**CHEM 4300 Instrumental Analysis**

[2 credit hours]

An introduction to modern chemical instrumentation and applications to chemical analysis. Topics include electrical, magnetic, nuclear and spectroscopic instrumentation.

**Prerequisites:** (CHEM 3310 with a minimum grade of C- and CHEM 3360 with a minimum grade of C-) and CHEM 3710 (may be taken concurrently) with a minimum grade of C- or CHEM 3730 (may be taken concurrently) with a minimum grade of C- or CHEM 4570 (may be taken concurrently) with a minimum grade of C- or CHEE 2230 (may be taken concurrently) with a minimum grade of C-

**Term Offered:** Fall

**CHEM 4305 Advanced Analytical Chemistry**

[4 credit hours]

An overview of new techniques in analytical chemistry. Topics include sample preparation and sampling, spectroscopic, separation, electrochemical, surface characterization and thermal methods.

**Prerequisites:** CHEM 3310 with a minimum grade of C

**Term Offered:** Fall

**CHEM 4310 Separation Methods**

[3 credit hours]

The theory, design and application of separation methods. Topics include extraction techniques, gas, liquid, and supercritical fluid chromatography, affinity and chiral separation, and capillary electrophoresis.

**Prerequisites:** CHEM 3310 with a minimum grade of C or CHEM 4300 with a minimum grade of C

**Term Offered:** Spring

**CHEM 4320 Electrochemistry**

[4 credit hours]

A fundamental study of electrochemical concepts, methods, instrumentation and applications.

**Prerequisites:** CHEM 4300 with a minimum grade of C

**Term Offered:** Spring

**CHEM 4330 Spectroscopic Methods**

[4 credit hours]

A comprehensive study of theory and instrumentation. Applications of spectroscopic methods including spectral interpretation. Topics include a study of absorption, emission, Raman, NMR, ESR, mass spectrometry, and related subjects. Important methodology and strategy in organic synthesis including disconnection and retrosynthetic analysis.

**Prerequisites:** CHEM 2410 with a minimum grade of C**Term Offered:** Spring**CHEM 4340 Mass Spectrometry**

[4 credit hours]

The principles and applications of mass spectrometry in chemistry, biochemistry, and related disciplines.

**Prerequisites:** CHEM 4300 with a minimum grade of D-**Term Offered:** Spring**CHEM 4350 Separation Methods Laboratory**

[1 credit hour]

Experiments covering topics discussed in CHEM 4310 lectures. Five hours of laboratory per week. Approved chemical safety goggles meeting the American National Standard 287.1-1968 must be worn by every student during every laboratory class meeting.

**Prerequisites:** (CHEM 3310 with a minimum grade of C and CHEM 3360 with a minimum grade of C) or (CHEM 4300 with a minimum grade of C and CHEM 4880 with a minimum grade of C)**Corequisites:** CHEM 4310**Term Offered:** Spring**CHEM 4400 Advanced Organic Chemistry**

[4 credit hours]

This course deals with chemical structure and reactivity correlations applied to the study of organic reaction mechanisms; stereochemical features including conformation and stereoelectronic effects; reaction dynamics, isotope effects and molecular orbital theory applied to pericyclic and photochemical reactions; and special reactive intermediates including carbenes, carbanions, and free radicals.

**Prerequisites:** CHEM 2420 with a minimum grade of B**Term Offered:** Fall**CHEM 4410 Organic Synthesis**

[4 credit hours]

Important methodology and strategy in organic synthesis including disconnection and retrosynthetic analysis.

**Term Offered:** Spring**CHEM 4430 Medicinal Chemistry**

[4 credit hours]

Qualitative and quantitative aspects of the design of new therapeutic agents are discussed. Approaches to the design of drugs and new therapeutic modalities directed at enzymes, receptors, membrane transport proteins and nucleic acids will be examined.

**Term Offered:** Fall**CHEM 4500 Advanced Biological Chemistry**

[4 credit hours]

The chemistry of cellular and molecular transformations in biochemical systems. Molecular structure of proteins, nucleic acids and membranes. Metabolism and biosynthesis of carbohydrates, amino acids and lipids; gene regulation and replication.

**Prerequisites:** CHEM 3520 with a minimum grade of C-**Term Offered:** Fall**CHEM 4510 Protein Chemistry**

[4 credit hours]

A detailed analysis of the structure and function of proteins. Current methodology for the analysis of structure, the basis for molecular associations and relationships between structure and biological function.

