

Chemistry and Biochemistry

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Bachelor of Science

Degree Program Hours: 120

The B.S. in Chemistry program is approved by the American Chemical Society and prepares the student for graduate study or a professional career as a chemist in industry, in government service, or in secondary school teaching. (Students interested in secondary teacher certification should contact the College of Arts and

Sciences Center for Academic Services at (305) 348-2978.)

Lower Division Preparation

Common Prerequisite Courses and Equivalencies

<u>FIU Course(s)</u>	<u>Equivalent Course(s)</u>
CHM 1045, CHM 1045L	CHMX045/X045L or CHMX040 and CHMX041 CHMX045C
CHM 1046, CHM 1046L	CHMX046/X046L or CHMX046C
CHM 2210, CHM 2210L CHM 2211, CHM 2211L	CHMX210/X210L and CHMX211/X211L or CHMX210C and CHMX211C
PHY 2048, PHY 2048L PHY 2049, PHY 2049L	PHYX048/X048L ¹ and PHYX049/X049L ¹ or PHYX048C ¹ and PHYX049C ¹ or PHY053/X053L ² and PHY054/X054L ² or PHYX053C ² and PHYX054C ²
MAC 2311	MACX311 or MACX281
MAC 2312	MACX312 or MACX282

¹The PHYX048/PHYX049 sequence is required for the Bachelor in Science degree. It is an option for the Bachelor in Arts degree.

²The PHYX053/PHYX054 sequence is not accepted for the Bachelor in Science degree.

Courses which form part of the statewide articulation between the State University System and the Florida College System will fulfill the Lower Division Common Prerequisites.

For generic course substitutions/equivalencies for Common Program Prerequisites offered at community colleges, state colleges, or state universities, visit: <https://www.flvc.org>. See Common Prerequisite Manual.

Common Prerequisites

CHM 1045	General Chemistry I	3
CHM 1045L	General Chemistry Lab I	1
CHM 1046	General Chemistry II	3
CHM 1046L	General Chemistry Lab II	1
CHM 2210	Organic Chemistry I ¹	4
CHM 2210L	Organic Chemistry I Lab ¹	1
CHM 2211	Organic Chemistry II ¹	3
CHM 2211L	Organic Chemistry II Lab ¹	1
PHY 2048	Physics with Calculus I ¹	4
PHY 2048L	Physics with Calculus I Lab ¹	1
PHY 2049	Physics with Calculus II ¹	4
PHY 2049L	Physics with Calculus II Lab ¹	1
MAC 2311	Calculus I	4
MAC 2312	Calculus II	4

¹Either the General Physics sequence or the Organic Chemistry Sequence must be taken at the lower division. Whichever is not taken must be taken before the degree is granted.

Students admitted to the university are admitted directly to their chosen major. Students are expected to make good progress based on critical indicators, such as GPA in specific courses or credits earned. In cases where students are not making good progress, a change of major

may be required. Advisors work to redirect students to more appropriate majors when critical indicators are not met.

Upper Division Program: (60 total hours, 48 hours must be 3000 level and above)

The following courses are required:

CHM 3120	Intro to Analytical Chemistry	3
CHM 3120L	Intro to Analytical Chemistry Lab	1
CHM 3410	Physical Chemistry I	4
CHM 3410L	Physical Chemistry I Lab	1
CHM 3411	Physical Chemistry II	4
CHM 3411L	Physical Chemistry II Lab	2
CHM 4130	Instrumental Analysis	3
CHM 4130L	Instrumental Analysis Lab	1
CHM 4220	Advanced Organic Chemistry	3
CHM 4304	Biological Chemistry I	3
CHM 4230L	Structure Determination Laboratory	1
or		
CHM 4304L	Biological Chemistry I Lab	1
CHM 4611	Advanced Inorganic Chemistry	3
CHM 4611L	Advanced Inorganic Chemistry Laboratory	1
CHM 4910L	Undergraduate Research in Chemistry	3
CHM 4930	Senior Seminar	1

One additional senior-level (4000) Chemistry course *

At least three additional credits to be chosen from the following list:

MAP 2302	Differential Equations	3
COP 2270	C for Engineers	3
MAC 2313	Multivariable Calculus	4

Students are required to take a nationally-normed chemistry examination in their last semester before graduation.

*CHM 4911L may not be used to satisfy this requirement.

Bachelor of Science in Chemistry with Honors

Admission to the Program

To be a candidate for the honors in chemistry degree a student must first:

1. Be admitted to the BS in Chemistry program with a lower division GPA of at least 3.5 in science and math courses, and an overall GPA of at least 3.2,
2. Have completed at least twelve semester hours of chemistry courses,
3. Have arranged to be sponsored by a tenured or tenure-earning faculty researcher, and
4. Submit a letter to the Chemistry Undergraduate Committee requesting permission to pursue the honors track course of study.
5. Note: Any exceptions to these admissions criteria must be approved by the Undergraduate Program Director.

Graduation Requirements

1. Completion of all requirements for the BS in Chemistry with a minimum GPA of 3.5 in science and math courses and overall GPA of 3.2.
2. Completion of an honors research project in collaboration with a faculty advisor. The results of the research project must be written in the form of an

honors thesis which is written in American Chemical Society-style publication format. The student must register for Undergraduate Research (CHM 4910L) and receive a grade of "B" or better. The faculty advisor and the departmental Undergraduate Research Committee must judge the thesis as suitable in style and content for publication in an appropriate American Chemical Society journal.

3. Submission of two completed and approved copies of the Honors Thesis must be presented to the Chemistry Department office; one copy is to be kept in the department, and the second copy is to be housed in the University library.
4. The results of the research project must be presented orally to an audience of peers and faculty members from all science department honors programs. The presentation will be graded by the Undergraduate Research Committee, and the student must receive a score of 4 or 5 on a 5-point scale for his/her presentation.

