

# DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY

## College of Sciences and Humanities

Department of Chemistry and Biochemistry  
214 Williams Hall  
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## Undergraduate Programs

- Biochemistry - B.S.
- Biotechnology - B.S.
- Chemistry - B.S.

## Minors

- Biochemistry
- Chemistry

## Graduate Programs

- Chemistry - M.A.
- Chemistry - M.S.
- Chemistry - Ph.D.

## Department of Chemistry and Biochemistry Faculty

- Abaysirigunawardena, Sanjaya C. (2015), Associate Professor, Ph.D., Wayne State University, 2008
- Abraham, Ann C. (2004), Associate Professor, Ph.D., University of Pittsburgh, 1983
- Bowers, David J. (2013), Associate Professor
- Bunge, Scott D. (2004), Associate Professor, Ph.D., Georgia Institute of Technology, 2001
- Burns, Andrew (1994), Professor, Ph.D., Brown University, 1990
- Cubon-Bell, Valerie A. (2010), Professor, Ph.D., Princeton University, 2008
- Datta, Bansidhar (2000), Associate Professor, University of Nebraska-Lincoln, 1989
- Dunietz, Barry (2012), Professor
- Ekanayake, Sujeewani K. (2012), Professor
- Fouad, Farid S. (2008), Professor, Ph.D., Northeastern University, 2003
- Friedrich, Dirk (2016), Associate Professor, Ph.D., Universitat Leipzig, 2013
- Goncalves Schmidt, Diana P. (2019), Assistant Professor
- Hegmann, Torsten (2011), Professor, Ph.D., Martin Luther University, 2001
- Huang, Songping D. (1998), Professor, Ph.D., Michigan State University, 1993
- Konar, Arkaprabha (2019), Assistant Professor, Ph.D., Michigan State University, 2015

- Leslie, Margaret R. (2004), Professor, Ph.D., Rhodes University, 1995
- Mao, Hanbin (2005), Professor, Ph.D., Texas A&M University, 2003
- Motry, Douglas H. (1996), Associate Professor, Ph.D., Michigan State University, 1996
- Pal Chaudhuri, Urmila (2008), Associate Professor, Ph.D., Indian Institute of Technology Madras, 2004
- Prevot, Marianne (2016), Assistant Professor
- Seed, Alexander J. (1996), Associate Professor, Ph.D., University of Hull
- Shen, Hao (2018), Assistant Professor, Ph.D., Cornell University, 2015
- Subramanian, Pritha (2006), Associate Professor, Ph.D., Kent State University, 2013
- Tandon, Santokh S. (2004), Professor, Ph.D., Guru Nanak Dev University, 1979
- Tubergen, Michael J. (1995), Professor, Ph.D., University of Chicago, 1991
- Wang, Zhiqiang (2007), Professor, Fudan University, 2000
- Zheng, Yaorong (2015), Associate Professor, Ph.D., University of Utah, 2011

## Biotechnology (BTEC)

### BTEC 10210 INTRODUCTION TO BIOTECHNOLOGY 3 Credit Hours

Basic principles and applications of modern biotechnology, including recombinant DNA technology, microbial technology, fermentation, genetic engineering, plant and animal tissue culture and medical biotechnology. Lecture three hours weekly.

**Prerequisite:** BSCI 10120.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

### BTEC 40191 SEMINAR: RECENT DEVELOPMENTS IN BIOTECHNOLOGY 1 Credit Hour

Recent developments in biotechnology explored through the presentation and discussion of research articles and reviews in the biotechnology literature.

**Prerequisite:** BTEC 10210; BSCI 30140, 30171, 30156; CHEM 30284.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter

### BTEC 40192 INTERNSHIP IN BIOTECHNOLOGY (ELR) 2-9 Credit Hours

(Repeatable for credit) Work experience in a biotechnology laboratory. Registration requires approval of program director and is dependent on availability of internship sites. Written report of activities required.

**Prerequisite:** Biotechnology major.

**Schedule Type:** Practical Experience

**Contact Hours:** 2-9 other

**Grade Mode:** Satisfactory/Unsatisfactory-IP

**Attributes:** Experiential Learning Requirement

**BTEC 40196 INDIVIDUAL INVESTIGATION IN BIOTECHNOLOGY (ELR) 2-9 Credit Hours**

(Repeatable for credit) Research experience in biotechnology. Registration requires approval of program director and research director. Written report required.

**Prerequisite:** Biotechnology major.

**Schedule Type:** Individual Investigation

**Contact Hours:** 2-9 other

**Grade Mode:** Satisfactory/Unsatisfactory-IP

**Attributes:** Experiential Learning Requirement

**BTEC 40210 CASE STUDIES IN BIOTECHNOLOGY (WIC) 3 Credit Hours**

Case studies used to explore biotechnology practice and the application of various technologies in industry and medicine. Emphasis placed on developing problem solving, information gathering, inductive reasoning and technical communication skills.

**Prerequisite:** BSCI 30140 and BSCI 30156 and BSCI 30171 and BSCI 40158 and BTEC 10210 and CHEM 30284.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**Attributes:** Writing Intensive Course

**BTEC 40220 BIOINFORMATICS 3 Credit Hours**

(Cross-listed with BSCI 40220, BSCI 50220 and BSCI 70220) Analysis of biological databases, including nucleic acid and protein sequence searching, multiple sequence alignment, protein classification, phylogenetic analysis, comparative genomics, proteomics, protein structure analysis.

**Prerequisite:** BSCI 30140 and BSCI 30156 and BSCI 40158.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**BTEC 40463 MEDICAL BIOTECHNOLOGY 3 Credit Hours**

(Cross-listed with BSCI 40463, BSCI 50463 and BSCI 70463) Medical Biotechnology provides a basic understanding of how living cells and cellular materials can be used for medical applications, particularly in the diagnosis and therapy of human diseases.

**Prerequisite:** BSCI 30140.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

## Chemistry (CHEM)

**CHEM 00020 INTRODUCTION TO CHEMISTRY 2 Credit Hours**

Problem-based introduction to the fundamentals of chemistry including significant figures, unit conversions, measurement, structure of matter, energy, composition of matter, atomic structure, the periodic table, introduction to bonding, and the formulas and names of both ionic and covalent compounds. Course does not count toward graduation.

**Prerequisite:** Math ACT score of 18; or ALEKS math assessment score of 45; or minimum C grade in any MATH course.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**CHEM 10030 CHEMISTRY IN OUR WORLD (KBS) 3 Credit Hours**

A course for non-science majors that utilizes environmental and consumer topics to introduce chemical principles and develop critical-thinking skills.

**Prerequisite:** None.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**Attributes:** Kent Core Basic Sciences, Transfer Module Natural Sciences

**CHEM 10031 CHEMISTRY IN OUR WORLD LABORATORY (KBS) (KLAB) 1 Credit Hour**

Discovery-based experiments to introduce chemical principles and develop critical-thinking skills. A course for non-science majors; includes chemistry that is related to environmental and consumer issues.

**Pre/corequisite:** CHEM 10030.

**Schedule Type:** Laboratory

**Contact Hours:** 3 lab

**Grade Mode:** Standard Letter

**Attributes:** Kent Core Basic Sciences, Kent Core Basic Sciences Lab, Transfer Module Natural Sciences, TAG Natural Science Lab

**CHEM 10050 FUNDAMENTALS OF CHEMISTRY (KBS) 3 Credit Hours**

Basic concepts of chemistry (including atomic structure, chemical bonding and reactions) necessary for courses in elementary organic chemistry and physiological chemistry. Students may only receive credit toward graduation for one of the following: CHEM 10050; or CHEM 10060 and CHEM 10061; or CHEM 10970 and CHEM 10971.

**Prerequisite:** Minimum 16 ACT math score or MATH 10675 or MATH 11009 or MATH 11010 or MATH 11012 or MATH 12002 or MATH 12011 or MATH 12021.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**Attributes:** Kent Core Basic Sciences, Transfer Module Natural Sciences

**CHEM 10055 MOLECULES OF LIFE (KBS) 3 Credit Hours**

An integrated introduction to molecular systems and their participation in the processes of life.

**Pre/corequisite:** MATH 10040 or MATH 10041 or MATH 10772 or MATH 10775 with a minimum C grade or any course between MATH 11009 to MATH 49998; or minimum 55 ALEKS math score; or minimum 22 ACT math score; or minimum 530 SAT math score.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**Attributes:** Kent Core Basic Sciences

**CHEM 10058 GENERAL CHEMISTRY FOR LIFE SCIENCES I (KBS) 4 Credit Hours**

This is a chemistry course for non-chemistry majors and those who are not on the premed/pre-pharm track. It focuses on fundamental concepts and the development of problem-solving strategies. Students are introduced to a variety of concepts in modern chemistry, emphasizing stoichiometry, introduction to chemical reactions, thermochemistry, periodicity, molecular structure, chemical bonding and behavior of gases. Classroom time is divided into lectures, discussions and problem-solving activities to enable students to develop foundational knowledge. Students may only receive credit toward graduation for one of the following courses: CHEM 10050 or CHEM 10055 or CHEM 10058 or CHEM 10060 or CHEM 10970 or CHEM 11060.

**Prerequisite:** MATH 10675 or MATH 10772 with a minimum C grade; or a pre/co-requisite of MATH 10775 or MATH 11009 or MATH 11010 and minimum 45 ALEKS math score.

