California State University
Channel Islands

PROPOSAL TO OFFER A NEW ACADEMIC PROGRAM/ MAJOR IN FALL 2004
(LONG FORM)

Proposed Name of Degree: Bachelor of Science in Chemistry

Options/ Emphases in the Degree: Biochemistry Option

Faculty Proposing New Program: Philip D. Hampton, PhD; Simone Aloisio, PhD

Review and Approval:

1. Curriculum Committee Approval:

Curriculum Chair: _____ Date: _____

2. Academic Senate Approval:

Chair, Academic Senate: _____ Date: _____

3. Administration Approval:

President (or designee): _____ Date: _____

1. Definition of the Proposed Degree Major Program

1a. ***Name of the campus submitting the request, the full and exact designation (degree terminology) for the proposed degree major program, and academic year of intended implementation.***

Campus - California State University Channel Islands
Degree - Bachelor of Science in Chemistry
Implementation – Fall 2004

1b. ***Name of the department, departments, division or other unit of the campus that would offer the proposed degree major program. Identify the unit that will have primary responsibility***.

Academic Affairs/Multiple Programs

1c. ***Name, title, and rank of the individual(s) primarily responsible for drafting the proposed degree major program.***

Philip D. Hampton, PhD
Professor of Chemistry

Simone Aloisio, PhD
Assistant Professor of Chemistry

1d. ***Objectives of the proposed degree major program***.

1. To provide students with a strong undergraduate educational preparation in Chemistry and Biochemistry that is founded on the "Big Ideas" in Chemistry.
2. To enhance students' problem-solving, analytical, oral communication, and written communication skills across the Chemistry curriculum.
3. To encourage team problem-solving and collaboration
4. To develop students' ability to read and understand primary literature
5. To provide students with hands-on exposure to laboratory research through internships and independent research.
6. To prepare students for further study in graduate or professional schools, or for employment in a variety of public and private organizations.

Big Ideas in Chemistry:

1. Geometric Structure: The three dimensional arrangement of atoms in a molecule results in a unique shape which can affect the properties, reactivity, and stability of a molecule, as well as its ability to interact with or bind to another molecule.
2. Electronic Structure: The energies and extent of filling of atomic orbitals and molecular orbitals in an atom or molecule affects the properties, reactivity and stability of an atom/molecule. Electronic structure includes the nature of bonds between atoms and the interaction between orbitals on neighboring or remote atoms.
3. Forces between Molecules: Interactions between groups in a molecule or between molecules can occur over a distance through dispersion forces, dipole-dipole interactions, hydrogen bonding, and crystal packing forces.
4. Thermodynamics: The stability of an atom/molecule influences its reactivity and determines whether an atom/molecule will react with another atom/molecule.
5. Kinetics: The rate at which one atom/molecule reacts with another atom/molecule is influenced greatly by the concentrations of the individual species undergoing the reaction, the rate of collisions between molecules, and by the energy needed for atoms/molecules to react individually or with one another.
6. Reactions: There are four basic ways that molecules react: (1) *Electron-transfer* (redox reactions); (2) *Lone electron sharing* (radical reactions); (3) *Electron pair sharing* (i.e., acid-base reactions, electrophilic/ nucleophilic reactions); and (4) *Concerted Reactions* (i.e., pericyclic reactions).

The Great Ideas of Chemistry were adapted from the following references:

Peter Atkins, *Chemistry: The Great Ideas*, personal communication to P. Hampton, 2003.

Peter Atkins and Loretta Jones, *Chemical Principles.* W.H.Freeman & Co, New York (2002).

Peter Atkins, *The Periodic Kingdom.* Weidenfeld and Nicolson, London (1995).

Peter Atkins, *Galileo's Finger: The 10 Great Ideas of Science.* Oxford University Press (2003)

Student Outcomes:

Through this degree program students will be able to:

1. Explain the "Big Ideas" of Chemistry and discriminate when they can be applied to problems in Chemistry.
2. Evaluate and propose explanations for symbolic, microscopic, and macroscopic (real-life) representations of concepts including their relationship to the "Big Ideas" of Chemistry:
3. Formulate hypotheses and devise and perform experiments to test a hypothesis as individuals and in a team.
4. Explain key concepts in Chemistry effectively through oral and written communication.
5. Interpret, evaluate and criticize the chemical literature.

All upper-division courses in the Chemistry Program require at least one writing assignment to reinforce writing skills developed in freshman composition courses.

As part of its on-going assessment of the Chemistry curriculum, embedded assessment will be used to assess student learning throughout the required courses in the Bachelor of Science in Chemistry. The below matrix identifies how the required courses in the Bachelor of Science in Chemistry reflect the various stages of mastery of the above student outcomes. Numbers refer to the student outcomes identified above and letters refer to the Big Ideas of Chemistry within the student outcomes.

	Required Chemistry Courses										
Student Learning Outcome	**121**	**122**	**250 & 251**	**305**	**311 & 312**	**314 & 315**	**371 & 372**	**460**	**Electives**	**492 or 494**	**499**
1a	*I*	*R*	*R*		*R*	*M*		*M*	*M*	*A*	*A*
1b	*I*	*R*	*R*		*R*	*R*	*M*	*M*	*M*	*A*	*A*
1c	*I*	*R*	*R*		*R*	*R*	*M*	*M*	*M*	*A*	*A*
1d		*I*	*R*		*R*	*R*	*M*	*M*	*M*	*A*	*A*
1e		*I*	*R*		*R*	*R*	*M*	*M*	*M*	*A*	*A*
1f		*I*	*R*		*R*	*M*		*M*	*M*	*A*	*A*
2a	*I*	*R*	*R*		*R*	*M*		*M*	*M*	*A*	*A*
2b	*I*	*R*	*R*		*R*	*R*	*M*	*M*	*M*	*A*	*A*
2c	*I*	*R*	*R*		*R*	*R*	*M*	*M*	*M*	*A*	*A*
2d		*I*	*R*		*R*	*R*	*M*	*M*	*M*	*A*	*A*
2e		*I*	*R*		*R*	*R*	*M*	*M*	*M*	*A*	*A*
2f		*I*	*R*		*R*	*M*		*M*	*M*	*A*	*A*
3	*I*	*R*	*R*		*R*	*R*	*R*	*R*	*R*	*M*	*M*
4	*I*	*R*	*R*		*R*	*R*	*R*	*R*	*R*	*M*	*M*
5				*I*	*R*	*R*	*R*	*R*	*R*	*M*	*M*

I = Student Learning Outcome is *Introduce*d in this course
R = Student Learning Outcome is *Reinforced* in this course
M = Student Learning Outcome is *Mastered* in this course
A = Student Learning Outcome is *Applied* to a research problem in this course

1e. ***Total number of units required for the major. List of all courses, by catalog number, title, and units of credit, to be specifically required for a major under the proposed degree program. Identify those new courses that are (1) needed to initiate the program and (2) needed during the first two years after implementation. Include proposed catalog descriptions of all new courses.***

120 Semester units required for the major.

BACHELOR OF SCIENCE IN CHEMISTRY

Lower Division Requirements (28 units)

CHEM 121	General Chemistry I	(4 units)
CHEM 122	General Chemistry II	(4 units)
CHEM 250	Quantitative Analysis	(2 units)
CHEM 251	Quantitative Analysis Laboratory	(2 units)
MATH 150	Calculus I	(4 units)
MATH 151	Calculus II	(4 units)
PHYS 100	Introduction to Physics I	
or PHYS 200	General Physics I	(4 units)
PHYS 101	Introduction to Physics II	
or PHYS 201	General Physics II	(4 units)