Combined BS/MS in Chemistry

To be considered for admission to the combined bachelor's/master's degree program, students must have completed at least 75-90 credits in the bachelor's degree program at FIU and meet the admissions criteria for the graduate degree program to which they are applying. Students need only apply once to the combined degree program, but the application must be submitted to Graduate Admissions before the student starts the last 30 credits of the bachelor's degree program. A student admitted to the combined degree program will be considered to have undergraduate status until the student applies for graduation from their bachelor's degree program. Upon conferral of the bachelor's degree, the student will be granted graduate status and be eligible for graduate assistantships. Only 5000-level or higher courses, and no more than the number of credits specified by the program catalog, may be applied toward both degrees.

Admission Requirements

- Current enrollment in the Bachelor of Science program in chemistry at FIU.
- Current GPA of 3.2 or higher.
- Official GRE general test scores.
- Three letters of recommendation.
- Approval of the Chemistry Graduate Committee.

Completion Requirements

Completed Bachelor of Science degree in chemistry at FIU

Required:

- 9 credits (3 courses) selected from graduate chemistry core courses. Required courses must be completed with an average of "B" or higher, and only one course may receive a grade less than "B-".
- Electives: 3 courses selected from the Chemistry Graduate Elective Offerings.
- 9 credits of Thesis Research and 2 credits of Thesis.
- 1 credit of Colloquium.

- Overlap: Up to 3 graduate level courses (9 credits) may be used to satisfy both the Bachelor's and Master's degree requirements.

Combined BS in Chemistry/MS in Forensic Science

To be considered for admission to the combined bachelor's/master's degree program, students must have completed at least 75-90 credits in the bachelor's degree program at FIU and meet the admissions criteria for the graduate degree program to which they are applying. Students need only apply once to the combined degree program, but the application must be submitted to Graduate Admissions before the student starts the last 30 credits of the bachelor's degree program. A student admitted to the combined degree program will be considered to have undergraduate status until the student applies for graduation from their bachelor's degree program. Upon conferral of the bachelor's degree, the student will be granted graduate status and be eligible for graduate assistantships. Only 5000-level or higher courses, and no more than the number of credits specified by the program catalog, may be applied toward both degrees.

Admission Requirements

- Current enrollment in the Bachelor of Science program in chemistry at FIU.
- Current GPA of 3.2 or higher.
- Official GRE general test scores.
- Three letters of recommendation.
- Approval of the Chemistry Graduate Committee.

Completion Requirements

Completed Bachelor of Science degree in chemistry at FIU

Required:

- BSC 5406 Forensic Biology
- CHS 5542 Forensic Chemistry
- CHS 5535 Forensic Analysis
- Required courses must be completed with an average of "B" or higher, and only one course may receive a grade of less than "B-".
- Electives: 5 courses selected from the Forensic Science Graduate Elective Offerings.
- 6 credits of Thesis Research and 1 credit of Thesis.
- 1 credit of Colloquium.
- Overlap: Up to 3 graduate level courses (9 credits) may be used to satisfy both the Bachelor's and Master's degree requirements.

Bachelor of Arts

Degree Program Hours: 120

This program is designed for students preparing for careers in medicine, pharmacy, dentistry, environmental studies, veterinary medicine, patent law, forensic science, secondary science education*.

The BA in Chemistry program is organized into four alternative areas of concentration. Students may choose to follow the "Standard BA in Chemistry Concentration" or

– in consultation with an advisor – choose a specific area of emphasis: the Biochemistry Concentration, the Environmental Chemistry Concentration, or the Forensic Chemistry Concentration. Each of the four options is described below.

*(Students interested in secondary teacher certification should contact the College of Arts and Sciences Center for Academic Services at (305) 348-2978.)

Lower Division Preparation for All Areas of Concentration

Common Prerequisite Courses and Equivalencies

<u>FIU Course(s)</u>	<u>Equivalent Course(s)</u>
CHM 1045, CHM 1045L	CHMX045/X045L or CHMX040 and CHMX041 CHMX045C
CHM 1046, CHM 1046L	CHMX046/X046L or CHMX046C
CHM 2210, CHM 2210L CHM 2211, CHM 2211L	CHMX210/X210L and CHMX211/X211L or CHMX210C and CHMX211C
PHY 2048, PHY 2048L PHY 2049, PHY 2049L	PHYX048/X048L ¹ and PHYX049/X049L ¹ or PHYX048C ¹ and PHYX049C ¹ or PHY053/X053L ² and PHY054/X054L ² or PHYX053C ² and PHYX054C ²
MAC 2311	MACX311 or MACX281
MAC 2312	MACX312 or MACX282

¹The PHYX048/PHYX049 sequence is required for the Bachelor in Science degree. It is an option for the Bachelor in Arts degree.

²The PHYX053/PHYX054 sequence is not accepted for the Bachelor in Science degree.

Courses which form part of the statewide articulation between the State University System and the Florida College System will fulfill the Lower Division Common Prerequisites.

For generic course substitutions/equivalencies for Common Program Prerequisites offered at community colleges, state colleges, or state universities, visit: <https://www.flvc.org>. See Common Prerequisite Manual.

Common Prerequisites

CHM 1045	General Chemistry I	3
CHM 1045L	General Chemistry Lab I	1
CHM 1046	General Chemistry II	3
CHM 1046L	General Chemistry II Lab	1
CHM 2210	Organic Chemistry I ¹	4
CHM 2210L	Organic Chemistry I Lab ¹	1
CHM 2211	Organic Chemistry II ¹	3
CHM 2211L	Organic Chemistry II Lab ¹	1
PHY 2048	Physics with Calculus I ²	4
PHY 2048L	Physics with Calculus I Lab ¹	1
PHY 2049	Physics with Calculus II ²	4
PHY 2049L	Physics with Calculus II Lab ¹	1
MAC 2311	Calculus I	4
MAC 2312	Calculus II	4

¹Either the General Physics sequence or the Organic Chemistry sequence must be taken at the lower division.