**Schedule Type:** Lecture  
**Contact Hours:** 4 lecture  
**Grade Mode:** Standard Letter  
**Attributes:** Kent Core Basic Sciences

**CHEM 10059 GENERAL CHEMISTRY FOR LIFE SCIENCES II 4 Credit Hours**

Continuation of CHEM 10058, emphasizing intermolecular forces, properties of mixtures, kinetics, equilibrium, main group chemistry, acid-base chemistry, thermodynamics and electrochemistry. Students may only receive credit toward graduation for one of the following courses: CHEM 10050 or CHEM 10055 or CHEM 10059 or CHEM 10061 or CHEM 10971.

**Prerequisite:** Minimum C grade in the following courses: CHEM 10058 or CHEM 10060 or CHEM 10970 or CHEM 11060.

**Schedule Type:** Lecture  
**Contact Hours:** 4 lecture  
**Grade Mode:** Standard Letter

**CHEM 10060 GENERAL CHEMISTRY I (KBS) 4 Credit Hours**

(Equivalent to CHEM 11060) This is a college-level chemistry course for science majors, focusing on fundamental concepts and the development of problem-solving strategies and critical thinking. Students are introduced to a variety of concepts of modern chemistry, emphasizing stoichiometry, introduction to chemical reactions, thermochemistry, atomic structure, periodicity, molecular structure, chemical bonding and behavior of gases. Classroom time is divided into lectures, discussions and problem-solving activities to enable students to develop both foundational knowledge and analytical skills. Students may only receive credit toward graduation for one of the following courses: CHEM 10050 or CHEM 10055 or CHEM 10058 or CHEM 10060 or CHEM 10970 or CHEM 11060.

**Prerequisite:** Minimum C grade in the following courses: MATH 10675 or MATH 10772 or MATH 10775 or MATH 11009 or MATH 11010; or minimum 67 ALEKS math score; or minimum 27 ACT math score.  
**Pre/corequisite:** MATH 11022 or MATH 12002 or MATH 12021.

**Schedule Type:** Lecture  
**Contact Hours:** 4 lecture  
**Grade Mode:** Standard Letter  
**Attributes:** Kent Core Basic Sciences, TAG Science

**CHEM 10061 GENERAL CHEMISTRY II (KBS) 4 Credit Hours**  
 Continuation of CHEM 10060, emphasizing intermolecular forces, properties of mixtures, main group chemistry, kinetics, equilibrium, acid-base chemistry, thermodynamics and electrochemistry. Students may only receive credit toward graduation for one of the following courses: CHEM 10050 or CHEM 10055 or CHEM 10059 or CHEM 10061 or CHEM 10971.

**Prerequisite:** Minimum C grade in the following courses: CHEM 10060 or CHEM 10970 or CHEM 11060.

**Schedule Type:** Lecture  
**Contact Hours:** 4 lecture  
**Grade Mode:** Standard Letter  
**Attributes:** Kent Core Basic Sciences, TAG Science

**CHEM 10062 GENERAL CHEMISTRY I LABORATORY (KBS) (KLAB) 1 Credit Hour**

Laboratory covering pertinent aspects of CHEM 10060.  
**Pre/corequisite:** CHEM 10058 or CHEM 10060 or CHEM 10970 or CHEM 11060.

**Schedule Type:** Laboratory  
**Contact Hours:** 3 lab  
**Grade Mode:** Standard Letter  
**Attributes:** Kent Core Basic Sciences, Kent Core Basic Sciences Lab, TAG Science

**CHEM 10063 GENERAL CHEMISTRY II LABORATORY (KBS) (KLAB) 1 Credit Hour**

Laboratory covering pertinent aspects of CHEM 10061, including qualitative analysis.

**Prerequisite:** CHEM 10062.  
**Pre/corequisite:** CHEM 10059 or CHEM 10061 or CHEM 10971.

**Schedule Type:** Laboratory  
**Contact Hours:** 3 lab  
**Grade Mode:** Standard Letter  
**Attributes:** Kent Core Basic Sciences, Kent Core Basic Sciences Lab, TAG Science

**CHEM 10970 HONORS GENERAL CHEMISTRY I (KBS) 4 Credit Hours**

Rigorous general chemistry course for qualified students. Stoichiometry, equilibrium, thermochemistry, atomic structure and chemical bonding, descriptive inorganic and nuclear chemistry.

**Prerequisite:** Special approval.  
**Schedule Type:** Lecture  
**Contact Hours:** 4 lecture  
**Grade Mode:** Standard Letter  
**Attributes:** Kent Core Basic Sciences

**CHEM 10971 HONORS GENERAL CHEMISTRY II (KBS) 4 Credit Hours**

A continuation of CHEM 10970. Topics include properties of mixtures, properties of the elements, periodic patterns, organic compounds, kinetics, equilibrium, thermodynamics and electrochemistry.

**Prerequisite:** Minimum C grade in CHEM 10970.  
**Schedule Type:** Lecture  
**Contact Hours:** 4 lecture  
**Grade Mode:** Standard Letter  
**Attributes:** Kent Core Basic Sciences

**CHEM 11060 GENERAL CHEMISTRY I BOOST (KBS) 6 Credit Hours**  
 (Equivalent to CHEM 10060) This is a college-level chemistry course for science majors, focusing on fundamental concepts and the development of problem-solving strategies and critical thinking. Students are introduced to a variety of concepts of modern chemistry, emphasizing stoichiometry, introduction to chemical reactions, thermochemistry, atomic structure, periodicity, molecular structure, chemical bonding and behavior of gases. This course includes five lecture sessions and one recitation session. Classroom time is divided into lectures, discussions and problem-solving activities to enable students to develop both foundational knowledge and analytical skills. Recitation sessions include problem solving with an emphasis on developing core skills. The endpoint of this course is identical to that of CHEM 10060. Students may only receive credit toward graduation for one of the following courses: CHEM 10050 or CHEM 10055 or CHEM 10060 or CHEM 10970 or CHEM 11060.

**Prerequisite:** MATH 10675 or MATH 10772 with a minimum C grade; or minimum 45 ALEKS math score and a pre/co-requisite of MATH 10775 or MATH 11009 or MATH 11010.

**Schedule Type:** Lecture, Recitation

**Contact Hours:** 5 lecture, 1 other

**Grade Mode:** Standard Letter

**Attributes:** Kent Core Basic Sciences

**CHEM 20095 SPECIAL TOPICS 1-3 Credit Hours**  
 (Repeatable for credit) Selected topics in chemistry.

**Prerequisite:** Special approval.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Standard Letter

**CHEM 20098 INTRODUCTION TO CHEMICAL RESEARCH (ELR) 1-3 Credit Hours**

Research experience for freshmen and sophomores. Registration requires prior approval of the research director. Does not count toward the electives for the BS or BA chemistry degree. A written report is required.

**Prerequisite:** Minimum overall 2.500 GPA in Chemistry and special approval.

**Schedule Type:** Research

**Contact Hours:** 1-3 other

**Grade Mode:** Satisfactory/Unsatisfactory-IP

**Attributes:** Experiential Learning Requirement

**CHEM 20481 BASIC ORGANIC CHEMISTRY I 4 Credit Hours**

Survey of the structure, preparation and reactions (including mechanisms) of organic compounds emphasizing the chemistry of biologically important functional groups. Students may only receive credit toward graduation for one of the following courses: CHEM 10055 or CHEM 20481 or CHEM 30482.

**Prerequisite:** Minimum C grade in the following courses: CHEM 10059 or CHEM 10061 or CHEM 10971.

**Schedule Type:** Lecture

**Contact Hours:** 4 lecture

**Grade Mode:** Standard Letter

**Attributes:** TAG Science

**CHEM 20482 BASIC ORGANIC CHEMISTRY II 2 Credit Hours**

Continuation of CHEM 20481, emphasizing the chemistry of functional groups prevalent in biological chemistry. Students may only receive credit toward graduation for one of the following courses: CHEM 10055 or CHEM 20482 or CHEM 30482.

**Prerequisite:** Minimum C grade in CHEM 20481.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**Attributes:** TAG Science

**CHEM 30051 CAREER PATHWAYS IN CHEMISTRY 1 Credit Hour**

Designed to introduce students to the wide range of career pathways available in chemistry. Students learn different strategies for identifying and pursuing career opportunities, and develop their communication skills through writing assignments and oral presentations.

**Prerequisite:** None.

**Schedule Type:** Lecture

**Contact Hours:** 1 lecture

**Grade Mode:** Satisfactory/Unsatisfactory

**CHEM 30105 ANALYTICAL CHEMISTRY I 3 Credit Hours**

Covers the fundamental theory, experimental methods, and applications of analytical chemistry principles in chemistry as well as other related disciplines such as life sciences and environmental science. It covers analytical measurements, experimental error, statistics, chemical equilibrium and titration, spectrometry as well as analytical separation techniques.

**Prerequisite:** CHEM 10061 or CHEM 10971.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 30106 ANALYTICAL CHEMISTRY II 2 Credit Hours**

Covers the theoretical basis and experimental methods of analytical chemistry not considered in Analytical Chemistry I (CHEM 30105), such as noise reduction, advanced chemical equilibria and titrations, electrochemistry, atomic spectroscopy, instrumental design, and sample preparation.

