Chemistry

David L. Thorsell, PhD, Chair

Objectives

The Chemistry Department has a strong student-centered chemistry program focused on skills and practices that promote career and personal development. The faculty is committed to innovative teaching methods and providing collaborative research experience for all interested students. Recently remodeled research laboratories and new equipment, including a 400MHz NMR spectrometer, provide an excellent environment for students to engage in undergraduate research projects. Through the promotion of undergraduate research opportunities, the department encourages one of the most effective methods of learning chemistry and building skills, confidence and résumés for later professional goals.

Programs offered by the Chemistry Department are designed to prepare the student for professional work in the various fields of basic and applied chemistry. The bachelor of science in chemistry or bachelor of science in biochemistry degree is recommended to students who wish to prepare themselves for graduate studies in chemistry, biochemistry, medical/dental school or for work in the chemical or biochemical industry. Both of these degrees have options for certification by the American Chemical Society. Some additional courses are required to meet the certification requirements.

The bachelor of arts degree is recommended for those desiring a solid foundation in chemistry along with greater freedom of choice for elective courses from programs such as education, business, engineering, or other fields within the university.

Degrees Offered

Bachelor of Arts
Bachelor of Science in Chemistry (and American Chemical Society certified option)
Bachelor of Science in Biochemistry (and American Chemical Society certified option)

Majors Offered

Chemistry
Chemistry with specialization in Humanities for Teaching
Biochemistry

Minor Offered

Chemistry

Bachelor of Arts
Major in Chemistry

In order to earn the bachelor of arts degree with a major in chemistry, students must complete a minimum of 180 quarter credits with a cumulative and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

ENGL 110	**College Writing: Inquiry and Argument**	**5**
PHIL 110	**Introduction to Philosophy and Critical Thinking**	**5**

Choose one of the following two courses: 5

HIST 120 **Origins of Western Civilization**
HIST 121 **Studies in Modern Civilization**

ENGL 120 **Introduction to Literature** **5**
Fine Arts (one approved 5 credit course; see course descriptions) **5**
PHIL 220 **Philosophy of the Human Person** **5**
Social Science I **5**
Social Science II (different discipline from Social Science I) **5**
Theology and Religious Studies Phase II (200-299) **5**
Ethics (upper division) **5**
Theology and Religious Studies Phase III (300-399) **5**
Interdisciplinary ..... **3 to 5**
Senior Synthesis ..... ***3 to 5**

*Major requirement.

NOTE: The senior synthesis core requirement for the bachelor of arts degree with a chemistry major is CHEM 488, 489 and 1 to 3 credits of CHEM 499 or 1 credit of CHEM 490.

II. Major Program Requirements

47 credits in chemistry, including:

CHEM 121 **General Chemistry I** **4**
CHEM 131 **General Chemistry Lab I** **1**
CHEM 122 **General Chemistry II** **4**
CHEM 132 **General Chemistry Lab II** **1**
CHEM 123 **General Chemistry III** **4**
CHEM 133 **General Chemistry Lab III** **1**
CHEM 231 **Fundamental Organic Chemistry I** **4**
CHEM 241 **Fundamental Organic Chemistry Lab I** **2**
CHEM 232 **Fundamental Organic Chemistry II** **4**
CHEM 242 **Fundamental Organic Chemistry Lab II** **2**
CHEM 319 **Quantitative Analysis** **5**
CHEM 361 **Physical Chemistry II** **3**
CHEM 371 **Physical Chemistry Lab I** **2**

Choose 10 credits from among the following electives 10

CHEM 260 **Laboratory Safety (2)**
CHEM 360 **Physical Chemistry I (3)**
CHEM 362 **Physical Chemistry III (3)**
CHEM 372 **Physical Chemistry Lab II (2)**
CHEM 415 **Advanced Inorganic Chemistry (3)**
CHEM 425 **Synthetic Inorganic Chemistry Lab (2)**
CHEM 426 **Instrumental Analysis (5)**
CHEM 436 **Advanced Organic Chemistry (3)**
CHEM 454 **Biochemistry I (3)**
CHEM 455 **Biochemistry II (2)**
CHEM 456 **Biochemistry III (3)**
CHEM 464 **Biochemistry Lab I (2)**
CHEM 465 **Biochemistry Lab II (1)**
CHEM 499 **Undergraduate Research (1 to 3)**
and special topics or independent study courses.