Whichever is not taken must be taken before the degree is granted.

²For the Bachelor of Arts degree, PHY 2053 and PHY 2054 may be substituted for PHY 2048 and PHY 2049.

Other Lower Division Courses Required for the Degree:

BSC 1010	General Biology I	3
BSC 1010L	General Biology I Lab	1

To qualify for acceptance into the upper division, FIU undergraduates must have met all the lower division requirements, completed 60 semester hours, and must be otherwise acceptable to the program.

Upper Division Program: (60 total hours, 48 hours must be 3000 level and above)

Upper Division Courses Required for All Concentrations

CHM 3120	Intro to Analytical Chemistry	3
CHM 3120L	Intro to Analytical Chemistry Lab	1
CHM 3400	Fundamentals of Physical Chemistry	3
CHM 3400L	Fundamentals of Physical Chemistry Lab	1
CHM 4304	Biological Chemistry I	3
CHM 4304L	Biological Chemistry I Lab	1
CHM 4930	Senior Seminar	1

Students are required to take a nationally-normed chemistry examination in their last semester before graduation.

Specific Courses by Concentration Standard BA-Chemistry Concentration

- Choose from List 1 (Cognate Area Courses): Any one course*
*Premed students should choose BSC 1011/1011L
- Choose from List 2 (Restricted Elective): Any two courses, one of which must include its corresponding lab.
- One senior level chemistry elective: (CHM4XXX/CHM5XXX)**

**CHM 4910L or CHM 4911L may not be used to satisfy this requirement.

Biochemistry Concentration

This concentration is intended for students who desire a comprehensive background in chemistry but with emphasis in biological chemistry. The curriculum is designed to contain all of the courses necessary for entry into medical and dental school.

- Choose from List 1 (Cognate Area Courses): BSC 1011/BSC 1011L
- Choose from List 2 (Restricted Electives): CHM 4300 & CHM 4230L or CHM 4307 & CHM 4307L and one other lecture course
- One senior level chemistry elective (CHM4XXX/CHM5XXX)** which is biomedically related.

**CHM 4910L or CHM 4911L may not be used satisfy this requirement.

Environmental Chemistry Concentration

This concentration is intended for students who desire a comprehensive background in chemistry but with an

interest in applying their expertise in chemistry to environmentally-related careers and issues.

- Choose from List 1 (Cognate Area Courses): An environmentally-related course
- Choose from List 2 (Restricted Electives): CHM 4130/4130L and one other lecture course
- One senior level chemistry elective (CHM4XXX/CHM5XXX)** which is environmentally-related.

**CHM 4910L or CHM 4911L may not be used to satisfy this requirement.

NOTE: Students may earn a Certificate in Environmental Studies (offered by the Department of Earth and Environment), by taking the appropriate environmental studies courses. This also satisfies the College's requirement of 9 credits outside the major.

Forensic Chemistry Concentration

This concentration is intended for students who desire a comprehensive background in chemistry but with an interest in applying their expertise in chemistry to a career in forensic science or criminalistics.

- Choose from List 1 (Cognate Area Courses): CCJ 2020
- Choose from List 2 (Restricted Electives): CHM 4130/4130L and one other lecture course
- One senior level chemistry elective (CHM4XXX/CHM5XXX or CHS4XXX/CHS5XXX)** with forensic emphasis.

**CHM 4910L or CHM 4911L may not be used satisfy this requirement.

List 1 – Cognate Area Courses

BSC 1011	General Biology II	3
BSC 1011L	Gen Biology II Lab	1
CCJ 2020	Introduction to Criminal Justice	3
EVR 3011	Environmental Resources	3
EVR 3013	Ecology of South Florida	3
EVR 3013L	Ecology of So FI Lab	1
EVR 4211	Water Resources	3
EVR 4211L	Water Resources Lab	1
EVR 4231	Air Resources	3
EVR 4310	Energy Resources	3
EVR 4592	Soils & Ecosystems	3
EVR 4592L	Soils & Ecosystems Lab	1
GLY 3202	Earth Materials	3
GLY 3202L	Earth Materials Lab	2
GLY 4822	Intro to Hydrogeology	3
OCE 3014	Oceanography – GL	3

List 2 – Restricted Electives

CHM 4220	Advanced Organic Chemistry	3
CHM 4300	Bio-organic Chemistry	3
CHM 4307	Biological Chemistry II	3
CHM 3610	Fundamentals of Inorganic Chemistry	3
CHM 3411*	Physical Chemistry II	4
CHM 4130	Instrumental Analysis	3
CHM 4230L	Structure Determination Lab	1
CHM 4130L	Instrumental Analysis Lab	1
CHM 4307L	Biological Chemistry II Lab	1
CHM 4611L	Advanced Inorganic Chemistry Lab	1
CHM 3411L	Physical Chemistry II Lab	2
CHS 4430	Introduction to Chemical Toxicology	3
CHS 4600	Marine Chemistry	3

*CHM 3410 is a prerequisite of CHM 3411.

Chemical Education Major

This program prepares students interested in chemistry and science for teaching at the secondary level. Students are encouraged to participate in on-campus teaching experiences that parallel their coursework, available to freshman and sophomores. Interested students are encouraged to contact the department for additional details and information on teacher support programs.