Upper-Division Requirements (20 units)

CHEM 305	Computer Applications in Chemistry	(1 unit)
CHEM 311	Organic Chemistry I	(3 units)
CHEM 312	Organic Chemistry I Laboratory	(1 unit)
CHEM 314	Organic Chemistry II	(3 units)
CHEM 315	Organic Chemistry II Laboratory	(1 unit)
CHEM 371	Physical Chemistry I	(3 units)
CHEM 372	Physical Chemistry Laboratory	(1 unit)
CHEM 460	Biochemistry I	(4 units)
CHEM 492	Internship/ Service Learning	
or CHEM 494	Independent Research	(2 units)
CHEM 499	Capstone Project	(1 unit)

Upper-Division Chemistry Electives (22 units)

A total of 22 units of electives, excluding courses numbered 330-349 (except CHEM 341) or 430-449, including a minimum of three laboratory courses. No more than 2 units of Chemistry learning community courses (i.e., CHEM 123, 124, 313 and 316) can be used as electives. CHEM 341 may be used as an elective toward the degree.

Total Units in the Bachelor of Science in Chemistry 70 units

TOTAL UNITS FOR GRADUATION

I.	Lower Division Required		28
II.	Upper Division Required		20
III.	Elective Courses in the Chemistry Major		22
V.	Upper Division Required Interdisciplinary General Education		6-9
	• In Chemistry Major	0-3	
	• Outside of Chemistry Major	6-9	
VI.	Other General Education (GE)		30
VII.	Title V		6
VIII.	University Electives		5-8
Total			**120**

Required Chemistry Major Courses Fulfilling GE Category Requirements

A-1 Oral Communication
No applicable course from the Chemistry Major

A-2 Writing Communication
No applicable course from the Chemistry Major

A-3 Critical Thinking
No applicable course from the Chemistry Major

B-1 Physical Sciences
CHEM 121 General Chemistry I *OR*
CHEM 122 General Chemistry II *OR*
PHYS 100 Introduction to Physics I *OR*
PHYS 200 General Physics I

B-2 Life Sciences
No applicable course from the Chemistry Major (non-Biochemistry Option)
Biochemistry Option:
BIOL 200 Principles of Organismal and Population Biology

B-3 Mathematics
MATH150 Calculus I

B-4 Computers and Information Technology
CHEM 305 Computer Applications in Chemistry

C-1 Fine Arts
No applicable course from the Chemistry Major

C-2 Literature
No applicable course from the Chemistry Major

C-3a Language
No applicable course from the Chemistry Major

C-3b Multicultural
No applicable course from the Chemistry Major

D Social Perspectives
No required course from the Chemistry Major
One course (three units) in this category may be met with Chemistry Electives (CHEM 326 or 341). CHEM 341 also satisfies the upper-division, interdisciplinary General Education requirement
CHEM 326 Scientific and Professional Ethics *OR*
CHEM 341 Drug Discovery and Development

E Human Psychological and Physiological Perspectives
No applicable course from the Chemistry Major

COURSE DESCRIPTIONS FOR CATALOG

COURSES IN THE CHEMISTRY PROGRAM

* = existing courses
1 = needed in first year of initiation of program
2 = needed during the first two years after implementation

CHEM 121 GENERAL CHEMISTRY I (4)*
Three hours lecture and three hours laboratory per week
Prerequisite: A passing score on the Chemistry Placement Examination or CHEM 105
An introductory chemistry course which provides an overview of the chemical and physical behavior of matter with a focus on qualitative and quantitative general inorganic, physical, and analytical chemistry. Lab fee required.
GenEd: B1

CHEM 122 GENERAL CHEMISTRY II (4)*
Three hours lecture and three hours laboratory per week
Prerequisite: CHEM 121 with a grade of C or better
An introductory chemistry course which provides an overview of the chemical and physical behavior of matter with a focus on quantitative general inorganic, physical, and analytical chemistry including kinetics and thermodynamics of reactions, gas phase and solution equilibria, and qualitative aspects of radiochemistry, organic chemistry, and polymer chemistry. Lab fee required.
GenEd: B1

CHEM 250 QUANTITATIVE ANALYSIS (2)*
Two hours lecture per week
Prerequisite: CHEM 122 with a grade of C or better
Co-requisite: CHEM 251
An examination of the theory and techniques involved in the quantification of inorganic, organic, and biological species from samples with an emphasis on the environmental, biological, and medical applications of the analysis techniques.

CHEM 251 QUANTITATIVE ANALYSIS LABORATORY (2)*
Six hours of laboratory per week
Prerequisite: CHEM 122 with a grade of C or better
Co-requisite: CHEM 250
A laboratory course designed to provide students with an exposure to the techniques used in the quantification of inorganic, organic, and biological species from samples using gravimetric and volumetric analyses, potentiometric titrations, atomic absorption spectrometry, UV-visible spectroscopy, GC, and GC/MS. Lab fee required.

CHEM 305 COMPUTER APPLICATIONS IN CHEMISTRY (1)
One hour of activity per week.
Prerequisite: CHEM 122 with a grade of C or better.
Introduction to using computer applications to solve chemical problems and present scientific information. The course introduces the student to on-line journals and literature searches, reading and understanding the scientific literature, computer modeling of molecules, and website development. Lab fee required.
Gen Ed. – B4

CHEM 311 ORGANIC CHEMISTRY I (3)*
Three hours lecture per week
Prerequisite: CHEM 122 with a grade of C or better
The structure and reactions of simple organic molecules and spectroscopic techniques (NMR, GC-MS, IR, and UV-visible) used to characterize molecules. Lab fee required.

CHEM 312 ORGANIC CHEMISTRY I LABORATORY (1)*
Three hours laboratory per week
Prerequisite: CHEM 311 (or taken concurrently) with a grade of C or better
A laboratory course designed to provide students with an exposure to the techniques and instrumentation (NMR, GC, GC-MS, LC, IR, and UV-visible) used to purify and characterize organic molecules resulting from organic reactions. Lab fee required.

CHEM 314 ORGANIC CHEMISTRY II (3)*
Three hours lecture per week
Prerequisite: CHEM 311 with a grade of C or better
An examination of the structure, reactions, and spectroscopy of organic compounds containing one or more functional groups, and the structures and reactions of biologically relevant molecules.

CHEM 315 ORGANIC CHEMISTRY II LABORATORY (1)*
Three hours laboratory per week
Prerequisite: CHEM 311, 312, and 314 (or taken concurrently) with grades of C or better
A laboratory course designed to provide students with experience in single-step and multi-step syntheses and characterization of organic molecules with hands-on access to instrumentation (NMR, GC, GC-MS, LC, IR, and UV-visible). Lab fee required.

CHEM 371 PHYSICAL CHEMISTRY I (3)[1]
Three hours lecture per week.
Prerequisite: CHEM 122 with a grade of C or better, PHYS 101 or PHYS 201, and MATH 150.
Designed to introduce the student to thermodynamics and kinetics. Areas covered will include the laws of thermodynamics, changes in state, chemical equilibrium, gas kinetic theory and rates of reactions. The will also be discussion on experimental methods used to determine chemical reaction rates.