III. Other Major Department Requirements

MATH 134	**Calculus I**	**5**
MATH 135	**Calculus II**	**5**
MATH 136	**Calculus III**	**5**
MATH 232	**Multivariable Calculus**	**3**

Choose physics series a or b 15

a. PHYS 105	**Mechanics**	
PHYS 106	**Waves, Sound, Electricity and Magnetism**	
PHYS 107	**Thermodynamics, Optics and Modern Physics**	
b. PHYS 121	**Mechanics**	
PHYS 122	**Electricity and Magnetism**	
PHYS 123	**Waves and Optics**	

Bachelor of Arts
Major in Chemistry
Specialization in Humanities for Teaching

In order to earn the bachelor of arts degree with a major in chemistry and specialization in humanities in teaching, students must complete a minimum of 180 credits with a cumulative grade point of 2.50 and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

HUMT 150	**Composition: Language and Thought**	**5**
HUMT 151	**Composition: Language and the Arts**	**5**
HUMT 152	**Logic, Ethics, and Discernment**	**5**
HUMT 161	**Humanities: Introduction to Tutoring**	**2**
HUMT 162	**Humanities: Introduction to Tutoring**	**1**
HUMT 163	**Humanities: Introduction to Tutoring**	**1**
HUMT 171	**Proseminar: Humanistic Foundations of Education**	**5**
HUMT 180	**Socio-Cultural Transformations I**	**5**
HUMT 181	**Socio-Cultural Transformations II**	**5**
HUMT 182	**Socio-Cultural Transformations III**	**5**
HUMT 273	**Seminar on Secondary Education**	**5**
HUMT 274	**Supervised Internship in Secondary Education**	**5**
HUMT 301	**Perspectives on the Person I**	**5**
HUMT 302	**Perspectives on the Person II**	**5**
HUMT 371	**Education and the Polity**	**5**
HUMT 372	**Leadership and Teaching**	**5**
HUMT 380	**Cultural Interface**	**5**
HUMT 400	**Seminar on Contemporary Problems**	**5**
HUMT 471	**Jesuit Education**	**5**
HUMT 472	**Jesuit Education Practicum**	**5**
CISS 120	**Poverty in America**	**5**

II. Major Program Requirements

CHEM 121/131	**General Chemistry I**	**5**
CHEM 122/132	**General Chemistry II**	**5**
CHEM 123/133	**General Chemistry III**	**5**

CHEM 231/241	**Fundamental Organic Chemistry I**	**6**
CHEM 232/242	**Fundamental Organic Chemistry II**	**6**
CHEM 319	**Quantitative Analysis**	**5**
CHEM 361	**Physical Chemistry II**	**3**
CHEM 371	**Physical Chemistry Lab I**	**2**
CHEM 260	**Laboratory Safety**	**2**
CHEM 454	**Biochemistry I**	**3**
CHEM 488/489	**Senior Synthesis**	**3**

Choose 5 credits from the following electives: 5

CHEM 360	**Physical Chemistry I (3)**
CHEM 362	**Physical Chemistry III (3)**
CHEM 372	**Physical Chemistry Lab (2)**
CHEM 415	**Advanced Inorganic Chemistry (3)**
CHEM 425	**Synthetic Inorganic Chemistry Lab (2)**
CHEM 426	**Instrumental Analysis (5)**
CHEM 436	**Advanced Organic Chemistry (3)**
CHEM 455	**Biochemistry II (2)**
CHEM 456	**Biochemistry III (3)**
CHEM 464	**Biochemistry Lab I (2)**
CHEM 465	**Biochemistry Lab II (1)**
CHEM 499	**Undergraduate Research (1 to 3)**

III. Other Major Department Requirements

BIOL 161	**Biology I: Molecular and Cellular Biology**	**4**
BIOL 171	**Biology I Lab**	**1**
MATH 134	**Calculus I**	**5**
MATH 135	**Calculus II**	**5**
MATH 136	**Calculus III**	**5**
MATH 232	**Multivariable Calculus**	**3**

Choose option a or b 15

a. PHYS 105	**Mechanics**
PHYS 106	**Waves, Sound, Electricity and Magnetism**
PHYS 107	**Thermodynamics, Optics and Modern Physics**
b. PHYS 121	**Mechanics**
PHYS 122	**Electricity and Magnetism**
PHYS 123	**Waves and Optics**

NOTE: For a secondary endorsement in general science, 5 credits of earth science is required.