**Prerequisites:** CHEM 3510 with a minimum grade of C-**Term Offered:** Spring**CHEM 4520 Enzymology**

[4 credit hours]

Survey of current methods to study enzyme-catalyzed reactions, and application to examples from major enzyme groups. Current topics in enzymology include abzymes and ribozymes, artificial enzymes, and enzymes, and enzyme engineering.

**Prerequisites:** CHEM 3510 with a minimum grade of C-**Term Offered:** Spring**CHEM 4560 Biophysical Chemistry Laboratory - WAC**

[2 credit hours]

Data Analysis of modern biophysical measurements related to the topics discussed in CHEM 4570 (Biophysical Chemistry), an introduction to scientific writing, and the preparation of scientific manuscripts. Six hours of laboratory per week.

**Prerequisites:** CHEM 3520 with a minimum grade of C-**CHEM 4570 Biophysical Chemistry**

[4 credit hours]

Principles and applications of physical chemistry as applied to biological macromolecules (i.e., proteins and nucleic acids in solution), including thermodynamics, kinetics and spectroscopy of macromolecular interactions.

**Prerequisites:** (PHYS 2080 with a minimum grade of C- and PHYS 2085 with a minimum grade of C- or PHYS 2140 with a minimum grade of C- and PHYS 2145 with a minimum grade of C-) and CHEM 3520 with a minimum grade of C-**Term Offered:** Fall**CHEM 4580 Bioinorganic Chemistry**

[4 credit hours]

Survey of biologically important metals and metal-ligand complexes, and the role of metal ions in proteins, metal ion transport and regulation, and metals in medicine.

**Prerequisites:** CHEM 3520 with a minimum grade of C-**CHEM 4600 Physical Inorganic Chemistry**

[4 credit hours]

Symmetry, bonding theories, magnetism, and spectroscopic characterization of inorganic compounds are described. Coverage of spectroscopic techniques such as NMR, EPR, UV/VIS, IR, AND Mossbauer focus on applications to inorganic systems.

**Prerequisites:** CHEM 3610 with a minimum grade of C**Term Offered:** Fall**CHEM 4610 Chemistry of the Transition and Post-Transition Elements**

[4 credit hours]

The organometallic chemistry of the transition metals, lanthanides and actinides is described. Synthesis, structure, bonding, and reactivity are considered. Applications in catalysis, bioinorganic, and materials chemistry are discussed.

**Prerequisites:** CHEM 3610 with a minimum grade of C**Term Offered:** Fall

**CHEM 4625 Chemistry of Main Group Elements**

[4 credit hours]

The inorganic and organometallic chemistry of main group elements is described. Synthesis, structure, bonding, and reactivity are considered. The use of main group reagents in synthesis, catalysis, and materials chemistry are discussed.

**Prerequisites:** CHEM 3610 with a minimum grade of C**Term Offered:** Spring**CHEM 4710 Quantum Chemistry and Spectroscopy**

[4 credit hours]

Fundamental principles of quantum mechanics and their application to model systems, atoms and molecules; Introduction to molecular spectroscopy.

**Term Offered:** Spring**CHEM 4720 Modern Topics in Physical Chemistry**

[4 credit hours]

Advanced topics of current interest in physical chemistry. Examples of topics include nanomaterials science, spectroscopic techniques, or molecular modeling.

**Prerequisites:** CHEM 3740 with a minimum grade of C- or CHEM 3730 with a minimum grade of C-**Term Offered:** Spring**CHEM 4800 Advanced Materials Chemistry**

[4 credit hours]

Introduction to important classes of solids, including conductors, magnetic materials, ferroelectrics, glasses, microporous materials, organic solids. Traditional and novel synthetic approaches, structure/property relationships, and characterization methods specific to solids.

**Prerequisites:** CHEM 3740 with a minimum grade of C**Term Offered:** Spring**CHEM 4810 Materials Science I**

[4 credit hours]

A generic materials science approach to the study of crystalline structure and defects (point, line and planar) in crystalline materials. The mechanisms and kinetics of diffusion in the condensed state.

**Term Offered:** Fall**CHEM 4820 Materials Science II**

[4 credit hours]

A materials science approach to the thermodynamics of condensed state equilibria. Phase transformation kinetics.