CHEM 372 PHYSICAL CHEMISTRY LABORATORY (1)[1]
Three hours lab per week.
Prerequisite: CHEM 371 (or concurrent registration)
Designed to introduce the student to experimental physical chemistry determining thermodynamics and kinetics. This class will provide a laboratory for the material covered in CHEM 371. Lab fee required.

CHEM 460 BIOCHEMISTRY I (4)*
Three hours lecture and three hours laboratory per week.
Prerequisite: CHEM 314 with a grade of C or better
Introduction to the physical and chemical properties of proteins and enzymes, and enzymatic catalysis and inhibition. Lab fee required.

CHEM 492 INTERNSHIP/SERVICE LEARNING (1-3)*
Prerequisite: Consent of instructor
Provides student credit for internship work and/or service learning in the community that culminates in a written and oral report. Repeatable.

CHEM 494 INDEPENDENT RESEARCH (1-3)*
Prerequisite: Consent of instructor
Provides student credit for independent research (laboratory or library) that culminates in a written and oral report. Repeatable.

CHEM 499 CHEMISTRY CAPSTONE COLLOQUIUM (1)[1]
Prerequisite: CHEM 371; CHEM 305 and CHEM 492 or 494 (or concurrent registration)
Oral and written presentation of work completed or work-in progress projects of CHEM 492, or 494, courses. Graded credit/no-credit.

MATH 150. CALCULUS I (4)*
A course in analytic geometry and calculus. Elementary and transcendental functions are introduced, their properties studied; limits, derivatives, integrals and mathematical modeling used in problem-solving in sciences.

MATH 151. CALCULUS II (4)*
Prerequisite: MATH 150. Topics include: differentiation, integration, sequences, infinite series, and power series. (A lower division requirement in the quantitative economics emphasis.)

PHYS 100 INTRODUCTION TO PHYSICS I (4)*
Three hours lecture and three hours laboratory per week
A non-calculus based introduction to the concepts and principles of physics. The areas covered include classical mechanics, wave motion and thermal physics. Practical examples will be used to illustrate the relationship between physics and other disciplines, especially the life sciences, and to develop problem-solving skills. Laboratory sessions will include computer-simulated experiments. Lab fee required.
GenEd: B1

PHYS 101 INTRODUCTION TO PHYSICS II (4)*
Three hours lecture and three hours laboratory per week
Prerequisite: PHYS 100
A non-calculus based introduction to the concepts and principles of physics. The areas covered include electromagnetic theory, light, and atomic and nuclear physics. Practical examples will be used to illustrate the relationship between physics and other disciplines, especially the life sciences, and to develop problem-solving skills. Laboratory sessions will include computer-simulated experiments. Lab fee required.
GenEd: B1

PHYS 200 GENERAL PHYSICS I (4)*
Three hours lecture and three hours laboratory per week
Prerequisite: MATH 150
A calculus-based introduction to the concepts and principles of physics. The areas covered include classical mechanics, wave motion and thermal physics. Practical examples will be used to illustrate the relationship between physics and other disciplines, including the life sciences, and to develop problem-solving skills.
Laboratory sessions will focus on computer-simulated experiments. Lab fee required.
GenEd: B1

PHYS 201 GENERAL PHYSICS II (4)*
Three hours lecture and three hours laboratory per week
Prerequisite: PHYS 200
A calculus-based introduction to the concepts and principles of physics. The areas covered include electromagnetic theory, light, and atomic and nuclear physics. Practical examples will be used to illustrate the relationship between physics and other disciplines, including the life sciences, and to develop problem-solving skills. Laboratory sessions will focus on computer-simulated experiments. Lab fee required.
GenEd: B1

1f. ***List of elective courses, by catalog number, title, and units of credit that can be used to satisfy requirements for the major. Identify those new courses that are (1) needed to initiate the program and (2) needed during the first two years after implementation. Include proposed catalog descriptions of all new courses.***

COURSE DESCRIPTIONS FOR CATALOG

* = existing courses
1 = needed in first year of initiation of program
2 = needed during the first two years after implementation

CHEM 123 GENERAL CHEMISTRY I PROBLEM-SOLVING (1)
One hour of recitation per week.
Prerequisite: Must be taken concurrently with CHEM 121
An instructor/peer-supervised interactive problem-solving session for students in CHEM 121 where students work in small groups on problems related to the content in CHEM 121.

CHEM 124 GENERAL CHEMISTRY II PROBLEM-SOLVING (1)
One hour of recitation per week.
Prerequisite: Must be taken concurrently with CHEM 122
An instructor/peer-supervised interactive problem-solving session for students in CHEM 122 where students work in small groups on problems related to the content in CHEM 122.

CHEM 301 ENVIRONMENTAL CHEMISTRY (3)*
Three hours lecture per week
Prerequisite: CHEM 122 with a grade of C or better
An introduction to the chemistry of the environment. The goal of this course is to teach the fundamental natural chemical processes of the atmosphere, oceans, and soil of the Earth; as well as the anthropogenic effects on this system. Current topics of environmental interest will be discussed. The sciences behind these processes will be the focus of this course.

CHEM 313 ORGANIC CHEMISTRY I LEARNING COMMUNITY (1)*
One-hour recitation per week
Co-requisite: CHEM 311
Interactive problem-solving session for students in CHEM 311 where students work in small groups on problems related to the content in CHEM 311.

CHEM 316 ORGANIC CHEMISTRY II LEARNING COMMUNITY (1)*
One-hour recitation per week
Co-requisite: CHEM 314
Interactive problem-solving session for students enrolled in CHEM 314 where students work in small groups on problems related to the content in CHEM 314.

CHEM 326 SCIENTIFIC AND PROFESSIONAL ETHICS (3)*
Three hours lecture per week
Discussion of ethical issues and societal challenges derived from scientific research and professional activities. Examines the sources, fundamental principles, and applications of

ethical behavior; the relationship between personal ethics and social responsibility of organizations; and the stakeholder management concept. Applies ethical principles to different types of organizations: business, non-profits, government, health care, science/technology, and other professional groups. Topics also include integrity of scientific research and literature and responsibilities of scientists to society, intellectual property, ethical practices in professional fields, ethical dilemmas in using animal or human subjects in experimentation, gene cloning, animal cloning, gene manipulation, genetic engineering, genetic counseling, and ethical issues of applying biotechnology in agricultural fields. Emphasizes cases to explore ethical issues. Same as BIOL 326 and MGT 326
GenEd: D and Interdisciplinary

CHEM 341 DRUG DISCOVERY AND DEVELOPMENT (3)*
Three hours lecture per week
How are drugs discovered? What determines the price for a drug? What is the difference between a generic and non-generic drug? These questions will be examined with an interdisciplinary approach. Topics include the isolation of compounds from natural sources, the screening of compounds for biological activity, structure-activity relationships of drugs, computer-assisted drug design, combinatorial chemistry, bioinformatics, the FDA approval process for new drugs, and the economic and business aspects of pharmaceutical investment and development. Same as BUS 341 and ECON 341.
GenEd: B1, D and Interdisciplinary

CHEM 373 PHYSICAL CHEMISTRY II (3)[2]
Three hours lecture per week.
Prerequisite: CHEM 122 with a grade of C or better, PHYS 101 or PHYS 201, and MATH 150.
Designed to introduce the student to quantum mechanics, atomic and molecular structure, spectroscopy, and statistical mechanics.

