CHEMISTRY (CHEM)

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CHEM 101 General Chemistry A Lecture/Discussion (3 Credit Hours)
Pre-requisites: MATH 117 or equivalent
Co-requisites: CHEM 111 and MATH 118
A year of high school chemistry is recommended; This non-majors course deals with the development of basic chemical principles. Multiple perspectives of matter will be used to describe and explain characteristics, properties, and relationships across the following topics: atomic structure, nuclear chemistry, periodicity, molecular structure, chemical bonding, chemical reactions, thermochemistry, aqueous solutions, gases
Interdisciplinary Option: Bioinformatics, Forensic Science
Outcomes:
Students will learn the foundational concepts of chemistry in these topic areas and develop skills in scientific problem solving and critical thinking

CHEM 102 General Chemistry B Lecture/Discussion (3 Credit Hours)
Pre-requisites: CHEM 101 or CHEM105; MATH 118 or equivalent
This non-majors course further develops principles from CHEM 101 & requires in-depth integration of concepts. Multiple perspectives of matter will be used to describe/explain characteristics, properties, & relationships across the following topics: liquids & solids, solutions, reaction kinetics, equilibria, acids & bases, reaction thermodynamics, electrochemical reactions.
Interdisciplinary Option: Bioinformatics, Forensic Science
Outcomes:
Students will deepen their understanding of foundational concepts of chemistry and advance their skills in scientific problem solving, critical thinking and synthesis of concepts

CHEM 102D General Chemistry B Discussion (0 Credit Hours)
Discussion to accompany the CHEM 102 lecture section.

CHEM 105 Chemical Principles (4 Credit Hours)
Pre-requisites: Math Placement Test or Math 117
Lecture, discussion and laboratory course for majors covering stoichiometry, reactions in aqueous solution, states of matter, electronic structure, thermodynamics, chemical bonding, molecular geometry and intermolecular forces. Emphasis given to writing electron configurations and Lewis diagrams, predicting molecular geometry and properties, mass/mole conversions and solving thermodynamic and gas law problems.
Outcomes:
Students will learn basic chemical principles in these areas

CHEM 106 Basic Inorganic Chemistry (4 Credit Hours)
Pre-requisites: CHEM 105 AND MATH 118 or equivalent
Laboratory course designed to illustrate fundamental models and theories in chemistry with an emphasis on significant digits, calculations, and analysis and discussion questions.
Interdisciplinary Option: Bioinformatics, Forensic Science
Outcomes:
Students will be able to use equipment properly and demonstrate correct laboratory technique

CHEM 111 General Chemistry Lab A (1 Credit Hour)
Pre-requisites: MATH 117 or placement test equivalent
Laboratory course designed to illustrate fundamental models and theories in chemistry with an emphasis on significant digits, calculations, and analysis and discussion questions.
Interdisciplinary Option: Bioinformatics, Forensic Science
Outcomes:
Students will be able to use equipment properly and demonstrate correct laboratory technique

CHEM 112 General Chemistry Lab B (1 Credit Hour)
Pre-requisites: CHEM 101 and 111 (or CHEM 105) and MATH 118 (or equivalent)
The second semester of general chemistry laboratory exposes students to qualitative analysis and continues the process of experimenting and collecting data to test the validity of theories and models presented in lecture.
Interdisciplinary Option: Bioinformatics, Forensic Science
Outcomes:
Students will demonstrate success in lab by making perceptive qualitative observations and accurate quantitative measurements

CHEM 160 Chemical Structure and Properties (3 Credit Hours)
Pre-requisites: MATH 117 or equivalent
Lecture and discussion course designed to create foundational knowledge and proficiency in essential chemistry concepts and skills. Topics include atomic structure, periodic properties, bonding and properties of molecules, solid states, interactions and connections of light and matter, quantum and molecular mechanics models of atoms and molecules.
Outcomes:
Students will use multiple perspectives of matter to describe and explain how atomic, molecular and interparticle structure determines the properties of common materials