**Prerequisite:** CHEM 30105.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**CHEM 30107 ANALYTICAL CHEMISTRY LABORATORY I (WIC) 1 Credit Hour**

Fundamental laboratory class for analytical chemistry. Provides hands-on experience to students on the subjects including data treatment, volumetric analysis, spectrophotometry, separation techniques and mass spectroscopy.

**Prerequisite:** CHEM 10063.

**Pre/corequisite:** CHEM 30105.

**Schedule Type:** Laboratory

**Contact Hours:** 3 lab

**Grade Mode:** Standard Letter

**Attributes:** Writing Intensive Course

**CHEM 30108 ANALYTICAL CHEMISTRY LABORATORY II (WIC) 2 Credit Hours**

Advanced analytical chemistry laboratory class which covers a broad range of modern analytical techniques, including ion-selective electrodes, voltammetry, atomic spectroscopy, mass-spectrometry and capillary electrophoresis. Unlike Analytic Chemistry Laboratory I (CHEM 30107) this class focuses on forensic rather than bioanalytical applications.

**Prerequisite:** CHEM 30105.

**Pre/corequisite:** CHEM 30107.

**Schedule Type:** Laboratory

**Contact Hours:** 6 lab

**Grade Mode:** Standard Letter

**Attributes:** Writing Intensive Course

**CHEM 30284 INTRODUCTORY BIOLOGICAL CHEMISTRY 4 Credit Hours**

Chemistry and metabolism of biochemically important compounds; nature of enzyme action; metabolic regulation and bioenergetics.

**Prerequisite:** CHEM 20481; or CHEM 30481 and CHEM 30482.

**Schedule Type:** Lecture

**Contact Hours:** 4 lecture

**Grade Mode:** Standard Letter

**CHEM 30301 INORGANIC CHEMISTRY I 3 Credit Hours**

Chemistry of hydrogen, ions in aqueous solution, redox reactions, coordination complexes: d-block chemistry, crystal field model, electronic spectra and magnetism, introduction to organometallic chemistry, periodic trends for p-block elements.

**Prerequisite:** CHEM 10061 or CHEM 10971.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 30475 ORGANIC CHEMISTRY LABORATORY I (ELR) 1 Credit Hour**

Practical experience in organic laboratory techniques on both micro- and macroscale: physical methods for purification and characterization of organic compounds, introduction to organic reactions.

**Prerequisite:** CHEM 10063.

**Pre/corequisite:** CHEM 20481 or 30481.

**Schedule Type:** Laboratory

**Contact Hours:** 1 lab

**Grade Mode:** Standard Letter

**Attributes:** Experiential Learning Requirement, TAG Science

**CHEM 30476 ORGANIC CHEMISTRY LABORATORY II 1 Credit Hour**

Continuation of CHEM 30475, involving multi-step organic experiments that utilize techniques introduced in CHEM 30475.

**Prerequisite:** CHEM 30475.

**Pre/corequisite:** CHEM 20482 or 30482.

**Schedule Type:** Laboratory

**Contact Hours:** 1 lab

**Grade Mode:** Standard Letter

**Attributes:** TAG Science

**CHEM 30481 ORGANIC CHEMISTRY I 4 Credit Hours**

Introduction to organic chemistry from structural, mechanistic and synthetic viewpoints with an emphasis on the chemistry of biologically relevant functional groups. Students may only receive credit toward graduation for one of the following courses: CHEM 10055 or CHEM 20481 or CHEM 30481.

**Prerequisite:** CHEM 10061 or CHEM 10971 with a minimum C grade.

**Schedule Type:** Lecture

**Contact Hours:** 4 lecture

**Grade Mode:** Standard Letter

**Attributes:** TAG Science

**CHEM 30482 ORGANIC CHEMISTRY II 4 Credit Hours**

Continuation of CHEM 30481; organic chemistry from mechanistic and synthetic viewpoints; IR and NMR spectroscopy; mass spectrometry. Students may only receive credit toward graduation for one of the following courses: CHEM 10055 or CHEM 20482 or CHEM 30482.

**Prerequisite:** CHEM 30481 with a minimum C grade.

**Schedule Type:** Lecture

**Contact Hours:** 4 lecture

**Grade Mode:** Standard Letter

**Attributes:** TAG Science

**CHEM 40092 INTERNSHIP IN CHEMISTRY AND BIOCHEMISTRY (ELR) 1-9 Credit Hours**

(Repeatable for credit) Workplace experience in chemistry or biochemistry relevant to a student's career objectives. Includes career advising and job search strategies. Comprehensive written report and presentation of activities required after completion of internship.

**Prerequisite:** Junior standing; and special approval.

**Schedule Type:** Practical Experience

**Contact Hours:** 3-27 other

**Grade Mode:** Satisfactory/Unsatisfactory-IP

**Attributes:** Experiential Learning Requirement

**CHEM 40093 VARIABLE TITLE WORKSHOP IN CHEMISTRY 1-6 Credit Hours**

(Repeatable for credit) Variable titled workshop in chemistry.

**Prerequisite:** Special approval.

**Schedule Type:** Workshop

**Contact Hours:** 1-6 other

**Grade Mode:** Satisfactory/Unsatisfactory

**CHEM 40099 SENIOR HONORS THESIS (ELR) 1-9 Credit Hours**

(Repeatable for credit) For departmental honors, may be started summer prior to senior year. Register each semester during senior year. Minimum total 5 credit hours.

**Prerequisite:** Special approval.

**Schedule Type:** Project or Capstone

**Contact Hours:** 1-9 other

**Grade Mode:** Standard Letter-IP

**Attributes:** Experiential Learning Requirement

**CHEM 40109 BIOANALYTICAL CHEMISTRY 3 Credit Hours**  
(Slashed with CHEM 50109 and CHEM 70109) Covers traditional as well as newly emerging topics in the field of bioanalytical chemistry. Provides an overview of the fundamental biological targets for bioanalytical assays, such as lipids, peptides, proteins, nucleic acids and cells. Briefly introduces traditional tools, such as chromatography, electrophoresis, mass spectrometry, fluorescence techniques, immunoassays, and biosensors. Discusses approaches most recently developed in the field, which include lab-on-a-chip and single molecule techniques.

**Prerequisite:** CHEM 30105.

**Pre/corequisite:** CHEM 30284 or CHEM 40245 or CHEM 40261.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 40113 CHEMICAL SEPARATIONS 3 Credit Hours**  
(Cross-listed with CHEM 50113 and CHEM 70113) Theory, instrumentation and applications of chemical separations for chemical analysis with an emphasis on gas and liquid chromatography.

**Prerequisite:** CHEM 30106.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 40115 APPLICATIONS OF SPECTROSCOPY AND IMAGING 3 Credit Hours**

(Slashed with CHEM 50115 and CHEM 70115) This course covers the fundamentals of optics, recent developments in spectroscopy and microscopy and their applications in chemistry. Included are methods of optical microscope-based spectroscopy and imaging in relation to analytical chemistry, biochemistry and polymer chemistry research; such as principles and applications of fluorescence spectroscopy, atomic force microscopy, optical tweezer and patch clamp.

**Prerequisite:** CHEM 30482.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 40195 SPECIAL TOPICS IN ANALYTICAL CHEMISTRY 1-3 Credit Hours**

(Slashed with CHEM 50195 and CHEM 70195) (Repeatable for credit) In depth examination of current topics in analytical chemistry through guided study of literature and presentations.

**Prerequisite:** Special approval.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Standard Letter

**CHEM 40245 BIOCHEMICAL FOUNDATIONS OF MEDICINE 4 Credit Hours**

(Slashed with CHEM 50245) Chemistry and metabolism of biologically important compounds; enzyme catalysis; metabolic regulation, inborn and induced errors of metabolism. Does not count toward the B.S. Biochemistry major.

**Prerequisite:** CHEM 30481.

**Pre/corequisite:** CHEM 30482.

**Schedule Type:** Lecture

**Contact Hours:** 4 lecture

**Grade Mode:** Standard Letter

**CHEM 40248 ADVANCED BIOLOGICAL CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 50248 and CHEM 70248) Supra-molecular structures of DNA, advanced topics in DNA replication, recombination, damage and repair; gene transcription, Pre-RNA processing, mRNA translation, post-translational modifications on proteins; protein folding, protein splicing, sorting of proteins in different parts of the cells, and protein turn-over; cell signaling and cell cycle; and genetic diseases and their therapies.

**Prerequisite:** CHEM 30284 or CHEM 40245.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 40251 ADVANCED BIOLOGICAL CHEMISTRY LABORATORY (WIC) 2 Credit Hours**

Practical experience in the characterization of biomolecules; recombinant DNA technology; electrophoretic separation of macromolecules, affinity purification; mass spectrometric approaches; protein folding; RNA structure, interactions and catalytic mechanisms.

**Pre/corequisite:** CHEM 40262.

**Schedule Type:** Laboratory

**Contact Hours:** 6 lab

**Grade Mode:** Standard Letter

**Attributes:** Writing Intensive Course

**CHEM 40261 BIOCHEMISTRY: BIOMOLECULE STRUCTURE AND FUNCTION 3 Credit Hours**

(Slashed with CHEM 50261 and CHEM 70261) Introduction to biochemical principles regarding the structure and function of biomolecules including water, amino acids, proteins, carbohydrates and lipids; emphasis on enzymes, membranes and bioenergetics.