Bachelor of Science in Chemistry

In order to earn the bachelor of science in chemistry degree, students must complete a minimum of 180 quarter credits with a cumulative and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

ENGL 110	**College Writing: Inquiry and Argument**	**5**
PHIL 110	**Introduction to Philosophy and Critical Thinking**	**5**

Choose one of the following two courses: 5

HIST 120	**Origins of Western Civilization**
HIST 121	**Studies in Modern Civilization**

ENGL 120	**Introduction to Literature**	**5**
Fine Arts (one approved 5 credit course; see course descriptions)		**5**
PHIL 220	**Philosophy of the Human Person**	**5**
Social Science I		**5**
Social Science II (different discipline from Social Science I)		**5**
Theology and Religious Studies Phase II (200-299)		**5**
Ethics (upper division)		**5**
Theology and Religious Studies Phase III (300-399)		**5**
Interdisciplinary		**3 to 5**
Senior Synthesis (CHEM 488, 489, and 499 required)		***3 to 5**

*Major requirement.

II. Major Requirements

60 credits in chemistry, including:

CHEM 121	**General Chemistry I**	**4**
CHEM 131	**General Chemistry Lab I**	**1**
CHEM 122	**General Chemistry II**	**4**
CHEM 132	**General Chemistry Lab II**	**1**
CHEM 123	**General Chemistry III**	**4**
CHEM 133	**General Chemistry Lab III**	**1**
CHEM 319	**Quantitative Analysis**	**5**
CHEM 335	**Organic Chemistry I**	**3**
CHEM 345	**Organic Chemistry Lab I**	**2**
CHEM 336	**Organic Chemistry II**	**3**
CHEM 346	**Organic Chemistry Lab II**	**2**
CHEM 337	**Organic Chemistry III**	**4**
CHEM 347	**Organic Chemistry Lab III**	**2**
CHEM 360	**Physical Chemistry I**	**3**
CHEM 361	**Physical Chemistry II**	**3**
CHEM 371	**Physical Chemistry Lab I**	**2**
CHEM 362	**Physical Chemistry III**	**3**
CHEM 372	**Physical Chemistry Lab II**	**2**
CHEM 426	**Instrumental Analysis**	**5**
CHEM	**Electives (400 level)**	**6**

III. Other Major Department Requirements

MATH 134	**Calculus I**	**5**
MATH 135	**Calculus II**	**5**
MATH 136	**Calculus III**	**5**
MATH 232	**Multivariable Calculus**	**3**
PHYS 121	**Mechanics**	**5**
PHYS 122	**Electricity and Magnetism**	**5**
PHYS 123	**Waves and Optics**	**5**

NOTE: 1. For the American Chemical Society certified degree option, the 6-credit elective, above under II, must be replaced by CHEM 415, CHEM 425, CHEM 454, CHEM 464, and three additional credits of

approved advanced work in chemistry (CHEM 499 is acceptable here). 2. For students planning graduate work, any of the courses, MATH 233, MATH 234, or CHEM 415, 425, 436, 454, 455, 456, 464, and 465 are strongly recommended as electives. 3. The senior synthesis core requirement for the bachelor of science degree in chemistry is CHEM 488, 489 and 1 to 3 credits of CHEM 499.

Bachelor of Science in Biochemistry

In order to earn the bachelor of science in biochemistry degree, students must complete a minimum of 180 quarter credits with a cumulative and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

ENGL 110	**College Writing: Inquiry and Argument**	**5**
PHIL 110	**Introduction to Philosophy and Critical Thinking**	**5**
Choose one of the following two courses:		5
HIST 120	**Origins of Western Civilization**	
HIST 121	**Studies in Modern Civilization**	
ENGL 120	**Introduction to Literature**	**5**
Fine Arts (one approved 5 cr. course; see course descriptions)		**5**
PHIL 220	**Philosophy of the Human Person**	**5**
Social Science I		**5**
Social Science II (different discipline from Social Science I)		**5**
Theology and Religious Studies Phase II (200-299)		**5**
Ethics (upper division)		**5**
Theology and Religious Studies Phase III (300-399)		**5**
Interdisciplinary		**3 to 5**
Senior Synthesis (CHEM 488, 489, and 499 required)		***3 to 5**