Lower Division Preparation

Common Prerequisites as Detailed Under the BA Degree

Additional Lower Division Courses (4)

BSC 1010	General Biology I	3
BSC 1010L	General Biology I Lab	1

Upper Division Program (60)

CHM 3945	Chemical Education Seminar	1
CHM 3120	Intro to Analytical Chemistry	3
CHM 3120L	Intro to Analytical Chemistry Lab	1
CHM 3400	Fundamentals of Physical Chemistry	3
CHM 3400L	Fundamentals of Physical Chemistry Lab	1
CHM 4304	Biological Chemistry I	3
CHM 4304L	Biological Chemistry I Lab	1
CHM 4930	Senior Seminar	1
CHS 4702	Inquiry Instruction in Chemistry	3

Chemical Education Major

List 1 – Elective

BSC 1011	General Biology II	3
BSC 1011L	General Biology II Lab	1

List 2 – Restricted Electives

Select any two courses. One must include a lab. (7 hrs. min)

CHM 4220	Advanced Organic Chemistry	3
CHM 4300	Bio-organic Chemistry	3
CHM 4307	Biological Chemistry II	3
CHM 3610	Fundamentals of Inorganic Chemistry	3
CHM 3411	Physical Chemistry II	4
CHM 4130	Instrumental Analysis	3
CHM 4230L	Structure Determination Lab	1
CHM 4130L	Instrumental Analysis Lab	1
CHM 4611L	Advanced Inorganic Chemistry Lab	1
CHM 3411L	Physical Chemistry II Lab	2

Education Requirements

SCE 4894	Nature of Math and Science	3
SCE 4194	Perspectives in Science and Math Education – GL	3
SCE 4330	Secondary Science Teaching Methods	3
SCE 4944	Student Teaching	6
SCE 4931	Senior Seminar in Science Education	2
RED 4325	Subject Area Reading	3
TSL 4324	ESOL Issues and Strategies for Content Teachers – GL	3

Out of Division Elective 3

Minor in Chemistry

The minor in chemistry requires at least 21 credits in chemistry to include:

General Chemistry I & II (CHM 1045, 1045L, and 1046, 1046L)	8
Introduction to Analytical Chemistry (CHM 3120, 3120L)	4
Organic Chemistry I & II (CHM 2210, CHM 2210L, CHM 2211, CHM 2211L)	9

At least half of the credits to be counted towards the minor must be taken at the University.

Pre-Medical, Dentistry, Veterinary, Optometry Curricula

Students who have satisfied the requirements for either the BA or the BS degree in chemistry will also have satisfied the course requirements for admission to professional schools in the above areas. The BA in Chemistry degree (Biochemistry Concentration) includes additional course work relevant to the career objectives of the student. Interested students should consult the Pre-Health Advisor at (305) 348-0515.

Cooperative Education

Students seeking the baccalaureate degree in chemistry may also take part in the Cooperative Education Program conducted in conjunction with Career Services in the Division of Student Affairs. The student spends one or two semesters fully employed in an industrial or governmental chemistry laboratory. For further information consult the Department of Chemistry, or Career Services at (305) 348-2423 (MMC) or (305) 919-5770 (BBC).

Department Policy

The Department of Chemistry does not award credit for courses by examination; it does, however, award credit for AP Chemistry with a score of 3 or higher and with evidence of a suitable laboratory experience. The department does not award credit for life experience.

Course Descriptions

Note: Laboratories may not be taken prior to the corresponding course. Laboratories must be taken concurrently where noted. Students must register for the laboratory separately.

Definition of Prefixes

CHM-Chemistry; CHS-Chemistry-Specialized; ISC-Interdisciplinary Natural Sciences; OCC - Chemical Oceanography

F-Fall semester offering; S-Spring semester offering; SS-Summer semester offering.

CHM 1025 Fundamentals of Chemistry (2). Introduces students to basic mathematics required in chemistry, nature of matter, atomic structure, simple chemical reactions and stoichiometry.

CHM 1032 Chemistry and Society (3). **CHM 1032L Chemistry and Society Lab (1).** A course for non-science majors which introduces students to basic concepts in chemistry and applies those concepts to contemporary issues such as air/water pollution, energy and food production, drugs, nutrition, and toxic chemicals. Prerequisites: One year of high school or college algebra. (Lab fees assessed) (F,S,SS)

CHM 1033 Survey of Chemistry (4). CHM 1033L Survey of Chemistry Lab (1). General and organic chemistry for non-science majors only. Atoms and molecules, states of matter, equilibrium, kinetics, acids and bases and introduction to organic chemistry. Laboratory must be taken concurrently. Does not fulfill requirements for chemistry, biology or pre-med majors. Prerequisites: One year of high school or college algebra. (Lab fees assessed) (S,SS)

CHM 1045 General Chemistry I (3). CHM 1045L General Chemistry Lab I (1). Fundamental principles of general chemistry: states of matter, atomic structure, stoichiometry, chemical bonding, acid-base reactions, and gas laws. Concurrent registration in both lecture and laboratory is required. Prerequisites: MAC 1105, MAC 1114, MAC 1140, or MAC 1147; or CHM 1025; or adequate placement test score. (Lab fees assessed) (F,S,SS)

CHM 1046 General Chemistry II (3). CHM 1046L General Chemistry Lab II (1). Continuation of General Chemistry I (CHM 1045). Fundamental principles of chemistry: thermodynamics, solutions, kinetics, equilibrium and electrochemistry. Concurrent registration in both lecture and laboratory is required. Prerequisites: CHM 1045 (with a "C" or better), CHM 1045L. (Lab fees assessed) (F,S,SS)

CHM 2200 Survey of Organic Chemistry (3). CHM 2200L Survey of Organic Chemistry Lab (1). A basic one-semester survey course in organic chemistry for non-majors presenting a broad background in the reactions and structures of organic molecules. Does not fulfill requirements for chemistry, biology, or pre-med majors. Laboratory must be taken concurrently with the course. Prerequisites: CHM 1032, CHM 1032L, CHM 1033, CHM 1033L, or CHM 1046, CHM 1046L. (Lab fees assessed)

CHM 2210 Organic Chemistry I (4). CHM 2210L Organic Chemistry Lab I (1). An introduction to chemical bonding and atomic structure theory as it pertains to the chemistry of carbon compounds. Correlation between structure and reactivity of organic molecules followed by a systematic look at the various reaction types using reaction mechanisms as a tool for study. Concurrent registration in both lecture and laboratory is required. Prerequisites: CHM 1046 (with a "C" or better), CHM 1046L. (Lab fees assessed) (F,S,SS)

CHM 2211 Organic Chemistry II (3). CHM 2211L Organic Chemistry Lab II (1). Continuation of CHM 2210, 2210L. Concurrent registration in lecture and laboratory is required. Prerequisites: CHM 2210 (with a "C" or better), 2210L. (Lab fees assessed) (F,S,SS) Lecture is corequisite for lab.