**Prerequisite:** CHEM 20481 or CHEM 30482.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 40262 BIOCHEMISTRY: METABOLISM AND GENE EXPRESSION 3 Credit Hours**

(Slashed with CHEM 50262 and CHEM 70262) Aspects of biochemistry focusing on information, chemical and energy flow, including: integration of metabolic pathways; DNA replication, repair, recombination and modification; transcription and translation; signal transduction, post-translational modification.

**Prerequisite:** CHEM 30284 OR CHEM 40261.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 40263 PHYSICAL BIOCHEMISTRY 3 Credit Hours**

(Slashed with CHEM 50263 and CHEM 70263) Principles and techniques of physical chemistry used in studying biomacromolecules and biological systems, spectroscopy, structure and properties of biological molecules.

**Prerequisite:** CHEM 40555 or CHEM 40567; and CHEM 30284 or CHEM 40245 or CHEM 40261.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 40264 MEDICAL BIOCHEMISTRY 3 Credit Hours**

(Slashed with CHEM 50264 and CHEM 70264) The course provides an in-depth exploration of the biochemical basis for disease and its application to clinical medicine with an emphasis on new discoveries and other advances.

**Prerequisite:** CHEM 40262 or BSCI 40143.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 40295 SPECIAL TOPICS IN BIOCHEMISTRY 1-3 Credit Hours**

(Slashed with CHEM 50295 and CHEM 70295) (Repeatable for credit) In depth examination of current topics in biochemistry through guided study of literature and presentations.

**Prerequisite:** Special approval.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Standard Letter

**CHEM 40302 INORGANIC CHEMISTRY II 3 Credit Hours**

(Slashed with CHEM 50302) Physical techniques of inorganic chemistry, molecular structure and bonding, metallic and ionic solids, organometallic chemistry, homogeneous and heterogeneous catalysis; solid-state and materials chemistry, nanomaterials, nanoscience and nanotechnology; molecular symmetry, molecular orbital theory of polyatomic molecules and octahedral complexes, electronic spectra and reaction mechanisms of d-block complexes.

**Prerequisite:** CHEM 30301.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 40303 INORGANIC CHEMISTRY III 2 Credit Hours**

(Slashed with CHEM 50303) Molecular symmetry, molecular orbital theory of polyatomic molecules and octahedra complexes, electronic spectra and reaction mechanisms of d-block complexes, periodic trends of Groups 1 and 2 and d-block, bioinorganic chemistry.

**Prerequisite:** CHEM 40302.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**CHEM 40352 INORGANIC MATERIALS CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 50352 and CHEM 70352) Broad survey of the synthesis, properties, characterization and applications of inorganic materials.

**Prerequisite:** CHEM 40302.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 40364 INTERMEDIATE INORGANIC CHEMISTRY LAB 1 Credit Hour**

A laboratory course providing experience in the synthesis of significant inorganic compounds and the techniques of various experimental and spectroscopic methods and chromatographic separations.

**Prerequisite:** CHEM 40302.

**Schedule Type:** Laboratory

**Contact Hours:** 3 lab

**Grade Mode:** Standard Letter

**CHEM 40365 BIOLOGICAL INORGANIC CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 50365 and CHEM 70365) Physical methods, s-block metals, metal ion-induced folding, electron transfer proteins, oxidoreductases, substrate binding and activation by non-redox mechanisms, biomineralization, group-atom transfer and metals in medicine.

**Prerequisite:** CHEM 30301.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 40395 SPECIAL TOPICS IN INORGANIC CHEMISTRY 1-3 Credit Hours**

(Slashed with CHEM 50395 and CHEM 70395) (Repeatable for credit) In depth examination of current topics in inorganic chemistry through guided study of literature and presentations.

**Prerequisite:** Special approval.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Standard Letter

**CHEM 40451 ORGANIC MATERIALS CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 50451 and CHEM 70451) Broad survey of the synthesis, properties, characterization and applications of organic and polymeric materials.

**Prerequisite:** CHEM 30482.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 40476 SPECTROSCOPIC IDENTIFICATION OF ORGANIC COMPOUNDS 2 Credit Hours**

(Slashed with CHEM 50476 and CHEM 70476) Strategies for structural elucidation of organic compounds from analysis of infrared, proton and carbon NMR, and mass spectrometric data through lectures and problem solving.

**Prerequisite:** CHEM 30482.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**CHEM 40477 INTERMEDIATE ORGANIC CHEMISTRY LABORATORY 1 Credit Hour**

(Slashed with CHEM 50477) Continuation of CHEM 30476, including hands-on use of a high-field NMR spectrometer; single and multistep organic syntheses.

**Prerequisite:** CHEM 30476 and CHEM 40483.

**Schedule Type:** Laboratory

**Contact Hours:** 1 lab

**Grade Mode:** Standard Letter

**CHEM 40483 INTERMEDIATE ORGANIC CHEMISTRY 2 Credit Hours**

(Slashed with CHEM 50483 and CHEM 70483) Continuation of CHEM 30482; organic chemistry from mechanistic and synthetic viewpoints, including synthetic design, organotransition metal chemistry and free radical chemistry.

**Prerequisite:** CHEM 30482 with a minimum C grade.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**CHEM 40485 PHYSICAL ORGANIC CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 50485 and CHEM 70485) This course presents a modern view of organic chemistry through the study of organic reaction mechanisms, advanced chemical bonding theories, high-energy intermediates and reactivity patterns common to organic chemical reactions. Emphasis is placed on synthetic organic chemistry with a focus on chemical structure, reactivity, chemical kinetics, thermodynamics, physical and chemical behavior and reaction mechanisms. Central to these investigations is understanding the use of molecular spectroscopy and molecular modeling software as investigative tools. A specific goal of this course is to introduce students to concepts necessary to solving mechanistic organic problems encountered in the research laboratory. The course covers common organic reaction mechanisms, experimental techniques and theoretical approaches to understanding reaction mechanisms. All topics are approached from a structural and mechanistic perspective. Emphasis is also placed on the importance of organic chemistry in biochemical systems. Classroom time is divided into lectures, discussions and problem solving sessions to enable students to develop both advanced knowledge and problem solving skills in organic chemistry.

**Prerequisite:** Minimum C grade in CHEM 30482.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 40495 SPECIAL TOPICS IN ORGANIC CHEMISTRY 1-3 Credit Hours**

(Slashed with CHEM 50495 and CHEM 70495) (Repeatable for credit) In depth examination of current topics in organic chemistry through guided study of literature and presentations.

**Prerequisite:** Special approval.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Standard Letter

**CHEM 40541 ADVANCED PHYSICAL CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 50541 and CHEM 70541) Covers basic materials of modern physical chemistry in two broad areas: thermodynamics and introductory quantum mechanics.

**Prerequisite:** CHEM 40556.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 40555 PHYSICAL CHEMISTRY I 3 Credit Hours**

(Slashed with CHEM 50555 and CHEM 70555) Fundamental concepts of physical chemistry, with example problems chosen emphasizing applications in chemistry and the biological sciences.

**Prerequisite:** Minimum C grade in CHEM 10061 or CHEM 10971; and a minimum C grade in MATH 12003; and PHY 23102.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 40556 PHYSICAL CHEMISTRY II 3 Credit Hours**

(Slashed with CHEM 50556 and CHEM 70556) A continuation of CHEM 40555. Areas covered include quantum mechanics, atomic and molecular structure, spectroscopy, statistical mechanics, theories of reaction rates and the solid state.

**Prerequisite:** CHEM 40555 or PHY 45301.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 40557 PHYSICAL CHEMISTRY LABORATORY 2 Credit Hours**

(Slashed with CHEM 50557 and CHEM 70557) Experiments in numerous areas of physical chemistry, including the interpretation and reporting of obtained experimental data, correlation of results with theory and an introduction to the computer treatment of data.

**Prerequisite:** CHEM 40556.

**Schedule Type:** Laboratory

**Contact Hours:** 3 lab

**Grade Mode:** Standard Letter

**CHEM 40559 NANOMATERIALS 3 Credit Hours**

(Slashed with CHEM 50559 and CHEM 70559) Fundamental aspects of nanomaterials ranging from nanoparticles to three-dimensional (3D) nanostructures emphasizing their synthesis, chemistry and applications.

**Prerequisite:** CHEM 10061 or CHEM 10971 and; CHEM 40555 or CHEM 40567.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 40563 QUANTUM CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 50563 and CHEM 70563) This course builds on the physical chemistry course sequence and introduces advanced topics of quantum mechanics and their applications in chemistry and towards understanding the electronic structure of atoms and molecules.

**Prerequisite:** CHEM 40556.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 40564 COMPUTATIONAL CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 50564 and CHEM 70564) The course introduces the theoretical foundations and practical techniques of computational chemistry research.

**Pre/corequisite:** CHEM 40556 or CHEM 40567.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 40567 PHYSICAL CHEMISTRY FOR LIFE SCIENCES 4 Credit Hours**

Traditional aspects of physical chemistry with minimal calculus treatment. Applications to the health sciences emphasized.

**Prerequisite:** Minimum C grade in CHEM 10061 or CHEM 10971; and MATH 12002 or MATH 12021.

**Pre/corequisite:** PHY 13002 or PHY 23102.

**Schedule Type:** Lecture

**Contact Hours:** 4 lecture

**Grade Mode:** Standard Letter

**CHEM 40568 ELEMENTARY PHYSICAL CHEMISTRY LABORATORY 1 Credit Hour**

Provides hands-on experience with calorimetry, viscosimetry and spectroscopic techniques.