*Major requirement

II. Major Requirements

60 credits of chemistry, including:

CHEM 121	**General Chemistry I**	**4**
CHEM 131	**General Chemistry Lab I**	**1**
CHEM 122	**General Chemistry II**	**4**
CHEM 132	**General Chemistry Lab II**	**1**
CHEM 123	**General Chemistry III**	**4**
CHEM 133	**General Chemistry Lab III**	**1**
CHEM 215	**Fundamental Inorganic Chemistry**	**3**
CHEM 319	**Quantitative Analysis**	**5**
CHEM 335	**Organic Chemistry I**	**3**
CHEM 345	**Organic Chemistry Lab I**	**2**
CHEM 336	**Organic Chemistry II**	**3**
CHEM 346	**Organic Chemistry Lab II**	**2**
CHEM 337	**Organic Chemistry III**	**4**
CHEM 347	**Organic Chemistry Lab III**	**2**
CHEM 361	**Physical Chemistry II**	**3**
CHEM 371	**Physical Chemistry Lab I**	**2**
CHEM 454	**Biochemistry I**	**3**

CHEM 455	**Biochemistry II**	**2**
CHEM 456	**Biochemistry III**	**3**
CHEM 464	**Biochemistry Lab 1**	**2**
CHEM 465	**Biochemistry Lab II**	**1**

Choose option a or b 5

a. CHEM 426	**Instrumental Analysis (5)**
b. CHEM 362	**Physical Chemistry III (3)**
CHEM 372	**Physical Chemistry Lab II (2)**

III. Other Major Department Requirements

BIOL 161	**Biology I: Molecular and Cellular Biology**	**4**
BIOL 171	**Biology I Lab**	**1**

Choose 10 credits from the following six courses: 10

BIOL 163	**Biology III: Physiology and Development (4)**
BIOL 173	**Biology III Lab (1)**
BIOL 240	**Genetics (5)**
BIOL 300	**Microbiology (5)**
BIOL 440	**Molecular Genetics (5)**
BIOL 485	**Cell Biology (5)**

MATH 134	**Calculus I**	**5**
MATH 135	**Calculus II**	**5**
MATH 136	**Calculus III**	**5**
MATH 232	**Multivariable Calculus**	**3**
PHYS 121	**Mechanics**	**5**
PHYS 122	**Electricity and Magnetism**	**5**
PHYS 123	**Waves and Optics**	**5**

NOTE: 1. For the American Chemical Society certified degree option, the student must take CHEM 425 and both CHEM 426 and CHEM 362/372. CHEM 360 and 362/372 are highly recommended electives for students planning graduate work in biochemistry. 2. The senior synthesis core requirement for the bachelor of science degree in biochemistry is CHEM 488, 489 and 1 to 3 credits of CHEM 499.

Minor in Chemistry

In order to earn a minor in chemistry, students must complete 35 credits in chemistry, including:

CHEM 121	**General Chemistry I**	**4**
CHEM 131	**General Chemistry Lab I**	**1**
CHEM 122	**General Chemistry II**	**4**
CHEM 132	**General Chemistry Lab II**	**1**
CHEM 123	**General Chemistry III**	**4**
CHEM 133	**General Chemistry Lab III**	**1**
CHEM 319	**Quantitative Analysis**	**5**
CHEM Elective (200-level or above)		***5**
Organic Chemistry (200-level or above)		**10**

*1 credit from CHEM/CRJS 480 Forensic Science may apply towards the CHEM elective requirement in the minor.

See policy for minors (84-1) for more information.

Chemistry Courses

Credit may be received for only one of each of the following sets of courses: CHEM 231/330/335; 232/331/336; 241/345; 242/346. A student who completes CHEM 231 with a grade of B or better may enroll in CHEM 336 with the instructor permission.

All prerequisite courses must be completed with a grade of C- or better for the prerequisite to be fulfilled.

CHEM 101 Introductory General Chemistry 5
Survey of inorganic chemistry, treating the basic principles and descriptive material relevant to the health sciences. Core lab science course. Four lecture and three laboratory hours per week. Prerequisite: MATH 107 or 110, or placement at a higher math level. (fall, winter, spring)

CHEM 102 Introductory Organic and Biochemistry 5
Organic chemistry and introduction to biochemistry with application to the health sciences. Four lecture and three laboratory hours per week. Prerequisite: CHEM 101 or equivalent.