CHEM 410 ADVANCED ORGANIC SYNTHESIS (4)[2]
Three hours lecture and three hours laboratory per week
Prerequisite: CHEM 314, CHEM 315, and CHEM 305 (or concurrent or consent of instructor)
Modern synthetic reactions and approaches in the design of complex organic molecules. Laboratory expands on content in CHEM 312 and 315 and introduces students to advanced synthetic reactions and techniques, including inert-atmosphere techniques. Lab fee required.

CHEM 415 MOLECULAR STRUCTURE DETERMINATION (4)[1]
Three hours lecture and three hours laboratory per week
Prerequisite: CHEM 314, CHEM 315, and CHEM 305 (or concurrent or consent of instructor)
Modern techniques for the determination of organic, inorganic, and biological molecular structure using X-ray crystallography, nuclear magnetic resonance spectroscopy, mass

spectrometry, infrared spectroscopy, ultraviolet spectroscopy, and molecular modeling. Lab fee required.

CHEM 450 INSTRUMENTAL ANALYSIS AND LABORATORY (4)[2]
Three hours lecture and three hours lab per week.
Prerequisite: CHEM 250, CHEM 251, CHEM 305 (or concurrent or consent of instructor), and CHEM 315 with a grade of C or better
Designed to introduce the student to chemical analysis using instrumental methods. Areas covered will include atomic and molecular spectroscopy, chromatography, and mass spectroscopy. Lectures will focus on theory and application of these techniques to organic, inorganic, and biochemical analysis. There will also be attention paid to experimental design, materials used in scientific apparatus, vacuum science and electronic circuits. The laboratory experiments are designed to complement the lecture material. Students will design some of their own experiments in this class. Lab fee required.

CHEM 461 BIOCHEMISTRY II (4)[1]
Three hours lecture and three hours laboratory per week.
Prerequisite: CHEM 460 with a grade of C or better; CHEM 305 (or concurrent or consent of instructor)
Introduction to the biosynthesis of proteins and nucleic acids, biosynthetic and metabolic pathways, photosynthesis, and gene expression. Lab fee required.

CHEM 465 BIOINORGANIC CHEMISTRY (3)[2]
Three hours lecture.
Prerequisite: CHEM 314 with a grade of C or better, and CHEM 305 (or concurrent or consent of instructor)
The inorganic chemistry of biological systems including the role of metals such as zinc, iron, copper, manganese, and molybdenum in protein/ enzyme function. The course will discuss principles of coordination chemistry, protein and DNA functional groups and their metal-binding ability, and the role of metal ions in the reaction mechanisms of metalloenzymes.

CHEM 490 SPECIAL TOPICS IN CHEMISTRY (1-3)*
Prerequisite: Consent of instructor
Specialized topics from the fields of Chemistry and Biochemistry. Repeatable by topic.

CHEM 497 DIRECTED STUDIES (1-3)*
Prerequisite: Consent of instructor
Provides student credit for curricular activities under the direction of a Chemistry faculty member. Repeatable.

1g. ***If any formal options, concentrations, or special emphases are planned under the proposed major, explain fully.***

Biochemistry Option: Instead of 22 units of Chemistry electives, students take 8 additional units of lower-division biology requirements and 12 additional units of upper-division chemistry and biology requirements for a total of 70 units in the option.

BIOCHEMISTRY OPTION

Chemistry Lower Division and Upper Division Requirements for the Bachelor of Science Degree (48 units)

Additional Lower Division Requirements (8 units)

BIOL 200	Principles of Organismal and Population Biology	(4 units)
BIOL 201	Principles of Cell and Molecular Biology	(4 units)

Additional Upper-Division Requirements (12 units)

BIOL 300	Cell Physiology	(4 units)
BIOL 400	Molecular Biology and Molecular Genetics	(4 units)
CHEM 461	Biochemistry II	(4 units)

Upper-Division Chemistry Electives (2 units)

A total of 2 units of electives, excluding courses numbered 330-349 or 430-449. Two units of Chemistry learning community courses (i.e., CHEM 123, 124, 313 and 316) or CHEM 341 may be used as electives toward the degree.

Total Units in the Bachelor of Science in Chemistry, Biochemistry Option 70 units

TOTAL UNITS FOR GRADUATION: BIOCHEMISTRY OPTION

I.	Lower Division Requirements		28
II.	Upper Division Requirements		20
III.	Required Option Courses		20
IV.	Chemistry Electives		2
IV.	Upper Division Required Interdisciplinary General Education		9
	• In Chemistry Major	0	
	• Outside of Chemistry Major	9	
V.	Other General Education (GE)		27
VI.	Title V		6
VII.	University Electives		8
Total			**120**

ADDITIONAL REQUIRED COURSES IN THE BIOCHEMISTRY OPTION

* = existing courses
1 = needed in first year of initiation of program
2 = needed during the first two years after implementation

BIOL 200 PRINCIPLES OF ORGANISMAL AND POPULATION BIOLOGY (4)*
Three hours lecture and three hours laboratory per week
An introduction to organismal biology including the diversity, comparative structure, organ system function, development, phylogeny, taxonomy and systematics of prokaryotes, protists, fungi, plants and animals. Discussion of the principles of evolution including speciation and natural selection, the environmental impact and ecosystem interaction of plants and animals, the behavior of animals, population genetics and population biology. A lab fee is required.
GenEd: B2

BIOL 201 PRINCIPLES OF CELL AND MOLECULAR BIOLOGY (4)*
Three hours lecture and three hours laboratory per week
Prerequisite: CHEM 105 or CHEM 121
This course will cover principles of basic chemistry, biological macromolecules, prokaryotic and eucaryotic cell structure and function, homeostasis, metabolism including both respiration and photosynthesis, cell division, signal transduction, Mendelian genetics, molecular genetics including transcription and translation, and a brief introduction to virology and immunology. The philosophy of science, scientific method and experimental design are foundational to the course. A lab fee is required.
GenEd: B2

BIOL 300 CELL PHYSIOLOGY (4)*
Three hours lecture and three hours laboratory per week
Prerequisite: CHEM 122; CHEM 311 and 312 or concurrent enrollment; BIOL 201 with a grade of C or better
Detailed study of the organization and functioning of cells and cellular organelles at the cellular and molecular levels, emphasizing experimental approaches and structural and functional relationships and their regulation and control. Topics include macromolecules, membrane phenomena, metabolism, enzyme kinetics, and cellular events associated with excitable cells and tissues. A lab fee is required.

BIOL 400 MOLECULAR BIOLOGY AND MOLECULAR GENETICS (4)*
Three hours lecture and three hours laboratory per week
Prerequisite: CHEM 314 and 315, 318 or 400; BIOL 300 or 302 with a grade of C or better
Study of informational macromolecules and how they direct molecular processes in both eukaryotic and prokaryotic cells. Topics include structure, function and regulation of the genetic material at the molecular level, gene organization, structures and functions of

DNA, RNA and proteins, gene transcription and expression, RNA processing, genomics and proteomics. A lab fee is required.

CHEM 461 BIOCHEMISTRY II (4)[1]
Three hours lecture and three hours laboratory per week.
Prerequisite: CHEM 400 with a grade of C or better
Introduction to the biosynthesis of proteins and nucleic acids, biosynthetic and metabolic pathways, photosynthesis, and gene expression. Lab fee required.

1h. Course prerequisites and other criteria for admission of students to the proposed degree major program, and for their continuation in it.