**Prerequisite:** CHEM 40555 or CHEM 40567.

**Schedule Type:** Laboratory

**Contact Hours:** 1 lab

**Grade Mode:** Standard Letter

**CHEM 40571 SURFACE CHEMISTRY 2 Credit Hours**

(Slashed with CHEM 50571 and CHEM 70571) Treatment of basic principles and concepts in surface and colloid chemistry. Relationship to practical systems emphasized. Two hours lecture weekly.

**Prerequisite:** CHEM 40555 or CHEM 40567.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**CHEM 40595 SPECIAL TOPICS IN PHYSICAL CHEMISTRY 1-3 Credit Hours**

(Slashed with CHEM 50595 and CHEM 70595) (Repeatable for credit) In depth examination of current topics in physical chemistry through guided study of literature and presentations.

**Prerequisite:** Special approval.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Standard Letter

**CHEM 40795 CURRENT TOPICS IN CHEMICAL EDUCATION 1-3 Credit Hours**

(Slashed with CHEM 50795) (Repeatable for credit) Recent advances in chemical research, instrumentation and theory important to chemical educators.

**Prerequisite:** Permission.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Satisfactory/Unsatisfactory

**CHEM 40796 INDIVIDUAL INVESTIGATION 1-8 Credit Hours**

(Repeatable for credit) Registration requires prior approval of the research director. Written report required. Maximum of two hours may be applied to the four hour CHEM 40000 elective requirement for the chemistry concentration within the B.S. in Chemistry.

**Prerequisite:** Minimum 2.500 overall GPA in Chemistry; and special approval.

**Schedule Type:** Individual Investigation

**Contact Hours:** 1-8 other

**Grade Mode:** Satisfactory/Unsatisfactory-IP

**CHEM 41010 BIOPHOTONICS 3 Credit Hours**

(Slashed with CHEM 51010) (Cross-listed with BSCI 41110 and BSCI 51110 and PHY 41010 and PHY 51010) Interdisciplinary overview of the basics of biophotonics; application of biophotonic techniques to probe biological samples. Introduction to the foundations of optics and photonics and how the molecular structure of organic molecules translates into unique photonic properties and targeting in biological cells or tissue. Preparation of fluorescent materials, advanced spectroscopy and cell visualization using regular and confocal fluorescence microscopy.

**Prerequisite:** Special approval.

**Schedule Type:** Combined Lecture and Lab

**Contact Hours:** 1 lecture, 6 lab

**Grade Mode:** Standard Letter

**CHEM 50093 VARIABLE TITLE WORKSHOP IN CHEMISTRY 1-6 Credit Hours**

(Repeatable for credit) Variable titled workshop in chemistry.

**Prerequisite:** Graduate standing; and special approval.

**Schedule Type:** Workshop

**Contact Hours:** 1-6 other

**Grade Mode:** Satisfactory/Unsatisfactory

**CHEM 50109 BIOANALYTICAL CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40109 and CHEM 70109) Covers traditional as well as newly emerging topics in the field of bioanalytical chemistry. The course will provide an overview of the fundamental biological targets for the bioanalytical assays, such as lipids, peptides, proteins, nucleic acids, and cells. The course will then briefly introduce traditional tools, such as chromatography, electrophoresis, mass spectrometry, fluorescence techniques, immunoassays, and biosensors. Finally, the course will discuss approaches most recently developed in the field, which include lab-on-a-chip and single molecule techniques.

**Prerequisite:** CHEM 30105; and graduate standing; and special approval.

**Corequisite:** CHEM 30284 or 40245 or 40261.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 50113 CHEMICAL SEPARATIONS 3 Credit Hours**

(Slashed with CHEM 40113 and CHEM 70113) Theory, instrumentation and applications of chemical separations for chemical analysis. Emphasis on gas and liquid chromatography.

**Prerequisite:** CHEM 30106; and graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 50115 APPLICATIONS OF SPECTROSCOPY AND IMAGING 3 Credit Hours**

(Slashed with CHEM 40115 and CHEM 70115) This course covers the fundamentals of optics, recent developments in spectroscopy and microscopy and their applications in chemistry. Included are methods of optical microscope-based spectroscopy and imaging in relation to analytical chemistry, biochemistry and polymer chemistry research; such as principles and applications of fluorescence spectroscopy, atomic force microscopy, optical tweezer and patch clamp.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 50166 PRINCIPLES AND APPLICATIONS IN ANALYTICAL CHEMISTRY 2 Credit Hours**

Survey of important principles and concepts and their application in Analytical Chemistry.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**CHEM 50195 SPECIAL TOPICS IN ANALYTICAL CHEMISTRY 1-3 Credit Hours**

(Slashed with CHEM 40195 and CHEM 70195) (Repeatable for credit) In depth examination of current topics in analytical chemistry through guided study of literature and presentations.

**Prerequisite:** Graduate standing; and special approval.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Standard Letter

**CHEM 50245 BIOCHEMICAL FOUNDATIONS OF MEDICINE 4 Credit Hours**

(Slashed with CHEM 40245) Introduction to chemistry and metabolism of important compounds in biological systems; enzymes and characteristics of enzyme catalysis; regulation of metabolism at molecular, cellular and organism levels; inborn and induced errors of metabolism. Designed and scheduled for and priority given to students in integrated life sciences program.

**Prerequisite:** CHEM 30481; and graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 4 lecture

**Grade Mode:** Standard Letter

**CHEM 50248 ADVANCED BIOLOGICAL CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40248 and CHEM 70248) Supra-molecular structures of DNA, advanced topics in DNA replication, recombination, damage and repair; gene transcription, Pre-RNA processing, mRNA translation, post-translational modifications on proteins; protein folding, protein splicing, sorting of proteins in different parts of the cells, and protein turn-over; cell signaling and cell cycle; and genetic diseases and their therapies.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 50261 BIOCHEMISTRY: BIOMOLECULE STRUCTURE AND FUNCTION 3 Credit Hours**

(Slashed with CHEM 40261 and CHEM 70261) Introduction to biochemical principles regarding the structure and function of biomolecules including water, amino acids, proteins, carbohydrates and lipids; emphases on enzymes, membranes and bioenergetics.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 50262 BIOCHEMISTRY: METABOLISM AND GENE EXPRESSION 3 Credit Hours**

(Slashed with CHEM 40262 and CHEM 70262) Aspects of biochemistry focusing on information, chemical and energy flow, including: integration of metabolic pathways; DNA replication, repair, recombination and modification; transcription and translation; signal transduction, and post-translational modification.

**Prerequisite:** CHEM 50261 or CHEM 70261; and graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 50263 PHYSICAL BIOCHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40263 and CHEM 70263) Principles and techniques of physical chemistry used in studying biomacro-molecules and biological systems. Topics covered are thermodynamics, spectroscopy, structure and properties of biological molecules.

**Prerequisite:** Graduate standing in Chemistry.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 50264 MEDICAL BIOCHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40264 and CHEM 70264) Course provides an in-depth exploration of the biochemical basis for disease and its application to clinical medicine with an emphasis on new discoveries and other advances.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 50266 PRINCIPLES AND APPLICATIONS IN BIOCHEMISTRY 2 Credit Hours**

Survey of important principles and concepts and their application in biochemistry.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture, 2 lab

**Grade Mode:** Standard Letter

**CHEM 50295 SPECIAL TOPICS IN BIOCHEMISTRY 1-3 Credit Hours**

(Slashed with CHEM 40295 and CHEM 70295) (Repeatable for credit) In depth examination of current topics in biochemistry through guided study of literature and presentations.

**Prerequisite:** Graduate standing; and special approval.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Standard Letter

**CHEM 50302 INORGANIC CHEMISTRY II 3 Credit Hours**

(Slashed with CHEM 40302) Physical techniques of inorganic chemistry, molecular structure and bonding, metallic and ionic solids, organometallic chemistry, homogeneous and heterogeneous catalysis; solid-state and materials chemistry, nanomaterials, nanoscience and nanotechnology; molecular symmetry, molecular orbital theory of polyatomic molecules and octahedral complexes, electronic spectra and reaction mechanisms of d-block complexes.

**Prerequisite:** CHEM 30301; and graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 50303 INORGANIC CHEMISTRY III 2 Credit Hours**

(Slashed with CHEM 40303) Molecular symmetry, molecular orbital theory of polyatomic molecules and octahedral complexes, electronic spectra and reaction mechanisms of d-block complexes, periodic trends Groups 1 and 2 and d-block, bioinorganic chemistry.

**Prerequisite:** CHEM 50302; and graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**CHEM 50352 INORGANIC MATERIALS CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40352 and CHEM 70352) Broad survey of the synthesis, properties, characterization and applications of inorganic materials.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 50365 BIOLOGICAL INORGANIC CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40365 and CHEM 70365) Physical methods, s-block metals, metal-induced stabilization, electron transfer proteins, oxidoreductases, hydrolases and lyases, metal transport and storage, nitrogenases, group-atom transfer and metals in medicine.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 50366 PRINCIPLES AND APPLICATIONS IN INORGANIC CHEMISTRY 2 Credit Hours**

Survey of important principles and concepts and their application in inorganic chemistry.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**CHEM 50395 SPECIAL TOPICS IN INORGANIC CHEMISTRY 1-3 Credit Hours**

(Slashed with CHEM 40395 and CHEM 70395) (Repeatable for credit) In depth examination of current topics in inorganic chemistry through guided study of literature and presentations.