**Term Offered:** Spring**CHEM 4830 Nanomaterials Science**

[4 credit hours]

This course is intended to serve as an introduction to nanomaterials science for non-specialists. It is accessible to upper division students in any technical major, including chemists, physicists, and engineers. The fundamentals of nanomaterials science and nanotechnology will be covered, including the origin of nanoscale properties, synthesis and characterization of nanomaterials (e.g. colloids, nanoparticles, nanowires, nanotubes, DNA-based structures), fabrication of larger-scale structures (e.g. self assembly, lithography), and characterization techniques (e.g. microscopy, microanalysis, spectroscopy). Applications will also be discussed.

**Prerequisites:** CHEM 1240 with a minimum grade of C- and (MATH 1840 with a minimum grade of C- or MATH 1860 with a minimum grade of C-) and PHYS 2140 with a minimum grade of C-**Term Offered:** Spring, Fall**CHEM 4850 X-Ray Crystallography**

[4 credit hours]

Theory and practice of structure determination by X-ray diffraction. Basics of symmetry, diffraction, and reciprocal space. Hands-on introduction to single-crystal and powder methods.

**Prerequisites:** MATH 1840 with a minimum grade of C or MATH 1860 with a minimum grade of C**Term Offered:** Fall**CHEM 4880 Advanced Laboratory III**

[2 credit hours]

Laboratory experiments and techniques relating to subjects developed in CHEM 4300. Six hours of laboratory per week. Approved chemical safety goggles meeting the American National Standard Z87.1-1968 must be worn by every student during every laboratory class meeting.

**Prerequisites:** (CHEM 3860 (may be taken concurrently) with a minimum grade of C- or CHEM 4560 (may be taken concurrently) with a minimum grade of C-) or CHEM 3360 with a minimum grade of C- and CHEM 4300 (may be taken concurrently) with a minimum grade of C-**Term Offered:** Fall**CHEM 4910 Undergraduate Research III**

[1-3 credit hours]

Thesis level research under the guidance of a faculty member. May be repeated. A minimum of three hours and an acceptable thesis required for credit toward the B.S. major. A maximum accumulated credit of 10 hours in CHEM 2910, 3910 and 4910 may be applied toward a degree. A written report is required. May be taken only as P/NC. Prerequisite: GPA (overall and in chemistry courses) above 2.5 and permission of department  
Corequisite: CHEM 3740 or 4570

**Prerequisites:** CHEM 3740 (may be taken concurrently) with a minimum grade of C- or CHEM 4570 (may be taken concurrently) with a minimum grade of C-**Term Offered:** Spring, Summer, Fall**CHEM 4920 Readings In Chemistry III**

[1-2 credit hours]

Readings from the literature of chemistry. May be taken only as P/NC.

**Term Offered:** Spring, Summer, Fall

### **CHEM 4980 Special Topics In Chemistry**

[2-4 credit hours]

An advanced course for chemistry majors in an important area of chemistry. Consult the undergraduate adviser for details. Course may be repeated for credit under different specialty numbers (topics).

**Prerequisites:** (CHEM 2420 with a minimum grade of C- and CHEM 3740 with a minimum grade of C-)

**Term Offered:** Spring, Fall

#### **Qualified students may be invited to work for the citation "honors in chemistry or biochemistry."**

1. **Admission:** The honors program is open to all chemistry or biochemistry majors studying toward the B.S. degree and to other students with the consent of the departmental honors advisor and the Chair of the department. The program may be undertaken concurrently with University Honors. Admission to the departmental Honors Program is based on academic standing, recommendations by instructors and an interview with the departmental honors advisor. A minimum overall GPA of 3.3 and a minimum GPA of 3.5 in chemistry course work are required for admission and to maintain good standing in the honors program. Any student may petition the departmental honors advisor for admission to the program. A student should normally begin the program no later than the end of the sophomore year.
2. **Requirements:** In addition to the credits required to complete the major, each honors student must satisfactorily complete CHEM 4910 with a written thesis and an oral research report upon completion of the research project. A minimum of six hours of the required chemistry courses at the 3000 and 4000 levels, in addition to CHEM 4910 must be taken for honors. These courses must be in at least two different areas of chemistry, to be selected from among analytical chemistry, biochemistry, inorganic chemistry, organic chemistry and physical chemistry. The instructor in each of these courses will plan activities above the normal requirements of the course for the honors student, in line with the aims of the Honors Program, to encourage independent scholarship. Outside reading and writing may be important components of each Honors course assignment. Students enrolled in the departmental Honors Program also are encouraged to participate in the department's colloquium program. In order to graduate with departmental honors, a minimum overall GPA of 3.3 and a minimum GPA of 3.5 in chemistry course work must be earned.