CHEM 161 Chemical Structure and Properties Laboratory (1 Credit Hour)
Pre-requisites: MATH 117 or equivalent
Laboratory course designed to create foundational knowledge and proficiency in essential chemistry lab skills including developing the knowledge and use of PPE, MSDS, and Chemical labels, basic statistical analysis and graphing, proper usage of common laboratory equipment and instrumentation, and keeping a laboratory notebook and writing reports.
Outcomes:
Students will learn essential chemistry lab skills, including best practices for chemical safety and hygiene, laboratory equipment, instrumentation, writing techniques, and measurements

CHEM 171 General Chemistry for Engineering Science Majors (3 Credit Hours)
Pre-requisites: MATH 118 or Math Placement Test; Co-requisite CHEM 173; Restricted to Engineering Science Students; A good background in high school chemistry is recommendation
This course is designed to acquaint students in engineering science with fundamental concepts of chemistry as well as their applications in the field of engineering. Students will survey topics in atomic structure, periodicity, chemical bonding, chemical reactions and reaction stoichiometry, gases, chemical thermodynamics, chemical kinetics, chemical equilibrium, and electrochemistry. A good background in high school chemistry is recommendation.
Outcomes:
Students should demonstrate proficient understanding of fundamental concepts and skills of general chemistry as well as their applications in the field of engineering

CHEM 173 General Chemistry Lab for Engineering Science Majors (1 Credit Hour)
Pre-requisites: MATH 118 or equivalent; Co-requisite: CHEM 173; Enrollment is restricted to declared ENGR majors; A good background in high school chemistry is recommendation
This lab course is a companion course to CHEM 171 General Chemistry for Engineering Science and is designed to support the development of chemistry concepts within the following topics: atomic structure, periodicity, chemical bonding, chemical reactions and reaction stoichiometry, gases, chemical thermodynamics, chemical kinetics, chemical equilibrium, and electrochemistry.

CHEM 180 Chemical Reactivity I (3 Credit Hours)
Pre-requisites: CHEM 160 and MATH 118 or equivalent
Lecture and discussion course designed to create foundational knowledge and proficiency in essential chemistry concepts and skills. Topics include acids and bases, buffers, chemical equilibrium, molecular thermodynamics and kinetics, nucleophilic substitutions, elimination reactions, carbonyl compounds and reactions with applications to biochemical pathways.
Outcomes:
Students will use qualitative and quantitative representations of matter to describe, explain, and predict how molecular structure and stability changes over time in chemical reactions

CHEM 181 Chemical Reactivity I Lab (1 Credit Hour)
Pre-requisites: CHEM 160, CHEM 161, and MATH 118 or equivalent
Laboratory course designed to utilize experiments to illustrate the relationships between the structures of compounds and their resulting properties Topics include identification of compounds using chromatography, mass spectrometry, infrared spectroscopy, and NMR, separation methods. Additional skills in analytical reasoning and information literacy will also be developed.
Outcomes:
Students will establish best practices for working safely in lab, analyzing compounds, interpreting spectra, and purification of reaction products

CHEM 195 Foundational Concepts in Chemistry (1-3 Credit Hours)
Foundational Chemistry seminar/topics course, 1-3 credit hours. Chemical topics vary by section and are selected from the CHEM 100- and/or 200-level Departmental curriculum. Departmental consent required.
Outcomes:
Students will use multiple perspectives of matter to describe and explain characteristics, properties, and relationships of chemical systems

CHEM 212 Quantitative Analysis Lecture (3 Credit Hours)
Pre-requisites: CHEM 106 or 102 and 112
This lecture course provides an introduction to modern analytical quantitative chemistry. Topics include chemical equilibrium, statistical analysis of data as well as modern and classical methods of chemical analysis.
Interdisciplinary Option: Forensic Science

CHEM 214 Quantitative Analysis Laboratory (1 Credit Hour)
Pre-requisites: CHEM 106 or 102 and 112; Pre or co-requisite: CHEM 212
This laboratory course introduces students to classical and modern methods of chemical analysis and teaches wet chemical laboratory techniques.
Interdisciplinary Option: Forensic Science

CHEM 221 Organic Chemistry I Lec/Disc (4 Credit Hours)
Pre-requisites: CHEM 106; Chemistry and Biochemistry majors only
A lecture, discussion and laboratory course for chemistry majors covering structure and bonding in organic molecules; nomenclature, chemical and physical properties and reactions of non-aromatic hydrocarbons, alkyl halides, alcohols, ethers; stereochemistry and conformational analysis; and spectroscopy.
Interdisciplinary Option: Bioinformatics, Forensic Science
Outcomes:
Students will understand the chemical behavior of organic molecules and the mechanisms of reactions