**Prerequisite:** Graduate standing; and special approval.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Standard Letter

**CHEM 50451 ORGANIC MATERIALS CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40451 and CHEM 70451) Broad survey of the synthesis, properties, characterization and applications of organic and polymeric materials.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 50466 PRINCIPLES AND APPLICATIONS IN ORGANIC CHEMISTRY 2 Credit Hours**

Survey of important principles and concepts and their application in Organic Chemistry.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**CHEM 50476 SPECTROSCOPIC IDENTIFICATION OF ORGANIC COMPOUNDS 2 Credit Hours**

(Slashed with CHEM 40476 and CHEM 70476) Strategies for structural elucidation of organic compounds from analysis of infrared, proton and carbon NMR and mass spectrometric data through lectures and problem solving.

**Prerequisite:** CHEM 30482; and graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**CHEM 50477 INTERMEDIATE ORGANIC CHEMISTRY LABORATORY 1 Credit Hour**

Continuation of CHEM 30476, including hands-on use of a high-field NMR spectrometer; single and multistep organic syntheses.

**Prerequisite:** CHEM 50483 and graduate standing.

**Schedule Type:** Laboratory

**Contact Hours:** 1 lab

**Grade Mode:** Standard Letter

**CHEM 50483 INTERMEDIATE ORGANIC CHEMISTRY 2 Credit Hours**

(Slashed with CHEM 40483 and CHEM 70483) Organic chemistry from mechanistic and synthetic viewpoints, including synthetic design, organotransition metal chemistry and free radical chemistry.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**CHEM 50485 PHYSICAL ORGANIC CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40485 and CHEM 70485) This course presents a modern view of organic chemistry through the study of organic reaction mechanisms, advanced chemical bonding theories, high-energy intermediates and reactivity patterns common to organic chemical reactions. Emphasis is placed on synthetic organic chemistry with a focus on chemical structure, reactivity, chemical kinetics, thermodynamics, physical and chemical behavior and reaction mechanisms. Central to these investigations is understanding the use of molecular spectroscopy and molecular modeling software as investigative tools. A specific goal of this course is to introduce students to concepts necessary to solving mechanistic organic problems encountered in the research laboratory. The course covers common organic reaction mechanisms, experimental techniques and theoretical approaches to understanding reaction mechanisms. All topics are approached from a structural and mechanistic perspective. Emphasis is also placed on the importance of organic chemistry in biochemical systems. Classroom time is divided into lectures, discussions and problem solving sessions to enable students to develop both advanced knowledge and problem solving skills in organic chemistry.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 50495 SPECIAL TOPICS IN ORGANIC CHEMISTRY 1-3 Credit Hours**

(Slashed with CHEM 40495 and CHEM 70495) (Repeatable for credit) In depth examination of current topics in organic chemistry through guided study of literature and presentations.

**Prerequisite:** Graduate standing; and special approval.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Standard Letter

**CHEM 50541 ADVANCED PHYSICAL CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40541 and CHEM 70541) Covers basic materials of modern physical chemistry in two broad areas: thermodynamics and introductory quantum mechanics.

**Prerequisite:** CHEM 50556; and graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 50555 PHYSICAL CHEMISTRY I 3 Credit Hours**

(Slashed with CHEM 40555 and CHEM 70555) Fundamental concepts of physical chemistry, with example problems chosen emphasizing application in chemistry and the biological sciences.

**Prerequisite:** Graduate standing in Chemistry.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 50556 PHYSICAL CHEMISTRY II 3 Credit Hours**

(Slashed with CHEM 40556 and CHEM 70556) A continuation of CHEM 50555. Areas covered are chemical kinetics, quantum chemistry and the solid state.

**Prerequisite:** CHEM 50555 or PHY 45301; and graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 50557 PHYSICAL CHEMISTRY LABORATORY 2 Credit Hours**

(Slashed with CHEM 40557 and CHEM 70557) Experiments in numerous areas of physical chemistry, including the interpretation and reporting of obtained experimental data, correlation of results with theory and an introduction to the computer treatment of data.

**Prerequisite:** Graduate standing.

**Pre/corequisite:** CHEM 50555 and CHEM 50556.

**Schedule Type:** Laboratory

**Contact Hours:** 4 lab

**Grade Mode:** Standard Letter

**CHEM 50559 NANOMATERIALS 3 Credit Hours**

(Slashed with CHEM 40559 and CHEM 70559). Fundamental aspects of nanomaterials ranging from nanoparticles to three-dimensional (3D) nanostructures emphasizing their synthesis, chemistry and applications.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 50563 QUANTUM CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40563 and CHEM 70563) This course builds on the physical chemistry course sequence and introduces advanced topics of quantum mechanics and their applications in chemistry and towards understanding the electronic structure of atoms and molecules.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 50564 COMPUTATIONAL CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40564 and CHEM 70564) The course introduces the theoretical foundations and practical techniques of computational chemistry research.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 50566 PRINCIPLES AND APPLICATIONS IN PHYSICAL CHEMISTRY 2 Credit Hours**

Survey of key principles and concepts and their application in Physical Chemistry.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**CHEM 50571 SURFACE CHEMISTRY 2 Credit Hours**

(Slashed with CHEM 40571 and CHEM 70571) Treatment of basic principles and concepts in surface and colloid chemistry. Relationship to practical systems emphasized.

**Prerequisite:** CHEM 40555 or 40567; and graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**CHEM 50595 SPECIAL TOPICS IN PHYSICAL CHEMISTRY 1-3 Credit Hours**

(Slashed with CHEM 40595 and CHEM 70595) (Repeatable for credit) In depth examination of current topics in physical chemistry through guided study of literature and presentations.

**Prerequisite:** Graduate standing; and special approval.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Standard Letter

**CHEM 50795 CURRENT TOPICS IN CHEMICAL EDUCATION 1-3 Credit Hours**

(Repeatable for credit) (Slashed with CHEM 40795) Designed to present recent advances in chemical research, instrumentation and theory to chemistry educators.

**Prerequisite:** Graduate standing; and special approval.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Satisfactory/Unsatisfactory

**CHEM 51010 BIOPHOTONICS 3 Credit Hours**

(Slashed with CHEM 41010) (Cross-listed with BSCI 41110 and BSCI 51110 and PHY 41010 and PHY 51010) Interdisciplinary overview of the basics of biophotonics; application of biophotonic techniques to probe biological samples. Introduction to the foundations of optics and photonics and how the molecular structure of organic molecules translates into unique photonic properties and targeting in biological cells or tissue. Preparation of fluorescent materials, advanced spectroscopy and cell visualization using regular and confocal fluorescence microscopy.

**Prerequisite:** Graduate standing; and special approval.

**Schedule Type:** Combined Lecture and Lab

**Contact Hours:** 1 lecture, 6 lab

**Grade Mode:** Standard Letter

**CHEM 60099 MASTERS CAPSTONE PROJECT 3-6 Credit Hours**

(Repeatable for credit) Capstone project in the form of literature reviews or research projects covering topics in chemistry, biochemistry or chemical education.

**Prerequisite:** Graduate standing.

**Schedule Type:** Project or Capstone

**Contact Hours:** 3-6 other

**Grade Mode:** Satisfactory/Unsatisfactory-IP

**CHEM 60199 THESIS I 2-6 Credit Hours**

Thesis students must register for a total of 6 hours, 2 to 6 hours in single semester distributed over several semesters if desired.

**Prerequisite:** Graduate standing.

**Schedule Type:** Masters Thesis

**Contact Hours:** 2-6 other

**Grade Mode:** Satisfactory/Unsatisfactory-IP

**CHEM 60254 BIOMEMBRANES 2 Credit Hours**

(Slashed with CHEM 70254) Biological membranes; composition, structure, dynamics and biogenesis; structure/function of protein mediated membrane transport.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**CHEM 60291 SEMINAR: RECENT DEVELOPMENTS IN BIOCHEMISTRY 1 Credit Hour**

(Repeatable for credit) (Slashed with CHEM 70291) Presentation and discussion of research papers from current biochemistry literature. Participation by students and faculty.

**Prerequisite:** Graduate standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 60299 THESIS II 2 Credit Hours**

Thesis students must continue registration until all degree requirements are met.

**Prerequisite:** CHEM 60199; and graduate standing.

**Schedule Type:** Masters Thesis

**Contact Hours:** 2 other

**Grade Mode:** Satisfactory/Unsatisfactory-IP

**CHEM 60327 MODERN INORGANIC CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 70327) Synthesis, structure and reactivity of inorganic compounds including transition metal and organometallic complexes.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 60391 SEMINAR: RECENT DEVELOPMENTS IN INORGANIC CHEMISTRY 1 Credit Hour**

(Repeatable for credit) (Slashed with CHEM 70391) Presentation and discussion of research papers from current inorganic chemistry literature. Participation by students and faculty.

**Prerequisite:** Graduate standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 60472 ADVANCED ORGANIC CHEMISTRY-SYNTHETIC ASPECTS 3 Credit Hours**

(Slashed with CHEM 70472) Disconnection approach to organic synthesis. Modern methods for carbon-carbon bond formation and functional group interconversion, and their application to natural product synthesis.

**Prerequisite:** CHEM 30482; and graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 60473 STEREOSELECTIVE ORGANIC SYNTHESIS 3 Credit Hours**

(Slashed with CHEM 70473) Modern methods of asymmetric synthesis; introduction to selected methods for stereoselective N-heterocycle synthesis; application of these methods in natural product synthesis.