Course Title	Prerequisites
BIOL 300 – Cell Physiology	BIOL 201, CHEM 121, CHEM 311 and 312 (or taken concurrently)
BIOL 400 – Molecular Biology	BIOL 300 or 302, CHEM 314, CHEM 315, CHEM 318 or 400
CHEM 122 – General Chemistry II	CHEM 121
CHEM 250 and 251 – Quantitative Analysis	CHEM 122
CHEM 301 – Environmental Chemistry	CHEM 122
CHEM 305 – Computer Applications in Chemistry	CHEM 122
CHEM 311 – Organic Chemistry I	CHEM 122
CHEM 312 – Organic Chemistry Laboratory I	CHEM 311 (or taken concurrently)
CHEM 314 – Organic Chemistry II	CHEM 311
CHEM 315– Organic Chemistry Laboratory II	CHEM 314 (or taken concurrently)
CHEM 371 – Physical Chemistry I	CHEM 122, PHYS 101 or 201, MATH 150
CHEM 372 – Physical Chemistry Laboratory	CHEM 371 (or concurrent registration)
CHEM 373 – Physical Chemistry II	CHEM 122, PHYS 101 or 201, MATH 150

CHEM 410 – Advanced Organic Synthesis	CHEM 314, CHEM 315, and CHEM 305 (or concurrent or permission)
CHEM 415 – Molecular Structure Determination	CHEM 314, CHEM 315, and CHEM 305 (or concurrent or permission)
CHEM 450 – Instrumental Analysis	CHEM 250, CHEM 251, CHEM 315, and CHEM 305 (or concurrent or permission)
CHEM 460 – Biochemistry I	CHEM 314
CHEM 461 – Biochemistry II	CHEM 460 and CHEM 305 (or concurrent or permission)
CHEM 465 – Bioinorganic Chemistry	CHEM 314 and CHEM 305 (or concurrent or permission)
CHEM 499 – Chemistry Capstone Colloquium	CHEM 371; CHEM 492, or CHEM 494 (or concurrent registration); and CHEM 305 (or concurrent or permission)

1i. ***Explanation of special characteristics of the proposed degree major program, e.g., in terminology, units of credit required, types of course work, etc.***

The program focuses on the "Big Ideas" of Chemistry and requires a hands-on learning experience through the Capstone Project. Students receiving this degree will participate in an applied or basic research project in the field of chemistry. The options for this are through independent research (laboratory or library), via a service learning project, or an internship. The students will present their work, both written and orally, in their capstone course. Writing throughout the curriculum is included in the Bachelor of Science degree.

The program also implements the distinguishing characteristics of all CSUCI programs: interdisciplinarity, a service learning approach, a co-operative learning component, teamwork, and a strong general education preparation.

1j. ***For undergraduate programs, provisions for articulation of the proposed major with community college programs.***

See attached spreadsheet for articulation agreements.

1k. ***Provision for meeting accreditation requirements, where applicable, and anticipated date of accreditation request.***

The major accrediting body for this degree is the ACS (American Chemical Society). To obtain an ACS accredited degree would require "significant breadth and depth" in the five major areas of chemistry: Biochemistry, and Analytical, Inorganic, Organic, and Physical Chemistry. Significant upper division lab work in four of these areas (excluding biochemistry) is required, with additional guidelines needed for an accredited biochemistry degree. While the courses in this degree provide a solid fundamental framework in the field of chemistry, with most of the courses filling some requirements for ACS accreditation, these requirements are not fully met, and ACS accreditation is not sought after at this time. Additional courses, including Inorganic Chemistry and integrated laboratories, will be added over the four years after implementation of this degree program and an ACS certified option will be added to the Bachelor of Science in Chemistry which will meet the ACS accreditation guidelines.

2. Need for the Proposed Degree Major Program

2a. ***List of other California State University campuses currently offering or projecting the proposed degree major program; list of neighboring institutions, public and private, currently offering the proposed degree major program***.

Currently, 20 of the 23 CSU campuses offer a degree in chemistry. The two that do not, besides CSUCI, are: CSU Maritime Academy, and CSU Monterey Bay. California Lutheran University is a private institution in Ventura County offers a degree in chemistry.

2b. ***Differences between the proposed program and programs listed in Section 2a above***.

This program will provide an opportunity for residents the local area to earn a state-supported CSU degree in chemistry. The program is distinctive in that the each class in the curriculum follows emphasizes the "Big Ideas" of chemistry. Students will be introduced to these themes in their first-year classes (General Chemistry), and this central theme will continue to be emphasized in the core and elective classes of the major. This curriculum focuses on the fundamentals, giving the students the knowledge, skills, and experience they need to be successful. The mechanism by which the students learn the "Big Ideas" is consistent with the values of CSUCI: interdisciplinarity, a service learning approach, learning cooperatively, teamwork, and a strong general education.

2f. ***Professional uses of the proposed degree major program***.

The student receiving a Bachelor of Arts in Chemistry will be prepared to enter the workforce, both public and private, in a variety of organizations. The local community offers above the average number of opportunities for employment for a student receiving this degree. The degree will also prepare students for further education, both graduate and professional. It is common for students with this degree to pursue further education in medical, dental, veterinary, and pharmacological studies, as well as specialized fields like patent law.

2g. ***The expected number of majors in the year of initiation and three years and five years thereafter. The expected number of graduates in the year of initiation and three years and five years thereafter.***

	Number of Majors	Number of Graduates
Initiation Year	8	0
Third Year	12	6
Fifth Year	20	14

3. Existing Support Resources for the Proposed Degree Major Program

3a. ***Faculty members, with rank, appointment status, highest degree earned, date and field of highest degree, and professional experience (including publications if the proposal is for a graduate degree), who would teach in the program***.

Philip Hampton
Professor of Chemistry
Ph.D. Chemistry, 1989

Simone Aloisio
Assistant Professor of Chemistry
Ph.D. Chemistry, 2000

Ching-Hua Wang
Professor of Biology
M.D., 1978
Ph.D., 1986

Louise Lutze-Mann
Associate Professor of Biology
Ph.D., 1983

Nancy Mozingo
Assistant Professor of Biology
Ph.D. Zoology, 1993

Amy Denton
Assistant Professor of Biology
Ph.D. Botany, 1997

Geoff Dougherty
Professor of Physics
Ph.D. Biophysics, 1979

Ivona Grzegorczyk
Professor of Mathematics
Ph.D. Mathematics, 1990

Nikolaos Diamantis
Assistant Professor of Mathematics
Ph.D. Mathematics, 1997

Jorge Garcia
Assistant Professor of Mathematics
Ph.D.

Jesse Elliot
Assistant Professor of Mathematics
Ph.D.

4. Additional Support Resources Required

4b. ***Any special characteristics of the additional faculty or staff support positions needed to implement the proposed program.***

No additional faculty or staff support positions are needed to implement the proposed program.

4c. ***The amount of additional lecture and/or laboratory space required to initiate and sustain the program over the next five years. Indicate any additional special facilities that will be required. If the space is under construction, what is the projected occupancy date? If the space is planned, indicate campus-wide priority of the facility, capital outlay program priority, and projected date of occupancy***.

The major requires no additional lecture or laboratory space to initiate. Existing facilities in the Science Building, along with future facilities in the Science Annex will provide the necessary laboratory space.