CHEM 104 Chemistry, Food and Nutrition 5
Basic general and organic chemistry in the contexts of food and nutrition, including atoms and molecules, ionic and molecular substances, chemical reactions, minerals, vitamins, fats and oils, lipids, carbohydrates, proteins, and the chemistry of cooking food. Core lab science. (spring)

CHEM 105 Introduction to Environmental Chemistry 5
Basic chemistry in the context of environmental processes, such as greenhouse gases, global warming, ozone, energy production and consumption, and groundwater contamination. Evaluation of the impact modern human life has upon the environment, and assessment of current topical literature. Fulfills core lab science requirement.

CHEM 121 General Chemistry I 4
Atomic and molecular structure, oxidation-reduction reactions, mass relationships, periodic properties, acids, bases ionic reactions. Five lectures per week. Prerequisites: CHEM 101 or high school chemistry and placement into MATH 120 or higher. Co-requisite: CHEM 131. (fall, winter)

CHEM 122 General Chemistry II 4
Thermochemistry, gases, solutions, equilibria. Four lectures per week. Prerequisite: CHEM 121 and MATH 120 or placement at a higher math level. Co-requisites: CHEM 132 . (winter, spring)

CHEM 123 General Chemistry III 4
Thermodynamics, kinetics, electrochemistry, nuclear chemistry, chemistry of metals and nonmetals. Four lectures per week. Prerequisite: CHEM 122. Co-requisite: CHEM 133. (spring, summer)

CHEM 131 General Chemistry Lab I 1

CHEM 132 General Chemistry Lab II 1
Introduction to basic laboratory procedures and safety, practice in modes of scientific inquiry, including observation, measurement, data collection, interpretation and evaluation of results, and reporting. Three hours per week. Prerequisite: CHEM 131 for 132. Co-requisites: CHEM 121 for 131; 122 for 132. (131, fall, winter; 132, winter, spring)

CHEM 133 General Chemistry Lab III 1
Introduction to qualitative chemical analysis on a semimicro scale. Experimentation in the chemistry of ionic systems and basic quantitative analytical methods. Four hours per week. Co-requisite: CHEM 123; Prerequisite: CHEM 132. (spring, summer)

CHEM 215 Fundamental Inorganic Chemistry 3
Foundational topics in inorganic chemistry with emphasis on coordination chemistry, solid state chemistry, inorganic descriptive chemistry and bioinorganic chemistry. Prerequisite: CHEM 123. (spring)

CHEM 231 Fundamental Organic Chemistry I 4

CHEM 232 Fundamental Organic Chemistry II 4

Structure, bonding, nomenclature, reactions, and synthesis of organic compounds: I) alkanes, alkenes, alkynes, alkyl halides, aromatic, and heteroaromatic compounds; II) alcohols, ethers, phenol, thiols, aldehydes, ketones, carboxylic acids and derivatives, amines, carbohydrates, amino acids, and proteins. Spectroscopic applications. Each is four lecture hours per week.Consult advisor for adequacy of 200 level organic chemistry series to satisfy admission requirements for specific medical schools. Prerequisites: CHEM 123 for 231; 231 for 232. (231 winter; 232 spring)

CHEM 241 Fundamental Organic Chemistry Lab I..... 2

CHEM 242 Fundamental Organic Chemistry Lab II..... 2

Techniques used in synthesis, isolation, and identification of organic compounds. Each is four laboratory hours per week. Co-requisite: 231 for 241; 232 for 242. Prerequisite: CHEM 133 for 241; 241 for 242. (241 winter; 242 spring)

CHEM 260 Laboratory Safety 2

Important aspects of hazardous chemicals and laboratory safety, including pertinent laws and regulations. Establishing and maintaining a safe working environment in the laboratory. Prerequisite: One quarter of general chemistry. (winter)

CHEM 291-293 Special Topics..... 1 to 5

CHEM 296 Directed Study ..... 1 to 5

CHEM 319 Quantitative Analysis..... 5

Theory, methods, and techniques of volumetric, electro-analytical, spectrophotometric, chromatographic and micro-analytical procedures in quantitative analysis; introductory statistics. Two lecture and six laboratory hours per week. Prerequisites: CHEM 123, 133 and junior level standing or permission of chair. (fall, winter)