CHM 2216 Organic Chemistry I Recitation (1). Supplemental course for Organic Chemistry I (CHM 2210) that teaches problem-solving skills and reinforces concepts learned in lecture. Prerequisite: CHM 1046. Corequisite: CHM 2210.

CHM 2219 Organic Chemistry II Recitation (1). Supplemental course for Organic Chemistry II (CHM 2211) that teaches problem-solving skills and reinforces concepts learned in lecture. Prerequisite: CHM 2210. Corequisite: CHM 2211.

CHM 3120 Introduction to Analytical Chemistry (3). CHM 3120L Introduction to Analytical Chemistry Lab (1). Fundamentals of classical quantitative analysis. Topics include theory of precipitation, acid-base and oxidation-reduction reactions, as well as an introduction to spectrophotometric methods of analysis, ion-exchange techniques and complex formation. Laboratory must be taken concurrently with the lecture. Prerequisites: CHM 1046, (with a "C" or better) CHM 1046L. (F,S,SS)

CHM 3400 Fundamentals of Physical Chemistry (3). CHM 3400L Fundamentals of Physical Chemistry Lab (1). Principles of physical chemistry. Topics include thermodynamics, equilibria, electrochemistry, and reaction kinetics. Laboratory must be taken concurrently with the course. Prerequisites: MAC 2311, 2312; PHY 2048, 2048L PHY 2049, 2049L, or PHY 2053, 2048L, and 2054, 2049L, CHM 3120, 3120L. (F, S)

CHM 3410 Physical Chemistry I (4). CHM 3410L Physical Chemistry Lab I (1). Principles of thermodynamics, gas laws, kinetic theory of gases, chemical equilibrium, electrochemistry, and kinetics. Laboratory to be taken concurrently with the course. Prerequisites: MAC 2311, 2312; PHY 2048, 2048L PHY 2049, PHY 2049L, and CHM 3120, CHM 3120L. (F)

CHM 3411 Physical Chemistry II (4). CHM 3411L Physical Chemistry Lab II (2). Introduction to quantum mechanics. The Schrodinger equation and its application to rotational, vibrational, and electronic spectroscopy, atomic and molecular structure, and bonding. Prerequisites: CHM 3410, 3410L. (S)

CHM 3610 Fundamentals of Inorganic Chemistry (3). Fundamental principles of inorganic chemistry including atomic properties, valence and molecular orbital bonding, ionic solids, coordination chemistry and applications. Prerequisites: CHM 2211, CHM 2211L.

CHM 3945 Chemical Education Seminar (1). Inquiry chemistry instruction approach incorporating chemical education research. Includes scientific discourse, assessment, and the use of technology in instruction. Prerequisites: CHM 1045, CHM 1045L, CHM 1046, CHM 1046L.

CHM 3949, CHM 4949 Cooperative Education in Chemistry (1-3). One semester of fulltime supervised work in an outside laboratory. Limited to students admitted to the University Coop Program. A written report and supervisor evaluation will be required of each student. (F,S)

CHM 4090L Introduction to Scientific Glassblowing (1). Basic glassblowing operations with glass tubing and rod are taught. Emphasis is on making and repair of scientific glassware. No prerequisites.

CHM 4130 Instrumental Analysis (3). CHM 4130L Instrumental Analysis Lab (1). Instrumental methods of chemical analysis, including electro-analytical methods, gas and liquid chromatography, mass spectrometry, x-ray fluorescence, and spectrophotometric methods. Prerequisites: CHM 3120, 3120L, CHM 2211, 2211L, CHM 3410, PHY 2048, 2048L, PHY 2049, 2049L, or permission of the instructor. (F,S)

CHM 4220 Advanced Organic Chemistry (3). An intensive examination of the major areas of contemporary organic chemistry. Reactive intermediates, pericyclic reactions, molecular rearrangements, and modern synthetic methods are among the topics covered. Prerequisites: CHM 2211, 2211L. (F)

CHM 4230L Structure Determination Lab (1). The qualitative analysis of organic compounds using modern spectroscopic, chromatographic and chemical methods. Prerequisites: CHM 2211, and 2211L. (F,S)

CHM 4300 Bio-Organic Chemistry (3). Chemistry of naturally-occurring organic compounds of biological importance. The relationship between organic chemistry and the chemical reactions which constitute the living organism. Prerequisites: CHM 2211, and 2211L. (S)

CHM 4304 Biological Chemistry I (3). **CHM 4304L Biological Chemistry I Lab (1).** Structures and functions of nucleic acids and proteins and cellular processes such as metabolism, replication and transcription are examined from a chemistry perspective. Prerequisites: CHM 2211, CHM 3120, BSC 1011 or permission of the instructor. Corequisite: A semester of physical chemistry. Lecture is corequisite for lab. (F,S,SS)

CHM 4307 Biological Chemistry II (3). Continuation of Biological Chemistry I (CHM 4304). Further exploration of bio-organic reaction mechanisms. Chemistry DNA synthesis and repair. Chemistry of information transfer. Reactions of drugs. Prerequisite: Biological Chemistry I (CHM 4304). (S)

CHM 4307L Biological Chemistry Lab II (1). Continuation of Biological Chemistry Laboratory I. Experimental methods presented include NMR, enzyme inhibition assays, macromolecular thermodynamics, peptide sequencing, ligand binding assays, chromatography. Prerequisites: CHM 4304, CHM 4304L. Corequisite: CHM 4307.