CHEM 222 Organic Chemistry II Lec/Disc (4 Credit Hours)
Pre-requisites: CHEM 221; Chemistry & Biochemistry majors only
A lecture, discussion and laboratory course for chemistry majors continuing from 221 covering nomenclature, properties, reactions, syntheses, and spectroscopy of further classes of aliphatic and aromatic compounds, carbohydrates and other polyfunctional compounds.
Interdisciplinary Option: Bioinformatics, Forensic Science
Outcomes:
Students will be able to assign IUPAC names, spectroscopically identify, prepare, and propose reactions for these groups

CHEM 223 Organic Chemistry A Lec/Disc (3 Credit Hours)
Pre-requisites: (CHEM 102 or CHEM 106) and MATH 118 (or equivalent)
Lecture and discussion course for non-chemistry majors surveying nomenclature, structures, properties, stereochemistry, reactions, mechanisms, and syntheses of aliphatic hydrocarbons, alkyl halides, alcohols, and ethers.
Interdisciplinary Option: Bioinformatics, Forensic Science
Outcomes:
Students will identify classes of organic compounds and typical reactions, discriminate amongst intermediate stabilities, postulate reaction mechanisms, plan multi-step syntheses, and analyze/interpret spectroscopic data

CHEM 224 Organic Chemistry B Lec/Disc (3 Credit Hours)
Pre-requisites: CHEM 223 or 221
The second semester lecture and discussion course of a two semester sequence, a continuation of CHEM 223 for non-chemistry majors emphasizing the organic chemistry of conjugated systems, aromatic compounds, carbonyl compounds, amines, carboxylic acids and their derivatives, carbohydrates, lipids, and proteins.
Interdisciplinary Option: Bioinformatics, Forensic Science
Outcomes:
Students will identify classes of organic compounds and typical reactions, discriminate amongst intermediate stabilities, postulate reaction mechanisms, plan multi-step syntheses, and analyze/interpret spectroscopic data

CHEM 225 Organic Chemistry Lab A (1 Credit Hour)
Pre-requisites: CHEM 102 and 112 (or CHEM 106) and MATH 118 (or equivalent)
A laboratory course for non-chemistry majors designed to reinforce lecture topics from CHEM 223 and to expose students to the safe handling of organic chemicals.
Interdisciplinary Option: Forensic Science
Outcomes:
Students will acquire basic laboratory techniques and practices for working with organic chemicals

CHEM 226 Organic Chemistry Lab B (1 Credit Hour)
Pre-requisites: CHEM 223 and CHEM 225 (or CHEM 221)
A laboratory course for non-chemistry majors designed to reinforce lecture topics from 224 and to expose students to organic synthesis.
Interdisciplinary Option: Forensic Science
Outcomes:
Students will perform reactions to prepare known organic compounds and then isolate and characterize the reaction products

CHEM 240 Chemical Reactivity II (3 Credit Hours)
Pre-requisites: CHEM 180 and CHEM 181; Bioinformatics majors have Pre-requisite: CHEM 180 Outcomes: Students will increase their ability to use qualitative and quantitative representations of matter to describe, explain, and predict how molecular structure and stability changes over time in chemical reactions
Lecture and discussion course designed to create foundational knowledge and proficiency in essential chemistry concepts and skills. Topics include the reactivity of: alkenes, arenes, alkynes, and polyfunctional organic molecules. These topics will expand and enhance the ability to use chemical principles to explain natural phenomena.

CHEM 241 Chemical Reactivity II Laboratory (1 Credit Hour)
Pre-requisites: CHEM 180 and CHEM 181
Laboratory course designed to teach students how to perform chemical synthesis reactions and to evaluate and report the results.
Outcomes:
Students will utilize best practices for working safely in lab and for synthesizing, purifying, and characterizing chemical compounds

CHEM 242 Chemical Synthesis Laboratory (2 Credit Hours)
Pre-requisites: CHEM 180 and CHEM 181
Laboratory course designed to teach students how to perform chemical synthesis reactions and to evaluate and report the results. Students will also learn how to search the chemistry literature for existing synthesis laboratory procedures.
Outcomes:
Students will utilize best practices for working safely in lab and for synthesizing, purifying, and characterizing chemical compounds