4d. ***Additional library resources needed. Indicate the commitment of the campus to purchase or borrow through interlibrary loan these additional resources.***

No additional library resources needed above the existing CSUCI Library acquisition program. The faculty is working with the Library staff to assure an appropriate level and subject distribution of library resources.

4e. ***Additional equipment or specialized materials that will be (1) needed to implement the program and (2) needed during the first two years after initiation. Indicate the source of funds and priority to secure these resource needs.***

No additional needs beyond those planned are required to implement the program. Group II funds from the Science Annex building will be used to purchase equipment needs for the first two years after initiation of the program.

5. Abstract of the Proposal and Proposed Catalog Description

CHEMISTRY

PROGRAMS OFFERED

- Bachelor of Arts in Chemistry
- Bachelor of Science in Chemistry
- Bachelor of Science in Chemistry, Option in Biochemistry
- Minor in Chemistry
- Certificate in Chemistry

The Chemistry Program at CSUCI is based on a "Big Ideas" approach to the discipline. Students will learn how to apply the "Big Ideas" skills to their analysis of concepts and problems. In addition to implementing the "Big Ideas" across the curriculum, students learn how to improve their analytical thinking, oral and written communication, and problem solving skills as individuals and in teams. The required courses in Chemistry degree provide breadth across the sub-disciplines of Analytical, Inorganic, Organic, and Physical Chemistry. The culmination of the degree involves a capstone project in conjunction with a service learning project, internship, or independent research experience. Writing skills are developed in all upper-division Chemistry courses.

CAREERS

Graduates from the Bachelor of Arts or Bachelor of Science in Chemistry will receive an excellent preparation for securing entrance to a pre-professional program (i.e., pre-medical, pre-veterinary, pre-dentistry, or pre-pharmacy), to graduate school in Chemistry or Biochemistry, and for employment in the academic, private, or public sector as Chemists, Biochemists, Forensic Scientists, and Materials Scientists.

The Bachelor of Arts in Chemistry is designed to provide a broad preparation in the Chemical Sciences and this degree is an excellent preparation for pre-professional (premedical, pre-dental, pre-pharmacy, and pre-veterinary) careers or graduate school in Chemistry. Required courses prepare students in four of the five traditional sub-disciplines of Chemistry: analytical, inorganic, organic, and physical chemistry. The Bachelor of Arts in Chemistry can serve as the depth of study necessary for securing a Single Subject Credential in Science for teaching at the high school and middle school level.

The Bachelor of Science in Chemistry provides the depth and breadth in the Chemical Sciences that is recommended for graduate study or for a career in Chemistry. Students who graduate with the BS in Chemistry will be extremely well-prepared for working at pharmaceutical companies or other chemical industries. Required courses provide depth of knowledge in all of the sub-disciplines of Chemistry: biochemistry and analytical, inorganic, organic, and physical chemistry.

The Minor in Chemistry provides non-majors with the Chemistry background that is needed to pursue graduate study or a career in an interdisciplinary field. Students in pre-professional programs (pre-medical, pre-dental, pre-veterinary, pre-pharmacy), or majoring in Biology or Environmental Science and Resource Management, in particular, should consider obtaining a Chemistry minor, since a significant portion of the coursework needed for the Chemistry minor is included in these programs.

The Certificate in Chemistry is designed to provide individuals who have already obtained a B.A. or B.S. degree in another discipline with the opportunity to obtain a certificate for advanced Chemistry coursework that is equivalent to a minor in Chemistry.

FACULTY

Philip D. Hampton, PhD
Professor of Chemistry
Academic Advisor for the Chemistry Program
Science Building Room 206
Phone: (805) 437-8869
Email: Philip.Hampton@csuci.edu

Simone Aloisio, PhD
Assistant Professor of Chemistry
Academic Advisor for the Chemistry Program
Science Building Room 207
Phone: (805) 437-8999
Email: Simone.Aloisio@csuci.edu

ADDITIONAL FACULTY

Ching-Hua Wang, M.D., Ph.D.
Professor and Chair, Biology Program
Academic Advisor for Biology Program
Science Building Room 204
Phone: (805) 437-8870
Email: ching-hua.wang@csuci.edu

Amy Denton, Ph.D.
Assistant Professor of Biology
Science Building Room 103
Phone (805) 437-8458
Email: amy.denton@csuci.edu

Geoffrey Dougherty, Ph.D.
Professor of Physics
Science Building Room 102
Phone: (805) 437-8990

California State University
Channel Islands

Email: geoffrey.dougherty@csuci.edu

Nancy Mozingo, Ph.D.
Assistant Professor of Biology
Science Building Room 205
Phone: (805) 437-8989
Email: nancy.mozingo@csuci.edu

REQUIREMENTS FOR THE BACHELOR OF SCIENCE DEGREE IN CHEMISTRY (120 UNITS)

Lower Division Requirements (28 Units)

1. Chemistry
   - CHEM 121 General Chemistry I (4)
   - CHEM 122 General Chemistry II (4)
   - CHEM 250 Quantitative Analysis (2)
   - CHEM 251 Quantitative Analysis Laboratory (2)

2. Math
   - MATH 150 Calculus I (4)
   - MATH 151 Calculus II (4)

3. Physics
   - PHYS 100 Introduction to Physics I or
     PHYS 200 General Physics I (4)
   - PHYS 101 Introduction to Physics II or
     PHYS 201 General Physics II (4)

Upper Division Requirements (20 Units)

CHEM 305 Computer Applications in Chemistry (1)
CHEM 311 Organic Chemistry I (3)
CHEM 312 Organic Chemistry I Laboratory (1)
CHEM 314 Organic Chemistry II (3)
CHEM 315 Organic Chemistry II Laboratory (1)
CHEM 371 Physical Chemistry I (3)
CHEM 372 Physical Chemistry Laboratory (1)
CHEM 460 Biochemistry I (4)
CHEM 492 Internship/ Service Learning
or CHEM 494 Independent Research (2)
CHEM 499 Capstone Project (1)

(9 units of the above courses will be counted toward lower-division General Education Categories B1, B3, and B4)

Upper Division Chemistry Electives (22)

A total of 22 units of electives, excluding courses numbered 330-349 (except CHEM 341) or 430-449, including a minimum of three laboratory courses. No more than 2 units of Chemistry learning community courses (i.e., CHEM 123, 124, 313 and 316) can be used as electives. CHEM 341 may be used as an elective toward the degree.