CHM 4320L Research Techniques in Organic Chemistry (2). Practical instruction in the more advanced manipulations and procedures of the modern chemistry laboratory. Restricted to B.S. chemistry majors. Prerequisites: CHM 3120, CHM 2211, CHM 2211L, CHM 3410, and CHM 3411L.

CHM 4321 Protein Chemistry (3). Structures of proteins and how they are determined. Protein-small molecule, protein-protein, protein-DNA, protein membrane interactions and their functions. Prerequisites: CHM 2211, BSC 1011, a biochemistry course or permission of the instructor. Corequisites: CHM 3410 or permission of the instructor.

CHM 4611 Advanced Inorganic Chemistry (3). Atomic structure, periodicity, bonding and structure of inorganic compounds, solution chemistry, ligand field theory, organometallic chemistry, and specific chemistry of the elements. Prerequisites: CHM 3120, CHM 2211, and CHM 3411. (F)

CHM 4611L Advanced Inorganic Chemistry Lab (1). Synthesis, purification, and study of coordination and organometallic compounds. Prerequisite: CHM 3411. Corequisite: CHM 4611. (F)

CHM 4910L Undergraduate Research in Chemistry (3). The student works directly with a professor on a research project. Credit is assigned based on 4 hr/wk laboratory/library work per credit hour. A written report is required. Report must be submitted to the Undergraduate Research Committee for approval. For additional credits of undergraduate research student must register for CHM 4911L. (F,S,SS)

CHM 4911L Undergraduate Research 2 (1-20). Faculty directed research in chemistry. Credit is assigned based on 4 hr/wk laboratory/library work per credit hour. May be repeated. Prerequisite: CHM 4910L. (F,S,SS)

CHM 4930 Senior Seminar (1). Techniques for preparation and presentation of a scientific seminar and postgraduate career development. Completion of an oral presentation, written report, and exit exam in chemistry required. Prerequisites: CHM 3400 or CHM 3411, or permission of the instructor. (F,S)

CHM 4931 Special Topics (3). Covers selected topics in chemistry. Prerequisite: Permission of the instructor.

CHM 4933 Special Topics (3). Covers selected topics in chemistry. Prerequisite: Permission of the instructor.

CHM 4934 Special Topics (3). Covers selected topics in chemistry. Permission of the instructor.

CHM 5138 Advanced Mass Spectrometry (3). Intensive examination of the processes and techniques involved in creating, controlling and measuring ionic species by mass spectrometry. Theory of mass spectrometry, methods of ionization, instrumental designs, quantitative mass spectrometry, meta-stable ions, and tandem mass spectrometry. Prerequisites: CHM 4130, CHM 4130L or permission of the instructor.

CHM 5139C Mass Spectrometry Workshop (2). Basic description of processes and techniques involved in creating, controlling and measuring elemental or molecular ionic species by mass spectrometry techniques. WS designed to provide hands on experience. Prerequisite: CHM 4130.

CHM 5150 Graduate Analytical Methods (3). Analysis of analytical data, electrochemistry, spectro-analytical techniques, chromatography, survey of new analytical methods. Prerequisites: Graduate standing or permission of the instructor.

CHM 5156 Advanced Chromatography (3). Intensive examination of the contemporary practice of chromatography including available chromatographic techniques, their selection and application. Prerequisites: CHM 4130 or permission of the instructor.

CHM 5165 Chemometrics and Sampling (3). Methods of evaluating analytical chemistry data. Planning sampling design for water, air and solids. Sample preparation and extraction techniques. Prerequisite: CHM 4130.

CHM 5225 Graduate Organic Chemistry (3). Advanced topics in organic chemistry. Structure of organic molecules, reaction mechanisms, organic synthesis, and natural product chemistry. Prerequisites: Graduate standing or permission of the instructor.

CHM 5236 Spectroscopic Techniques and Structures Elucidation (3). Advanced techniques for the spectroscopic identification of organic compounds. Interpretation of spectral information for determination of structures of various classes of organic compounds. Prerequisites: CHM 4220 and CHM 4230L.

CHM 5250 Organic Synthesis (3). Use of classical and modern reactions in the design and construction of complex organic molecules including natural products. Some topics covered will be construction reactions, refunctionalization, stereochemistry and conformational analysis. Prerequisites: CHM 4220 or permission of the instructor.

CHM 5251 Organometallic Chemistry (3). Fundamentals and applications of organometallic chemistry. Structures and bonding, ligand types, organometallic reactions, physical methods of characterization. Prerequisites: CHM 4611, CHM 3411.

CHM 5252 Asymmetric Synthesis (3). Recent advances in asymmetric synthesis for the selective design and construction of tetrahedral stereo-centers. Focus on principles of configuration in transition state assemblies. Prerequisite: CHM 4220.

CHM 5263 Physical Organic Chemistry (3). A series of topics will be discussed including molecular orbital theory as it pertains to organic molecules, kinetic and thermodynamic approaches to the study of reaction mechanisms, quantitative approaches to conformational analysis, etc. Prerequisites: CHM 4220 and physical chemistry or permission of the instructor.

CHM 5280 Natural Products Chemistry and Biosynthesis (3). Studies of the chemical origins (biosynthesis), properties, and synthesis of the various classes of naturally occurring compounds: terpenes, steroids, alkaloids, and acetogenins. Prerequisites: CHM 4220 or permission of the instructor.