CHEM 260 Quantitative Methods in Chemistry (3 Credit Hours)
Pre-requisites: CHEM 180, CHEM 181 and MATH 131 (or MATH 161); BIOI-BS majors, Pre-requisite: CHEM 180 and MATH 131 (or MATH 161)
Lecture and discussion course designed to create foundational knowledge and proficiency in essential chemistry concepts and skills. Topics include quantitative description of gases, liquids, and solutions, kinetics of chemical reactions, chemical equilibria, acids and bases, the thermodynamics of chemical reactions, electrochemistry, and spectroscopy.
Outcomes:
Students will deepen their understanding of foundational concepts of chemistry and advance their skills in scientific problem solving, critical thinking, and synthesis of concepts

CHEM 261 Quantitative Methods in Chemistry Laboratory (1 Credit Hour)
Pre-requisites: CHEM 180 and CHEM 181 and MATH 131 (or MATH 161)
Laboratory course designed for non-majors. The course provides students continued laboratory and chemical safety topics, scientific writing, peer review, and importance of articulating lab results in content. It will teach students how to perform chemical analysis using a variety of techniques including titration, kinetics, and spectrophotometry. Students also learn about the peer review process.
Outcomes:
Students will utilize best practices for working safely in lab during experiments designed to include kinetics, acids & bases, buffers, and spectrophotometry

CHEM 272 Analytical Chemistry Laboratory (2 Credit Hours)
Pre-requisites: CHEM 180, CHEM 181, and MATH 131 (or MATH 161)
This course continues exposure to laboratory and chemical safety topics, scientific writing, and articulating experiment results. The course utilizes hands-on lab experiments to teach a variety of analytical methods for quantifying a diverse set of chemical species. Data analysis, calibration methods, peer review are also of focus.
Outcomes:
Students will utilize best practices for lab safety, demonstrate application of analytical methods in chemical analysis, articulate results through scientific writing, and explain importance of accuracy & precision of data

CHEM 280 Environmental & Chemical Analysis (3 Credit Hours)
Pre-requisites: CHEM 240 and CHEM 260; Pre- or Co-requisite: CHEM 272
Lecture and discussion course designed to create foundational knowledge and proficiency in essential chemistry concepts and skills. Topics include the chemical analytical process, sample preparation, quantitative analysis, and data evaluation and validation. These topics will expand and enhance the ability to use chemical principles to analyze various types of environmental samples.
Outcomes:
Students will increase their ability to use both qualitative and quantitative reasoning to follow the chemical analytical process for various types of samples encountered in the Environment, Life Sciences, and Industry

CHEM 300 Undergraduate Research (1-6 Credit Hours)
Pre-requisites: Prior consultation with the instructor and a completed agreement form; Agreement forms for this directed study course are obtained from the department office, and the completed form (signed by the student, instructor, and chairperson) must be deposited in the chemistry office before the student can register for the course
This course gives undergraduate students an opportunity to participate in research in a selected area.
This course satisfies the Engaged Learning requirement.
Outcomes:
Students will accomplish the research task defined in the contractual arrangement between the student and the instructor

CHEM 300P Introduction to Chemistry Research (1 Credit Hour)
Pre-requisites: CHEM 101 and 111 (or CHEM 105)
This two week course will focus on issues of chemical safety, research protocols, data recording, and instrumentation use. Typical course meetings will involve in-class presentations, group discussions, and hands-on experience.
Outcomes:
Expose students to of essential and important issues of chemical safety, research protocols, data recording, and instrumentation use for students preparing for undergraduate and graduate chemistry research

CHEM 301 Physical Chemistry I (3 Credit Hours)
Pre-requisites: (CHEM 240 and CHEM 260) or CHEM 222 or CHEM 224; and MATH 162 or 263A; and PHYS 112 or 122
Lecture and discussion course covering principles and applications of thermodynamics and kinetic theory and emphasizing the laws of thermodynamics and statistical theory and their ramifications for equilibrium and non-equilibrium systems.
Outcomes:
Students will acquire fundamental knowledge of work, heat, their interconversions and the relationships between entropy, free energy and heat capacity