**Prerequisite:** CHEM 30482; and graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 60541 ADVANCED PHYSICAL CHEMISTRY 3 Credit Hours**

Covers basic materials of modern physical chemistry in two broad areas: thermodynamics and introductory quantum mechanics.

**Prerequisite:** CHEM 50556; and graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 60591 SEMINAR: RECENT DEVELOPMENTS IN PHYSICAL CHEMISTRY 1 Credit Hour**

(Repeatable for credit) (Slashed with CHEM 70591) Presentation and discussion of research papers from current physical chemistry literature. Participation by students and faculty.

**Prerequisite:** Graduate standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 60691 SEMINAR: RECENT DEVELOPMENTS IN INDUSTRIAL CHEMISTRY 1 Credit Hour**

Presentation and discussion of research papers from the current industrial chemistry field. Participation by students and faculty.

**Prerequisite:** Graduate standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter

**CHEM 60894 COLLEGE TEACHING OF CHEMISTRY 1 Credit Hour**

(Repeatable for credit) (Slashed with CHEM 70894) Experience in teaching of chemistry at college level.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 1 lecture

**Grade Mode:** Satisfactory/Unsatisfactory

**CHEM 60898 MASTERS RESEARCH 1-15 Credit Hours**

(Repeatable for credit) Research for master's students. Credits earned may be applied toward degree if department approves.

**Prerequisite:** Graduate standing.

**Schedule Type:** Research

**Contact Hours:** 1-15 other

**Grade Mode:** Satisfactory/Unsatisfactory-IP

**CHEM 61191 SEMINAR: PROBLEM SOLVING IN ANALYTICAL CHEMISTRY 1 Credit Hour**

(Repeatable for credit) (Slashed with CHEM 71191) Problem solving in analytical chemistry, including chemical analysis methods, instrumentation, sample preparation, and data handling.

**Prerequisite:** Graduate standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 61491 SEMINAR: PROBLEM SOLVING IN ORGANIC CHEMISTRY 1 Credit Hour**

(Repeatable for credit) (Slashed with CHEM 71491) Practical experience in the solving of current problems of synthesis, spectroscopy, and mechanism in organic chemistry.

**Prerequisite:** Graduate standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 62191 SEMINAR: ANALYTICAL CHEMISTRY 1 Credit Hour**

(Repeatable for credit) (Slashed with CHEM 72191) Student and faculty presentations on topics in analytical chemistry.

**Prerequisite:** Graduate standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 62291 SEMINAR: BIOCHEMISTRY 1 Credit Hour**

(Repeatable for credit) (Slashed with CHEM 72291) Student and faculty presentations on topics in biochemistry

**Prerequisite:** Graduate standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 62391 SEMINAR: INORGANIC CHEMISTRY 1 Credit Hour**

(Repeatable for credit) (Slashed with CHEM 72391) Student and faculty presentations on topics in inorganic chemistry.

**Prerequisite:** Graduate standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 62491 SEMINAR: ORGANIC CHEMISTRY 1 Credit Hour**

(Repeatable for credit) (Slashed with CHEM 72491) Presentation of topics from the recent literature on aspects of organic chemistry including synthesis, spectroscopy, mechanism, and materials properties.

**Prerequisite:** Graduate standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 62591 SEMINAR: PHYSICAL CHEMISTRY 1 Credit Hour**

(Repeatable for credit) (Slashed with CHEM 72591) Student and faculty presentations on topics in physical chemistry.

**Prerequisite:** Graduate standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 62691 SEMINAR: INDUSTRIAL CHEMISTRY 1 Credit Hour**

Presentation of current research in industrial chemistry. Participation by students and faculty.

**Prerequisite:** Graduate standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter

**CHEM 62791 SEMINAR: CHEMICAL EDUCATION 1 Credit Hour**

Presentation of current research in chemical education. Participation by students and faculty.

**Prerequisite:** Graduate standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter

**CHEM 70093 VARIABLE TITLE WORKSHOP IN CHEMISTRY 1-6 Credit Hours**

(Repeatable for credit) Variable title workshop in Chemistry.

**Prerequisite:** Doctoral standing; and special approval.

**Schedule Type:** Workshop

**Contact Hours:** 1-6 other

**Grade Mode:** Satisfactory/Unsatisfactory

**CHEM 70109 BIOANALYTICAL CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40109 and CHEM 50109) Covers traditional as well as newly emerging topics in the field of bioanalytical chemistry. The course will provide an overview of the fundamental biological targets for the bioanalytical assays, such as lipids, peptides, proteins, nucleic acids, and cells. The course will then briefly introduce traditional tools, such as chromatography, electrophoresis, mass spectrometry, fluorescence techniques, immunoassays, and biosensors. Finally, the course will discuss approaches most recently developed in the field, which include lab-on-a-chip and single molecule techniques.

**Prerequisite:** CHEM 30105; and doctoral standing; and special approval.

**Corequisite:** CHEM 30284 or CHEM 40245 or CHEM 40261.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70113 CHEMICAL SEPARATIONS 3 Credit Hours**

(Slashed with CHEM 40113 and CHEM 50113) Theory, instrumentation and applications of chemical separations for chemical analysis. Emphasis on gas and liquid chromatography.

**Prerequisite:** CHEM 30106; and doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70115 APPLICATIONS OF SPECTROSCOPY AND IMAGING 3 Credit Hours**

(Slashed with CHEM 40115 and CHEM 50115) This course covers the fundamentals of optics, recent developments in spectroscopy and microscopy and their applications in chemistry. Included are methods of optical microscope-based spectroscopy and imaging in relation to analytical chemistry, biochemistry and polymer chemistry research; such as principles and applications of fluorescence spectroscopy, atomic force microscopy, optical tweezer and patch clamp.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70195 SPECIAL TOPICS IN ANALYTICAL CHEMISTRY 1-3 Credit Hours**

(Slashed with CHEM 40195 and CHEM 50195) (Repeatable for credit) In depth examination of current topics in analytical chemistry through guided study of literature and presentations.

**Prerequisite:** Doctoral standing; and special approval.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Standard Letter

**CHEM 70248 ADVANCED BIOLOGICAL CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40248 and CHEM 50248) Supra-molecular structures of DNA, advanced topics in DNA replication, recombination, damage and repair; gene transcription, Pre-RNA processing, mRNA translation, post-translational modifications on proteins; protein folding, protein splicing, sorting of proteins in different parts of the cells, and protein turn-over; cell signaling and cell cycle; and genetic diseases and their therapies.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70254 BIOMEMBRANES 2 Credit Hours**

(Slashed with CHEM 60254) Biological membranes; composition, structure, dynamics and biogenesis; structure/function of protein mediated membrane transport.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**CHEM 70261 BIOCHEMISTRY: BIOMOLECULE STRUCTURE AND FUNCTION 3 Credit Hours**

(Slashed with CHEM 40261 and CHEM 50261) Introduction to biochemical principles regarding the structure and function of biomolecules including water, amino acids, proteins, carbohydrates and lipids; emphases on enzymes, membranes and bioenergetics.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70262 BIOCHEMISTRY: METABOLISM AND GENE EXPRESSION 3 Credit Hours**

(Slashed with CHEM 40262 and CHEM 50262) Aspects of biochemistry focusing on information, chemical and energy flow, including: integration of metabolic pathways; DNA replication, repair, recombination and modification; transcription and translation; signal transduction, and post-translational modification.

**Prerequisite:** CHEM 50261 or CHEM 70261; and doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70263 PHYSICAL BIOCHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40263 and CHEM 50263) Principles and techniques of physical chemistry used in studying biomacromolecules and biological systems. Topics covered are thermodynamics, spectroscopy, structure and properties of biological molecules.

**Prerequisite:** Doctoral standing in Chemistry.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70264 MEDICAL BIOCHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40264 and CHEM 50264) The course provides an in-depth exploration of the biochemical basis for disease and its application to clinical medicine with an emphasis on new discoveries and other advances.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70291 SEMINAR: RECENT DEVELOPMENTS IN BIOCHEMISTRY 1 Credit Hour**

(Slashed with CHEM 60291)(Repeatable for credit) Presentation and discussion of research papers from current biochemistry literature. Participation by students and faculty.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 70295 SPECIAL TOPICS IN BIOCHEMISTRY 1-3 Credit Hours**

(Slashed with CHEM 40295 and CHEM 50295) (Repeatable for credit) In depth examination of current topics in biochemistry through guided study of literature and presentations.

**Prerequisite:** Doctoral standing; and special approval.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Standard Letter

**CHEM 70327 MODERN INORGANIC CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 60327) Synthesis, structure and reactivity of inorganic compounds including transition metal and organometallic complexes.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70352 INORGANIC MATERIALS CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40352 and CHEM 50352) Broad survey of the synthesis, properties, characterization and applications of inorganic materials.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70365 BIOLOGICAL INORGANIC CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40365 and CHEM 50365) Physical methods, s-block metals, metal-induced stabilization, electron transfer proteins, oxidoreductases, hydrolases and lyases, metal transport and storage, nitrogenases, group-atom transfer and metals in medicine.