CHEM 123	General Chemistry I Problem-Solving (1)
CHEM 124	General Chemistry II Problem-Solving (1)
CHEM 301	Environmental Chemistry (3)
CHEM 313	Organic Chemistry I Learning Community (1)
CHEM 316	Organic Chemistry II Learning Community (1)
CHEM 341	Drug Discovery and Development (3)
CHEM 346	Scientific and Professional Ethics (3)
CHEM 410	Advanced Organic Synthesis (4)
CHEM 415	Molecular Structure Determination (4)
CHEM 450	Instrumental Analysis (4)
CHEM 460	Biochemistry I (4)
CHEM 461	Biochemistry II (4)
CHEM 465	Bioinorganic Chemistry (3)
CHEM 473	Physical Chemistry II (3)
CHEM 490	Special Topics in Chemistry (1-3)
CHEM 492	Internship/ Service Learning (1-3)
CHEM 494	Independent Research (1-3)
CHEM 497	Directed Studies (1-3)

Required Supporting and Other GE Courses (42 – 45 units)
American Institutions Requirement (6)
Other Courses in GE Categories A-E (36* – 39)
*Three units of General Education Category D may be included as Chemistry Electives (CHEM 326 or 341)

Electives in Any Discipline (5 – 8* units)

REQUIREMENTS FOR THE BACHELOR OF SCIENCE DEGREE IN CHEMISTRY, BIOCHEMISTRY OPTION (120 UNITS)

Lower Division Requirements (36 Units)

1. Chemistry
   - CHEM 121 General Chemistry I (4)
   - CHEM 122 General Chemistry II (4)
   - CHEM 250 Quantitative Analysis (2)
   - CHEM 251 Quantitative Analysis Laboratory (2)

2. Biology
   - BIOL 200 Principles of Organismal and Population Biology (4)
   - BIOL 201 Principles of Cell and Molecular Biology (4)

3. Math
   - MATH 150 Calculus I (4)
   - MATH 151 Calculus II (4)

4. Physics
   - PHYS 100 Introduction to Physics I or
     PHYS 200 General Physics I (4)
   - PHYS 101 Introduction to Physics II or
     PHYS 201 General Physics II (4)

Upper Division Requirements (32 Units)

1. Chemistry

   - CHEM 305 Computer Applications in Chemistry (1)
   - CHEM 311 Organic Chemistry I (3)
   - CHEM 312 Organic Chemistry I Laboratory (1)
   - CHEM 314 Organic Chemistry II (3)
   - CHEM 315 Organic Chemistry II Laboratory (1)
   - CHEM 371 Physical Chemistry (3)
   - CHEM 372 Physical Chemistry Laboratory (1)
   - CHEM 460 Biochemistry I (4)
   - CHEM 461 Biochemistry II (4)
   - CHEM 492 Internship/ Service Learning
     or CHEM 494 Independent Research (2)
   - CHEM 499 Capstone Project (1)

2. Biology

BIOL 300 Cell Physiology (4)
BIOL 400 Molecular Biology and Molecular Genetics (4)

(12 units of the above requirements will be counted toward lower-division General Education Categories B1, B2, B3, and B4)

Upper Division Chemistry Electives (2)

A total of 2 units of electives, excluding courses numbered 330-349 or 430-449. Two units of Chemistry learning community courses (i.e., CHEM 123, 124, 313 and 316) or CHEM 341 may be used as electives toward the degree.

CHEM 123 General Chemistry I Problem-Solving (1)
CHEM 124 General Chemistry II Problem-Solving (1)
CHEM 301 Environmental Chemistry (3)
CHEM 313 Organic Chemistry I Learning Community (1)
CHEM 316 Organic Chemistry II Learning Community (1)
CHEM 341 Drug Discovery and Development (3)
CHEM 346 Scientific and Professional Ethics (3)
CHEM 410 Advanced Organic Synthesis (4)
CHEM 415 Molecular Structure Determination (4)
CHEM 450 Instrumental Analysis (4)
CHEM 460 Biochemistry I (4)
CHEM 461 Biochemistry II (4)
CHEM 465 Bioinorganic Chemistry (3)
CHEM 473 Physical Chemistry II (3)
CHEM 490 Special Topics in Chemistry (1-3)
CHEM 492 Internship/ Service Learning (1-3)
CHEM 494 Independent Research (1-3)
CHEM 497 Directed Studies (1-3)

Required Supporting and Other GE Courses (39 – 42 units)
American Institutions Requirement (6)
Other Courses in GE Categories A-E (33* – 36)
*Three units of General Education Category D may be included as Chemistry Electives (CHEM 326 or 341)

Electives in Any Discipline (5 – 8* units)

PROPOSED COURSE OF STUDY

Bachelor of Science in Chemistry

FIRST YEAR (31 Units)

FALL (14 Units)
Composition and Rhetoric (ENGL 102 or ENGL 105); GE Category A-2 (3)
Critical Reasoning; GE Category A-3 (3)
CHEM 121 General Chemistry I; GE Category B-1 (4)
MATH 150 Calculus I; GE Category B-3 (4)

SPRING (17 Units)
University Elective or ENGL 103 (3)
CHEM 122 General Chemistry II (4)
MATH 151 Calculus II (4)
Foreign Language Requirement; GE Category C-3a (3)
University Elective (3)

SECOND YEAR (29 Units)

FALL (14 Units)
Oral Communication; GE Category A-1 (3)
CHEM 311 Organic Chemistry I (3)
CHEM 312 Organic Chemistry I Laboratory (1)
Social Science, General Education Requirement; GE Category D (3)
Physics requirement (PHYS 100 or 200); (4)

SPRING (15 Units)
CHEM 314 Organic Chemistry II (3)
CHEM 315 Organic Chemistry II Laboratory (1)
Social Science, General Education Requirement; GE Category D (3)
Physics requirement (PHYS 101 or 201); (4)
CHEM 305 Computer Applications in Chemistry; GE Category B-4 (1)
U.S. History; Title V (3)

THIRD YEAR (30 Units)

FALL (16 Units)
CHEM 371 Physical Chemistry (3)
CHEM 372 Physical Chemistry Laboratory (1)
CHEM 460 Biochemistry I (3)
Life Science, General Education Requirement; GE Category B-2 (3)*
Literature, General Education Requirement; GE Category C-2 (3)*
Multicultural General Education Requirement; GE Category C-3b (3)*

SPRING (14 Units)
CHEM 250 Quantitative Analysis (2)
CHEM 251 Quantitative Analysis Laboratory (2)
Human Physiological and Psychological Perspectives, General Education Requirement; GE Category E (3)*
Social Science, General Education Requirement; GE Category D (3)*
Chemistry Elective, Laboratory (4)

FOURTH YEAR (32 - 33 Units)

FALL (16 Units)
Chemistry Elective, Laboratory (4)
Chemistry Elective, Lecture (*may include CHEM 326 or 341 which satisfy GE Category D);* (3)
Social Science, General Education Requirement; GE Category D (*if not satisfied with CHEM 326 or 341, otherwise University Elective*); (3)*
Chemistry Elective, Lecture (3)
American Institutions Requirement; Title V (3)

SPRING (14 Units)
Visual and Performing Arts, General Education Requirement; GE Category C-1 (3)*
Chemistry Elective, Lecture (3)
Chemistry Elective, Lecture (3)
CHEM 492 Internship/ Service Learning or 494 Independent Research (2)
CHEM 499 Chemistry Colloquium (1)

Note to Students: To maximize University Electives, it is recommended that the nine units of upper-division, interdisciplinary general education courses (numbered 330-349 or 430-449) be taken from those courses marked with an asterisk (*), in order to meet simultaneously Categories A-E and the nine units of Upper-Division General Education.