CHEM 302 Physical Chemistry II (3 Credit Hours)
Pre-requisites: (CHEM 240 and CHEM 260) or CHEM 222 or CHEM 224; and MATH 162 or 263A; and PHYS 112 or 122
Lecture and discussion course covering principles of quantum mechanics with the applications to chemical properties and spectroscopy of atoms and molecules.
Outcomes:
Students will acquire fundamental knowledge of the physical laws that govern chemical processes, and learn how to apply these laws to predict the structure and properties of chemical systems

CHEM 303 Physical Chemistry Lab I (2 Credit Hours)
Co-requisites: CHEM 302
Pre or This course covers principles and techniques of experimental physical chemistry including the practice of numerical data analysis, solid-state electronics, and vacuum technology along with their applications to magnetic resonance, high-resolution spectroscopy, and chemical thermodynamics. Outcome: Students will acquire broad-based knowledge of laboratory skills central to experimental physical chemistry.

CHEM 305 Physical Biochemistry for the Biological Sciences (3 Credit Hours)
Pre-requisites: (CHEM 240 and 260) or CHEM 222 or CHEM 224, and PHYS 112, and MATH 132 or equivalent; Restricted to Biochemistry and Forensic Science majors
Lecture course covering principles and biological applications of thermodynamics, kinetics, quantum mechanics and molecular spectroscopy.
Interdisciplinary Option: Forensic Science
Outcomes:
Students will learn how fundamental concepts in physical chemistry can be used to understand biological processes

CHEM 306 Physical Biochemistry Lab (1 Credit Hour)
Pre-requisites: CHEM 305
This laboratory course will introduce apparatus, and analysis used in experimental physical chemistry for biochemistry students.
Outcomes:
Students will acquire broad-based knowledge of laboratory skills central to biophysical chemistry

CHEM 307 Inorganic Chemistry (3 Credit Hours)
Pre-requisites: (CHEM 240 and CHEM 242 and CHEM 260) or CHEM 222 or (CHEM 224 and CHEM 226); Restricted to Biochemistry majors
Lecture course covering atomic structure, chemical bonding, and transition metal, solid state, organometallic and bioinorganic chemistry.
Outcomes:
Students will learn chemical principles in important areas of inorganic chemistry

CHEM 314 Instrumental Analysis (4 Credit Hours)
Pre-requisites: (CHEM 272 and CHEM 280) or (CHEM 212, CHEM 214, and (CHEM 222 or (CHEM 224 and CHEM 226); and PHYS 112 or PHYS 122; Restricted to Chemistry majors
This course discusses and demonstrates how instrumental techniques such as atomic spectroscopy, molecular spectroscopy, mass spectrometry and chemical separations can be used to identify the chemical composition of a sample. The hands-on approach will enable students to perform instrumental analysis independently.
Outcomes:
Students will be able to select the most suitable analytical method to identify a sample

CHEM 323 Medicinal Chemistry (3 Credit Hours)
Pre-requisites: CHEM 361 or CHEM 370
This course examines how medicinal chemists design and synthesize drug candidates to meet FDA requirements of efficacy and safety, and how a testing strategy measures efficacy vs. toxicity comprising the therapeutic index. Topics include drug-receptor/enzyme binding, PK, ADME, patenting of IP, and the ethical aspects of pharmaceuticals.
Outcomes:
Students will be able explain the strategy of drug candidate analog design, synthesis, binding and inhibition constants, drug testing strategies, pharmacokinetics, structure-activity relationships (SAR), and the therapeutic index of drugs

CHEM 340 Advanced Inorganic Chemistry (3 Credit Hours)
Pre-requisites: CHEM 302
Lecture course covering modern theories of atomic and molecular structure as applied to inorganic chemistry with discussion of acid-base theories, the chemistry, spectra and reaction mechanisms of coordination and organometallic compounds. Symmetry is used to develop molecular orbital diagrams, predict geometry, hybridization schemes and interpret electronic spectra.
Outcomes:
Students will learn chemical principles in these areas