CHEM 330 Organic Chemistry IA..... 4

CHEM 331 Organic Chemistry IIA..... 4

Structural theory, functional groups, nomenclature, stereochemistry, kinetics and thermodynamics of organic reactions, syntheses of organic compounds and applications. Emphasizes the use of kinetic and non-kinetic methods in the determination of reaction mechanisms, and qualitative structure-reactivity correlations. IA: Hydrocarbons, alkyl halides, ethers and alcohols, spectroscopy. IIA: Aromatics, aldehydes and ketones, carboxylic acids and their derivatives, amines, carbohydrates and lipids. Prerequisites: one year of general chemistry with laboratory for 330; CHEM 330 or one semester of organic chemistry for 331. Co-requisites: CHEM 345 (2 cr) Organic Chemistry Laboratory I for 330; CHEM 346 (2 cr) Organic Chemistry Laboratory II for 331. Offered summer only, 330 in first four weeks and 331 in second four weeks.

CHEM 332 Organic Chemistry IIIA..... 2

The chemistry of carbanions, amino acids, proteins and nucleic acids. Offered concurrently with CHEM 337 in spring quarter. A new course for students wanting credit for the 300-level organic series. NOTE: CHEM 330-332 are equivalent to CHEM 335-337. Prerequisite: CHEM 331.

CHEM 335 Organic Chemistry I 3

Structural theory, functional groups, nomenclature, stereochemistry, kinetics and thermodynamics of organic reactions, syntheses of organic compounds, and applications; hydrocarbons and alkyl halides. Four lectures per week. Prerequisite: CHEM 123. (fall)

CHEM 336 Organic Chemistry II 3

Structural theory, functional groups, nomenclature, stereochemistry, kinetics and thermodynamics of organic reactions, syntheses of organic compounds, and applications; spectroscopy, aromatic and oxy-organic compounds. Four lectures per week. Prerequisite: CHEM 335. (winter)

CHEM 337 Organic Chemistry III 4
Structural theory, functional groups, nomenclature, stereochemistry, kinetics and thermodynamics of organic reactions, syntheses of organic compounds, and applications; amines, phenols and aryl halides, carbanions and the structure and chemistry of biomolecules. Four lectures per week. Prerequisite: CHEM 336. (spring)

CHEM 345 Organic Chemistry Lab I 2
Theory and practice of laboratory techniques; experimental study of properties of organic compounds; introduction to organic synthesis. Four hours per week. Prerequisite: CHEM 133. Co-requisite: CHEM 335. (fall)

CHEM 346 Organic Chemistry Lab II 2
Application of laboratory techniques in simple and multistep syntheses; qualitative and quantitative measurements of properties of organic compounds; determination of kinetic and thermodynamic parameters. Four hours per week. Prerequisite: CHEM 345. Co-requisite: CHEM 336. (winter)

CHEM 347 Organic Chemistry Lab III 2
Instrumental and classical qualitative techniques applied to the identification of organic compounds. Five hours per week. Prerequisite: CHEM 346 (or 242) Co-requisite: CHEM 337 (or prerequisite 232). (spring)

CHEM 360 Physical Chemistry I 3

CHEM 361 Physical Chemistry II 3

CHEM 362 Physical Chemistry III 3
1. Quantum chemistry and spectroscopy. 2. States of matter, thermodynamics, equilibrium, kinetics. 3. Theory of reaction rates, thermodynamics of solutions, phase equilibrium, electrochemistry, photochemistry and statistical thermodynamics. Three lectures per week. 1 may be taken either before or after 2 and 3. Prerequisites: CHEM 123, CHEM 133, MATH 232, and one year of physics for CHEM 360 and CHEM 361; CHEM 361 for CHEM 362. (360 fall, 361 winter, 362 spring)

CHEM 371 Physical Chemistry Laboratory I 2

CHEM 372 Physical Chemistry Laboratory II 2
Quantitative measurements of physical chemical phenomena, detailed data analysis, and evaluation. Four laboratory hours per week. Prerequisites: CHEM 319 for CHEM 371; CHEM 371 for CHEM 372. CHEM 361 is co-requisite or prerequisite for CHEM 371; CHEM 362 is a co-requisite or prerequisite for CHEM 372. (371 winter, 372 spring)