CHM 5285 Marine Natural Products: Chemistry and Pharmacology/Toxicology (3). Identification, isolation, and characterization of toxic and other biologically active compounds from marine sources.

CHM 5302 Organic Chemistry of Nucleic Acids (3). Organic chemistry of ribose sugars, nucleoside heterocyclic bases, mechanism-based inhibitors of enzymes involve in nucleic acid metabolism, and chemical synthesis of DNA. Prerequisites: CHM 4220 or permission of the instructor.

CHM 5305 Graduate Biological Chemistry (3). Structures of biological molecules; Biochemical reaction mechanisms; Enzyme kinetics; Biomolecular thermodynamics; Biomolecular spectroscopy. Prerequisites: Graduate standing or permission of instructor.

CHM 5306 Special Topics in Biological Chemistry (3). Investigation of one or more areas of biologically related chemistry. Prerequisites: CHM 4304 or permission of the instructor.

CHM 5325 Physical Chemistry of Proteins (3). Protein structures, dynamics and functions. Use of spectroscopic methods. Thermodynamics of protein folding and ligand

binding. Enzyme Kinetics. Prerequisites: Biological Chemistry and Physical Chemistry or permission of the instructor.

CHM 5351 Computer Modeling of Biological Molecules (3). Introduces use of computers in studying biological macromolecules. Simulations, visualization methods, software, databases. Prerequisites: CHM 3411, Biochemistry recommended.

CHM 5380 Special Topics in Organic Chemistry (VAR). An intensive examination of one or more areas selected by instructor and students. Prerequisites: CHM 4220 and physical chemistry or permission of the instructor.

CHM 5423 Atmospheric Chemistry (3). Chemical processes in atmospheres. Photochemistry, chemical kinetics, tropospheric and stratospheric chemical reactions, anthropogenic effects on the earth's atmosphere and chemistry of planetary atmospheres. Prerequisites: CHM 3410, CHM 3411, or permission of the instructor.

CHM 5425 Graduate Physical Chemistry (4). Prequantum physics, the Schrodinger equation and its solutions, atoms and molecules, rotational, vibrational, and electronic spectroscopy. Prerequisites: Graduate standing or permission of the instructor.

CHM 5426 Graduate Physical Chemistry II (4). Gas laws; thermodynamics and equilibrium, electrochemistry, and chemical kinetics. Prerequisites: Graduate standing or permission of the instructor.

CHM 5440 Kinetics and Catalysis (3). Theory of elementary reactions, activated complex theory, mechanisms of complex reactions. Prerequisites: CHM 3411, MAP 2302.

CHM 5490 Physical Spectroscopy (3). Introduction to atomic and molecular quantum states, selection rules, and fundamental principles of spectroscopy. Introduction to group theory and to the theory of UV/visible, infrared, Raman, microwave, NMR, photoelectron, and mass spectroscopies, and the applications of these methods to the determination of fundamental physical properties and the structure of organic and inorganic molecules. Prerequisite: Physical Chemistry.

CHM 5490L Physical Spectroscopy Lab (1). The theory of spectroscopy and the use of modern instrumentation to investigate molecular structure. Prerequisites: CHM 2211, 2211L. Corequisites: PHY 4604 or CHM 5490.

CHM 5503 Physical Chemistry of Nucleic Acids (3). Physical chemistry of nucleic acids including spectroscopic determination of structures of DNAs, RNAs, and DNA-protein complexes and thermodynamic and kinetic studies of nucleic acid-ligand complexes and nucleic acid structures. Prerequisites: CHM 4304 or permission of the instructor.

CHM 5506 Physical Biochemistry (3). Physical properties of bio-molecules, molecular conformation; thermodynamic, kinetic, and spectroscopic properties of biomolecules. Prerequisites: CHM 4304 or permission of the instructor.

CHM 5517 Solid State (3). Crystalline form of solids, lattice dynamics, metals, insulators, semiconductors, and

dielectric materials. Prerequisites: CHM 5490 or PHY 4604.

CHM 5540 Group Theory In Chemistry (3). The fundamental theory is developed with emphasis given to representations. Specific applications covered, with emphasis on molecular orbital theory and spectroscopy. Prerequisite: CHM 3411.

CHM 5586 Computational Chemistry (3). Surveys computational methods for studying issues pertinent to organic and biological chemistry. Emphasis on developing an understanding of principles and putting methods to use. Includes methods for studying reaction thermodynamics, reaction mechanisms and NMR spectral properties. Prerequisites: CHM 3410, CHM 3411.

CHM 5650 Physical Inorganic Chemistry (3). Introduction to use of physical methods to determine the structure of inorganic compounds. Prerequisite: CHM 4611 or permission of the instructor.

CHM 5681 Special Topics in Inorganic Chemistry (VAR). An intensive examination of one or more areas selected by instructor and students. Prerequisites: CHM 4611 or permission of the instructor.

CHM 5765 Aquatic Chemistry (3). Redox chemistry, chemistry of sediments, organic biogeochemistry, chemodynamics, and fates or organic pollutants in aqueous environments. Prerequisites: CHM 2211, CHM 4130, or permission of the instructor.

CHM 5931 Special Topics (3). A course covering selected special topics in chemistry.

CHM 5932 Special Topics (3). A course covering selected special topics in chemistry.

CHM 5934 Special Topics in Analytical Chemistry (VAR). An intensive examination of one or more areas selected by instructor and students. Prerequisites: CHM 4130 or permission of the instructor.

CHM 5936 Special Topics in Environmental Chemistry (3). An intensive examination of one or more areas selected by the instructor and students. Prerequisite: Permission of the instructor.

CHM 5938 Special Topics in Physical Chemistry (VAR). An intensive examination of one or more areas selected by instructor and students. Prerequisites: CHM 3411 or permission of the instructor.