CHEM 341 Advanced Inorganic Laboratory (1 Credit Hour)
Pre- or co-requisites: CHEM 340
A laboratory course illustrating topics and techniques used in modern inorganic chemistry; coordination and organometallic compounds are prepared and characterized by IR, UV-Vis and NMR spectroscopy, and magnetic susceptibility measurements. All experimental work is recorded in a laboratory notebook and includes a formal written report.
Outcomes:
Students will demonstrate success in lab by making perceptive qualitative observations and accurate quantitative measurements

CHEM 361 Principles of Biochemistry (3 Credit Hours)
Pre-requisites: CHEM 222 or CHEM 224 or (CHEM 240 pre-req and CHEM 260 co-req)
This course examines the structural' functional relationships in proteins, nucleic acids, carbohydrates and lipids as well as their metabolic pathways. CHEM 361 is cross-listed with BIOL 366. CHEM 361 may not count towards CHEM-BS, BIOC-BS, or BIOC-BA degrees. These students must take CHEM 370.
Interdisciplinary Option: Bioinformatics
Course equivalencies: X-BIOL366/BIOI366/CHEM361
Outcomes:
Students will be able to demonstrate an understanding of biological molecules and how they are metabolized

CHEM 365 Proteomics (3 Credit Hours)
Pre-requisites: CHEM 361 or CHEM 370
Proteomics describes and deciphers the protein structures that are the result of biochemical interactions encoded in a genome. To understand these processes, proteins have to be identified, sequenced, categorized, and classified with respect to their function and interaction in a protein network. This course will teach students how to characterize functional protein networks, examine their dynamic alteration during physiological and pathological processes. The course will also cover techniques to analyze and identify proteins using protein databases and study protein to protein interactions in the discover of drugs for diseases.
Interdisciplinary Option: Bioinformatics
Course equivalencies: CHEM365/BIOI386

CHEM 370 Biochemistry I (3 Credit Hours)
Pre-requisites: CHEM 222 or (CHEM 224 and CHEM 226) or (CHEM 240 and CHEM 242 pre-req, and CHEM 260 co-req); Restricted to Chemistry and Biochemistry majors
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. Chemistry and Biochemistry majors must take CHEM 370. CHEM 361 may not count towards CHEM-BS, BIOC-BS, or BIOC-BA degrees.
Course equivalencies: X- CHEM 370/CHEM 470
Outcomes:
Students will be able to demonstrate an understanding of structural-functional relationships in biological molecules and how carbohydrates are metabolized

CHEM 371 Biochemistry II (3 Credit Hours)
Pre-requisites: CHEM 370
This is the second part of a two-semester Biochemistry lecture series that emphasizes important biochemical concepts on lipid, amino acid and nucleotide metabolic pathways as well as the structure and function of nucleic acids. Special topics on sensory systems, motility, immunology and drug development will also be discussed.
Outcomes:
Students will be able to demonstrate an understanding of metabolic pathways and of current research topics in biochemistry

CHEM 372 Biochemistry Laboratory I (2 Credit Hours)
Pre-requisites: CHEM 242 or CHEM 222 or CHEM 226; and (CHEM 260 and CHEM 272) or (CHEM 212 and CHEM 214); and CHEM 370; Restricted to Biochemistry majors
This laboratory is designed to simulate a research experience and to teach basic techniques utilized in a biochemistry laboratory. The course theme involves a comparative investigation of the enzyme glyceraidehyde-3-phosphate dehydrogenase (GAPDH) from various animal sources. All procedures required in lab will be found by the student in the library and proposed to the instructor(s) as a pre-lab exercise. Each two-student team will be working on GAPDH from either an aquatic or land animal source, e.g., trout, tuna, pork beef or chicken.
Outcomes:
Students will be able to purify and characterize an enzyme in a research context

CHEM 373 Biochemistry Laboratory II (2 Credit Hours)
This laboratory course is designed to simulate a research project in which molecular biology techniques and biochemistry are integrated. Those techniques are used as important tools to help solve questions in enzyme structure and function. he course theme involves an investigation on the relationship between protein structure and function of the ADP-glucose pyrophosphorylase (ADP-Glc PPase) from Escherichia coli. All procedure required in lab will be found by the student in the library and proposed to the instructor(s) as a pre-lab exercise. Each two-student team will be working on a specific ADP-Glc PPase that has been previously obtained in a recombinant form. Their genes will be provided in a plasmid form. The student will learn strategies to produce and test a hypothesis in this area. Additionally, the student will learn how to integrate molecular biology techniques and biochemistry.
Outcomes:
Students will study the basic concepts of enzyme structure relationships and how to investigate them