**Prerequisite:** CHEM 30301; and doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70391 SEMINAR: RECENT DEVELOPMENTS IN INORGANIC CHEMISTRY 1 Credit Hour**

(Slashed with CHEM 60391)(Repeatable for credit) Presentation and discussion of research papers from current inorganic chemistry literature. Participation by students and faculty.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 70395 SPECIAL TOPICS IN INORGANIC CHEMISTRY 1-3 Credit Hours**

(Slashed with CHEM 40395 and CHEM 50395) (Repeatable for credit) In depth examination of current topics in inorganic chemistry through guided study of literature and presentations.

**Prerequisite:** Doctoral standing; and special approval.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Standard Letter

**CHEM 70451 ORGANIC MATERIALS CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40451 and CHEM 50451) Broad survey of the synthesis, properties characterization and applications of organic and polymeric materials.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70472 ADVANCED ORGANIC CHEMISTRY-SYNTHETIC ASPECTS 3 Credit Hours**

(Slashed with CHEM 60472) Disconnection approach to organic synthesis. Modern methods for carbon-carbon bond formation and functional group interconversion, and their application to natural product synthesis. Doctoral standing.

**Prerequisite:** CHEM 30482.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70473 STEREOSELECTIVE ORGANIC SYNTHESIS 3 Credit Hours**

(Slashed with CHEM 60473) Modern methods of asymmetric synthesis; introduction to selected methods for stereoselective N-heterocycle synthesis; application of these methods in natural product synthesis.

**Prerequisite:** CHEM 30482; and doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70476 SPECTROSCOPIC IDENTIFICATION OF ORGANIC COMPOUNDS 2 Credit Hours**

(Slashed with CHEM 40476 and CHEM 50476) Strategies for structural elucidation of organic compounds from analysis of infrared, proton and carbon NMR, and mass spectrometric data through lectures and problem solving.

**Prerequisite:** CHEM 30482; and doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**CHEM 70483 INTERMEDIATE ORGANIC CHEMISTRY 2 Credit Hours**

(Slashed with CHEM 40483 and CHEM 50483) Organic chemistry from mechanistic and synthetic viewpoints, including synthetic design, organotransition metal chemistry and free radical chemistry.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**CHEM 70485 PHYSICAL ORGANIC CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40485 and CHEM 50485) This course presents a modern view of organic chemistry through the study of organic reaction mechanisms, advanced chemical bonding theories, high-energy intermediates and reactivity patterns common to organic chemical reactions. Emphasis is placed on synthetic organic chemistry with a focus on chemical structure, reactivity, chemical kinetics, thermodynamics, physical and chemical behavior and reaction mechanisms. Central to these investigations is understanding the use of molecular spectroscopy and molecular modeling software as investigative tools. A specific goal of this course is to introduce students to concepts necessary to solving mechanistic organic problems encountered in the research laboratory. The course covers common organic reaction mechanisms, experimental techniques and theoretical approaches to understanding reaction mechanisms. All topics are approached from a structural and mechanistic perspective. Emphasis is also placed on the importance of organic chemistry in biochemical systems. Classroom time is divided into lectures, discussions and problem solving sessions to enable students to develop both advanced knowledge and problem solving skills in organic chemistry.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70495 SPECIAL TOPICS IN ORGANIC CHEMISTRY 1-3 Credit Hours**

(Slashed with CHEM 40495 and CHEM 50495) (Repeatable for credit) In depth examination of current topics in organic chemistry through guided study of literature and presentations.

**Prerequisite:** Doctoral standing; and special approval.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Standard Letter

**CHEM 70541 ADVANCED PHYSICAL CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40541 and CHEM 50541) Covers basic materials of modern physical chemistry in two broad areas: thermodynamics and introductory quantum mechanics.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70555 PHYSICAL CHEMISTRY I 3 Credit Hours**

(Slashed with CHEM 40555 and CHEM 50555) Fundamental concepts of physical chemistry, with example problems chosen emphasizing applications in chemistry and the biological sciences.

**Prerequisite:** Doctoral standing in Chemistry.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70556 PHYSICAL CHEMISTRY II 3 Credit Hours**

(Slashed with CHEM 40556 and CHEM 50556) Fundamental concepts of physical chemistry of current interest. Included are biological and medical aspects of physical chemistry. Graduate credit given to nonchemistry and nonphysics majors and with permission to certain chemistry majors.

**Prerequisite:** CHEM 50555 or 70555; and doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70557 PHYSICAL CHEMISTRY LABORATORY 2 Credit Hours**  
(Slashed with CHEM 40557 and CHEM 50557) Experiments in numerous areas of physical chemistry, including the interpretation and reporting of obtained experimental data correlation of results with theory and an introduction to the computer treatment of data.

**Prerequisite:** Doctoral standing.

**Pre/corequisite:** CHEM 70555 and CHEM 70556.

**Schedule Type:** Laboratory

**Contact Hours:** 4 lab

**Grade Mode:** Standard Letter

**CHEM 70559 NANOMATERIALS 3 Credit Hours**

(Slashed with CHEM 40559 and CHEM 50559) Fundamental aspects of nanomaterials ranging from nanoparticles to three-dimensional (3D) nanostructures emphasizing their synthesis, chemistry and applications.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70563 QUANTUM CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40563 and CHEM 50563) This course builds on the physical chemistry course sequence and introduces advanced topics of quantum mechanics and their applications in chemistry and towards understanding the electronic structure of atoms and molecules.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70564 COMPUTATIONAL CHEMISTRY 3 Credit Hours**

(Slashed with CHEM 40564 and CHEM 50564) The course introduces the theoretical foundations and practical techniques of computational chemistry research.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**CHEM 70571 SURFACE CHEMISTRY 2 Credit Hours**

(Slashed with CHEM 40571 and CHEM 50571) Treatment of basic principles and concepts in surface and colloid chemistry. Relationship to practical systems emphasized.

**Prerequisite:** CHEM 40555 or CHEM 40567; and doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**CHEM 70591 SEMINAR: RECENT DEVELOPMENTS IN PHYSICAL CHEMISTRY 1 Credit Hour**

(Slashed with CHEM 60591)(Repeatable for credit) Presentation and discussion of research papers from current physical chemistry literature. Participation by students and faculty.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 70595 SPECIAL TOPICS IN PHYSICAL CHEMISTRY 1-3 Credit Hours**

(Slashed with CHEM 40595 and CHEM 50595) (Repeatable for credit) In depth examination of current topics in physical chemistry through guided study of literature and presentations.

**Prerequisite:** Doctoral standing; and special approval.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Standard Letter

**CHEM 70894 COLLEGE TEACHING OF CHEMISTRY 1 Credit Hour**

(Repeatable for credit) (Slashed with CHEM 60894) Experience in teaching of chemistry at college level.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 1 lecture

**Grade Mode:** Satisfactory/Unsatisfactory

**CHEM 71191 SEMINAR: PROBLEM SOLVING IN ANALYTICAL CHEMISTRY 1 Credit Hour**

(Slashed with CHEM 61191)(Repeatable for credit) Problem solving in analytical chemistry, including chemical analysis methods, instrumentation, sample preparation, and data handling.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 71491 SEMINAR: PROBLEM SOLVING IN ORGANIC CHEMISTRY 1 Credit Hour**

(Slashed with CHEM 61491)(Repeatable for credit) Practical experience in the solving of current problems of synthesis, spectroscopy, and mechanism in organic chemistry.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 72191 SEMINAR: ANALYTICAL CHEMISTRY 1 Credit Hour**

(Repeatable for credit) (Slashed with CHEM 62191) Student and faculty presentations on topics in analytical chemistry.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 72291 SEMINAR: BIOCHEMISTRY 1 Credit Hour**

(Repeatable for credit) (Slashed with CHEM 62291) Student and faculty presentations on topics in biochemistry.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 72391 SEMINAR: INORGANIC CHEMISTRY 1 Credit Hour**

(Slashed with CHEM 62391)(Repeatable for credit) Student and faculty presentations on topics in inorganic chemistry.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 72491 SEMINAR: ORGANIC CHEMISTRY 1 Credit Hour**

(Slashed with CHEM 62491)(Repeatable for credit) Presentation of topics from the recent literature on aspects of organic chemistry including synthesis, spectroscopy, mechanism, and materials properties.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 72591 SEMINAR: PHYSICAL CHEMISTRY 1 Credit Hour**

(Slashed with CHEM 62591)(Repeatable for credit) Student and faculty presentations on topics in physical chemistry.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Standard Letter-IP

**CHEM 80199 DISSERTATION I 15 Credit Hours**

(Repeatable for credit) Doctoral dissertation, for which registration in two semesters is required, first of which will be semester in which dissertation work is begun and continuing until the completion of 30 hours.

**Prerequisite:** Doctoral standing; and special approval.

**Schedule Type:** Dissertation

**Contact Hours:** 15 other

**Grade Mode:** Satisfactory/Unsatisfactory-IP

**CHEM 80299 DISSERTATION II 15 Credit Hours**

(Repeatable for credit) Continuing registration required of doctoral students who have completed the initial 30 hours of dissertation and continuing until all degree requirements are met.

**Prerequisite:** CHEM 80199; and doctoral standing.

**Schedule Type:** Dissertation

**Contact Hours:** 15 other

**Grade Mode:** Satisfactory/Unsatisfactory-IP

**CHEM 80898 RESEARCH 1-15 Credit Hours**

(Repeatable for credit) Research for doctoral students. Credits earned may be applied toward degree if department approves.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Research

**Contact Hours:** 1-15 other

**Grade Mode:** Satisfactory/Unsatisfactory-IP