CHS 3501 Survey of Forensic Science (3). A survey course introducing the principles and techniques of forensic science as they pertain to crime scene investigation and crime laboratory analysis.

CHS 3501L Survey of Forensic Science Laboratory (1). Laboratory course to accompany survey of forensic science lecture with emphasis on biological evidence. Topics include, CSI, DNA, toxicology, and serology. Corequisite: CHS 3501.

CHS 3511C Forensic Evidence (3). Introduces forensic science students to important aspects of the analysis of physical evidence including crime scene investigation techniques, professional practice and ethics, introduction to the law, and quality assurance. Prerequisites: CHM 1045, CHM 1045L, CHM 1046, CHM 1046L, CHM 2210,

CHM 2210L, CHM 2211, CHM 2211L, CHM 3120, CHM 3120L, or permission of the instructor.

CHS 4100 Radiochemistry (3). **CHS 4100L Radiochemical Techniques Lab (1).** Production, isolation, methods of detection, counting statistics and estimation of radioisotopes. Applications to chemical, physical and biological problems. Laboratory must be taken concurrently with the course. Prerequisites: CHM 3410 or CHM 3400, or PHY 3107 plus CHM 1046, or permission of the instructor. Corequisite: Students must register for both CHS 4100 and 4100L.

CHS 4430 Introduction to Chemical Toxicology (3). Course focuses on basic principles of toxicology and pharmacology of drugs and related chemicals from a molecular, mechanistic, and physiochemical viewpoint. Prerequisites: CHM 4304 or BCH 3033.

CHS 4503C Forensic Science (3). Modern instrumental methods of chemical analysis and their use in the administration of justice. Prerequisites: CHM 3120 and CHM 2211 or permission of the instructor. Corequisites: a semester of physical chemistry or permission of the instructor.

CHS 4503L Forensic Science Lab (1). Laboratory to accompany Forensic Science, CHS 4503C. Prerequisites: CHM 3120, CHM 3120L, CHM 2211, CHM 2211L or permission of the instructor.

CHS 4533C Forensic Biochemistry Applications (3). Forensic applications of biochemistry including metabolite analysis, DNA analysis and other laboratory methods and data interpretation. Prerequisites: BSC 1010, CHM 2211, CHM 4304, or BCH 3033.

CHS 4591 Forensic Science Internship (3). Internship in a forensic-science laboratory, contributing in a specific manner on an assigned problem. Twenty hrs/wk. Written report required. Open only to students in the Criminalistics Chemistry Program. Prerequisite: Senior standing.

CHS 4600 Marine Chemistry (3). A study of how the chemistry of marine systems operate and interact with biological, geological, and physical processes. Prerequisites: CHM 2211, CHM2211L, CHM 3120, CHM 3120L (or permission of the instructor).

CHS 4702 Inquiry Instruction in Chemistry (3). Inquiry chemistry instruction approach incorporating chemistry education research. Includes general topics, scientific discourse, assessment and technology use in teaching. Prerequisites: CHM 3945 or PHY 3012.

CHS 5435 Pharmacology and Toxicology of Drugs (3). Provides an in-depth understanding of basic pharmacological and toxicological principles of drug action from a molecular, mechanistic, and physiochemical viewpoint. Prerequisite: Graduate standing.

CHS 5502 Forensic Chemistry for Teachers (3). Incorporates concepts and techniques from the application of analytical chemistry, molecular biology, biochemistry, toxicology, and microscopy to forensic casework. Exposure to teaching resources in these areas and case study format of presentation. Open to education majors only. Prerequisites: CHM 3120, CHM 3120L, CHM 2211, and CHM 2211L or permission of the instructor.

CHS 5535 Forensic Analysis (3). An introduction to established chemical analysis techniques used in forensic science and new techniques under development. Prerequisites: CHM 3120, CHM 3120L, CHM 2211, CHM 2211L or permission of the instructor.

CHS 5535L Forensic Analysis Lab (1). Laboratory to accompany Forensic Analysis CHS 5535. Prerequisites: CHM 3120, CHM 3120L, CHM 2211, CHM 2211L or permission of the instructor.

CHS 5536 Forensic DNA Chemistry (3). Chemical basis for current methodologies of DNA analysis. DNA sequencing, PCR, STR, AFLP, mass spectrometry. Prerequisites: CHM 4304 or permission of the instructor.

CHS 5538C Chemistry and Analysis of Drugs (3). Introduction to the chemistry of drugs of abuse, including reactivity, synthesis and the principles of analysis from solid doses and from body fluids. Laboratory analysis through the determination of unknown samples. Prerequisites: CHM 4130, CHM 4130L, CHM 4304, CHM 4304L.

CHS 5539 Forensic Toxicology (3). Provides the basic concepts of forensic toxicology as it applies to drug and body fluid analysis. Prerequisites: CHM 2211+L, CHM 3120+L, CHM 4304+L (BCH 3033+L) or permission of the instructor.

CHS 5542 Forensic Chemistry (3). Advanced analytical methods in Forensic Chemistry for application to the analysis of controlled substances, materials (i.e., paint, glass, and fibers), flammable and explosives residues with an emphasis on new methods and method development.

CHS 5545 Chemistry and Analysis of Explosives (3). Chemistry and reactivity, including thermochemistry, of modern industrial and military explosives with an emphasis on the analysis of explosives residues from post-blast debris and from samples of environmental interest. Prerequisites: CHM 4130, CHM 4130L.

ISC 4041 Scientific Literature (1). This course presents a perspective on the scientific literature and scientific documentation. Problems in using and searching the scientific literature will be specifically designed to meet the needs of various disciplines, e.g. chemistry, environmental science, physics, biology. Prerequisites: 16 semester hours of science.

OCC 5050 Chemical Oceanography (3). Interaction of chemical processes in marine systems with biological, geological, and physical processes. Prerequisites: Graduate standing or permission of the instructor.