CHEM 380 Chemistry Seminar (1 Credit Hour)
Pre-requisites: CHEM 240 or CHEM 222 or CHEM 224
A weekly seminar course with presentations, generally given by outside speakers, covering topics in chemistry usually not encountered in the classroom.
Outcomes:
Students will demonstrate their understanding by writing a one page summary of each presentation

CHEM 385 Advanced Enzyme Kinetics and Mechanisms (3 Credit Hours)
Pre-requisites: CHEM 370
The major themes in this course will be topics that are related to modern enzymology. The structure of this course will involve lectures by Dr. Ballicora for each topic, and discussion with the students.
Outcomes:
Students will be able to understand enzyme mechanisms and be able to make oral presentations on recently published articles

CHEM 386 The Chemistry of Enzymes (3 Credit Hours)
Pre-requisites: CHEM 370, restricted to Biochemistry majors
The course describes the chemical strategies employed by enzymes to accelerate reactions combined with an examination of the specialized methods employed to study enzyme chemistry. The course is lecture based with concurrent problems sets. The course content will focus on deductive reasoning to understand what is observed how best analyze data obtained from the study of enzymes.
Outcomes:
Students will gain an understanding of transient state chemical kinetics as it pertains to the study of enzymes

CHEM 387 Plant Biochemistry (3 Credit Hours)
Pre-requisites: CHEM 370
The major themes in this course will be about topics that are related to plant biochemistry and metabolism. The structure of the course will involve lectures for each topic, with discussion with the students. Students will learn how plants and photosynthetic organisms acquire and process energy. Plant metabolism will constitute a central part of the course, focusing on the main differences from other living organisms. A solid understanding of plant metabolism will inspire the student to think about all the possibilities that plant biochemistry and biotechnology offer to solve critical problems, such as malnutrition, global climate change, drug discovery, and infectious diseases.
Outcomes:
Students will be able to understand how knowledge of plant biochemistry is important in many areas, including medicine, nutrition and climate change

CHEM 388 Biophysical Chemistry (3 Credit Hours)
Pre-requisites: CHEM 361 or 370
Survey of experimental methods for the physicochemical characterization of biomolecules. Topics include electrophoresis, mass spectrometry, calorimetry, optical spectroscopy, NMR, and X-ray crystallography.
Outcomes:
Students will have a conceptual understanding of different experimental methods for the physicochemical characterization of biomolecules and will be able to evaluate utility and limitations of the different approaches

CHEM 395 Special Topics in Chemistry (3 Credit Hours)
Pre-requisites: Satisfactory progress toward completion of the core chemistry courses, and junior or senior status
Course content varies from semester to semester and has included advanced topics in analytical, inorganic, organic, physical, and biochemistry.
Outcomes:
Students will acquire an advanced understanding of a selected topic in chemistry

CHEM 395B Bioethics Minor Capstone: Chemical Topics (3 Credit Hours)
Pre-requisites: Two Science courses and two Ethics courses
This course number will only be used when CHEM 395 is tagged with the Bioethics Minor Capstone course.
Interdisciplinary Option: Bioethics
Outcomes:
Students will understand the connection between ethical and chemical issues with regard to the special topic in chemistry

CHEM 396 Special Topics in Biochemistry (1-3 Credit Hours)
1) Course content varies from semester to semester and includes advanced topics in biochemistry. 2) Satisfactory progress toward completion of the core chemistry courses, and junior or senior status. 3) Students will acquire an advanced understanding of a selected topic in biochemistry.

CHEM 399 Internship in Biochemistry or Chemistry (2-3 Credit Hours)
A supervised field placement to give students training or work experience in aspects of biochemistry or chemistry that are not commonly available on campus. Students will work outside the classroom (e.g. industrial setting or national lab) applying and extending their biochemistry or chemistry skills, typically for at least 150 hours to receive 3 credits or for more than 100 hours for 2 credits. Permission of faculty advisor Students must complete a total of 3 credits to receive engaged learning credit. This course satisfies the Engaged Learning requirement.
Outcomes:
Students will acquire practical experience in biochemistry or chemistry related job settings

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 (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.