CHEM 391-393 Special Topics ..... 1 to 5

CHEM 396 Directed Study ..... 1 to 5

CHEM 415 Advanced Inorganic Chemistry 3
Advanced topics in inorganic chemistry, with particular attention to the transition metals, including their compounds, properties and biochemistry. Prerequisite: CHEM 361. (spring)

CHEM 425 Synthetic Inorganic Chemistry Laboratory 2
Synthesis and characterization of inorganic compounds involving a variety of laboratory techniques and instrumentation, including, high temperature, vacuum line or inert atmosphere and nonaqueous solvent syntheses and characterization by NMR, FTIR, conductivity, GC, magnetic susceptibility and UV-Vis spectroscopy. Four laboratory hours per week. Prerequisite: CHEM 319. Co-requisite: CHEM 415. (spring)

CHEM 426 Instrumental Analysis 5
Theory and techniques of instrumental methods representative of spectrometric, electroanalytical and chromatographic techniques. Two lecture and two four-hour laboratory periods per week. Prerequisites: CHEM 319, 361. (spring)

CHEM 436 Advanced Organic Chemistry 3
Advanced topics in organic chemistry. Directed reading and/or lectures. Prerequisite: CHEM 361 and one year of organic chemistry. (fall)

CHEM 454 Biochemistry I 3
Structure and function of amino acids, proteins, lipids, carbohydrates and nuclear acids. Kinetics and mechanisms of enzyme action. Molecular aspects of cell biology and function. Prerequisites: BIOL 161 and 171 or permission of chair; CHEM 232 or CHEM 337. (fall)

CHEM 455 Biochemistry II 2
Mechanistic study of the biosynthesis of nucleic acids and proteins using directed readings. Two lecture hours per week. Prerequisite: CHEM 454. (winter)

CHEM 456 Biochemistry III 3
Intermediary metabolism: A study of the metabolism of carbohydrates, lipids, amino acids, and nucleic acids with emphasis on enzymology, thermodynamics, metabolic control mechanisms, and integration of control between metabolic pathways. Prerequisite: CHEM 454. (spring)

CHEM 464 Biochemistry Lab I 2
Current laboratory methods in biochemistry including amino acid analysis, enzyme kinetics, protein purification techniques, gel electrophoresis, immunoblotting, and fatty acid analysis. Prerequisites: CHEM 242 or CHEM 347; CHEM 319. Co-requisite: CHEM 454. (fall)

CHEM 465 Biochemistry Lab II 1
Methods of biotechnology including the polymerase chain reaction. Three laboratory hours per week. Prerequisites: CHEM 454 and CHEM 464. Co-requisite: CHEM 455. (winter)

CHEM 480-483 Interdisciplinary Core Course ..... 3 to 5
Title and content change each term.

CHEM 488 Senior Synthesis Seminar I 1
Initiation of a research project. Includes online chemical literature search, project formulation, annotated bibliography and preparation of a brief research proposal. Required as part of the senior synthesis core requirement for chemistry, biochemistry and medical technology majors. Prerequisites: CHEM 232 or CHEM 336, minimum 10 credits of chemistry at SU or permission of chair. (fall)

CHEM 489 Senior Synthesis Seminar II 1
Presentation of the senior synthesis project. Includes oral and written presentation of the senior synthesis project according to the American Chemical Society guidelines for undergraduate research presentations. Required as part of the senior synthesis core requirement for chemistry, biochemistry and medical technology majors. Prerequisite: CHEM 488. (spring)

CHEM 490 Senior Synthesis ..... 1 to 3
Capstone activity, including in-depth investigation of scientific or clinical topics. Prerequisites: CHEM 488 and permission of chair.

CHEM 491-493 Special Topics ..... 1 to 5

CHEM 496 Independent Study ..... 1 to 5

CHEM 497 Directed Reading ..... 1 to 5

CHEM 498 Directed Research ..... 1 to 5
Permission of chair required.

CHEM 499 Undergraduate Research ..... 1 to 6
Literature and laboratory investigation of a research problem in collaboration with a chemistry department faculty member or approved external advisor. A minimum of four laboratory hours per week per credit. Prerequisite: CHEM 488 permission of chair.