Bachelor of Science in Chemistry, Biochemistry Option

FIRST YEAR (28 Units)

FALL (14 Units)
Composition and Rhetoric (ENGL 102 or ENGL 105); GE Category A-2 (3)
Critical Reasoning; GE Category A-3 (3)
CHEM 121 General Chemistry I; GE Category B-1 (4)
MATH 150 Calculus I; GE Category B-3 (4)

SPRING (14 Units)
University Elective or ENGL 103 (3)
Oral Communication; GE Category A-1 (3)
CHEM 122 General Chemistry II (4)
MATH 151 Calculus II (4)

SECOND YEAR (31 Units)

FALL (15 Units)
CHEM 311 Organic Chemistry I (3)
CHEM 312 Organic Chemistry I Laboratory (1)
Physics requirement (PHYS 100 or 200); (4)
Foreign Language Requirement; GE Category C-3a (3)
BIOL 200 Principles of Organismal and Population Biology; GE Category B-2 (4)

SPRING (16 Units)
CHEM 314 Organic Chemistry II (3)
CHEM 315 Organic Chemistry II Laboratory (1)
CHEM 305 Computer Applications in Chemistry, General Education Requirement; GE Category B-4 (1)
Physics requirement (PHYS 101 or 201) (4)
BIOL 201 Principles of Cell and Molecular Biology (4)
U.S. History; Title V (3)

THIRD YEAR (29 Units)

FALL (15 Units)
CHEM 250 Quantitative Analysis (2)
CHEM 251 Quantitative Analysis Laboratory (2)
CHEM 460 Biochemistry I (4)
Social Science, General Education Requirement; GE Category D (3)
BIOL 300 Cell Physiology (4)

SPRING (14 Units)

CHEM 371 Physical Chemistry (3)
CHEM 372 Physical Chemistry Laboratory (1)
CHEM 461 Biochemistry II (4)
Human Physiological and Psychological Perspectives, General Education Requirement; GE Category E (3)*
Social Science, General Education Requirement; GE Category D (3)*

FOURTH YEAR (32 Units)

FALL (15 Units)
BIOL 400 Molecular Biology and Genetics (4)
Chemistry Elective (2)
Visual and Performing Arts, General Education Requirement; GE Category C-1 (3)*
American Institutions Requirement; Title V (3)
Literature, General Education Requirement; GE Category C-2 (3)*

SPRING (17 Units)
CHEM 499 Chemistry Colloquium (1)
Capstone Requirement (CHEM 492 or 494) (2)
Social Science, General Education Requirement; GE Category D (3)*
Social Science, General Education Requirement; GE Category D (3)*
Multicultural General Education Requirement; GE Category C-3b (3)*
University Elective (3)
University Elective (2)

To maximize University Electives, it is recommended that the nine units of upper-division, interdisciplinary general education courses (numbered 330-349 or 430-449) be taken from those courses marked with an asterisk (*), in order to meet simultaneously Categories A-E and the nine units of Upper-Division General Education.

REQUIREMENTS FOR THE MINOR IN CHEMISTRY (23 units)

Lower Division Requirements (8 units):
CHEM 121 General Chemistry I and Laboratory (4)
CHEM 122 General Chemistry II and Laboratory (4)

Upper Division Requirements (8 units):
CHEM 311 Organic Chemistry I (3)
CHEM 312 Organic Chemistry I Laboratory (1)
CHEM 314 Organic Chemistry II (3)
CHEM 315 Organic Chemistry II Laboratory (1)

Electives (7 units):
A total of 7 units of electives on the 300-400 level or CHEM 250 and CHEM 251; a maximum of three units of an upper-division interdisciplinary General Education course (CHEM 330-349 or CHEM 430-449) and/ or one unit of a Learning Community course (CHEM 313 or 316) can be applied to the Chemistry minor. Interdisciplinary General Education courses that are cross-listed with Chemistry can be counted toward the Chemistry minor.

REQUIREMENTS FOR THE CERTIFICATE IN CHEMISTRY (23 units)

Lower Division Requirements (8 units):
CHEM 121 General Chemistry I and Laboratory (4)
CHEM 122 General Chemistry II and Laboratory (4)

Upper Division Requirements (8 units):
CHEM 311 Organic Chemistry I (3)
CHEM 312 Organic Chemistry I Laboratory (1)
CHEM 314 Organic Chemistry II (3)
CHEM 315 Organic Chemistry II Laboratory (1)

Electives (7 units):
A minimum of seven units of courses with the CHEM prefix to include CHEM 250 and 251 or other upper-division CHEM prefix courses, but excluding upper-division general education courses (CHEM 330-349 or 430-449). A maximum of one unit of a Learning Community course (CHEM 313 or 316) may be applied toward the Certificate.

COURSE LIST:

CHEM 100 CHEMISTRY AND SOCIETY (3)
Three hours lecture and three hours laboratory per week
An introduction to the basic principles of chemistry and a consideration of the benefits and problems arising from applications of chemistry. Discussions of foods and food additives, drugs, plastics and other materials of everyday life, fuel sources, the atmosphere, and fresh water. Lab fee required.
GenEd: B1

CHEM 105 INTRODUCTION TO CHEMISTRY (3)
Three hours lecture per week
Prerequisite: A passing score on the ELM Examination
Introduces the basic principles and concepts in Chemistry. Topics covered include: measurements, units and unit conversion, scientific notation, stoichiometry, atomic structure, the concept of the mole, types of compounds, and problem solving.
GenEd: B1

CHEM 121 GENERAL CHEMISTRY I (4)
Three hours lecture and three hours laboratory per week
Prerequisite: A passing score on the Chemistry Placement Examination or CHEM 105
An introductory chemistry course which provides an overview of the chemical and physical behavior of matter with a focus on qualitative and quantitative general inorganic, physical, and analytical chemistry. Lab fee required.
GenEd: B1

CHEM 122 GENERAL CHEMISTRY II (4)
Three hours lecture and three hours laboratory per week
Prerequisite: CHEM 121 with a grade of C or better
An introductory chemistry course which provides an overview of the chemical and physical behavior of matter with a focus on quantitative general inorganic, physical, and analytical chemistry including kinetics and thermodynamics of reactions, gas phase and solution equilibria, and qualitative aspects of radiochemistry, organic chemistry, and polymer chemistry. Lab fee required.
GenEd: B1

CHEM 123 GENERAL CHEMISTRY I PROBLEM-SOLVING (1)
One hour of recitation per week.
Prerequisite: Must be taken concurrently with CHEM 121
An instructor/peer-supervised interactive problem-solving session for students in CHEM 121 where students work in small groups on problems related to the content in CHEM 121.

CHEM 124 GENERAL CHEMISTRY II PROBLEM-SOLVING (1)
One hour of recitation per week.
Prerequisite: Must be taken concurrently with CHEM 122
An instructor/peer-supervised interactive problem-solving session for students in CHEM 122 where students work in small groups on problems related to the content in CHEM 122.

CHEM 250 QUANTITATIVE ANALYSIS (2)
Two hours lecture per week
Prerequisite: CHEM 122 with a grade of C or better
Co-requisite: CHEM 251
An examination of the theory and techniques involved in the quantification of inorganic, organic, and biological species from samples with an emphasis on the environmental, biological, and medical applications of the analysis techniques.

CHEM 251 QUANTITATIVE ANALYSIS LABORATORY (2)
Six hours of laboratory per week
Prerequisite: CHEM 122 with a grade of C or better
Co-requisite: CHEM 250
A laboratory course designed to provide students with an exposure to the techniques used in the quantification of inorganic, organic, and biological species from samples using gravimetric and volumetric analyses, potentiometric titrations, atomic absorption spectrometry, UV-visible spectroscopy, GC, and GC/MS. Lab fee required.

CHEM 301 ENVIRONMENTAL CHEMISTRY (3)
Three hours lecture per week
Prerequisite: CHEM 122 with a grade of C or better
An introduction to the chemistry of the environment. The goal of this course is to teach the fundamental natural chemical processes of the atmosphere, oceans and soil of the Earth, as well as the anthropogenic effects on this system. Current topics of environmental interest will be discussed. The sciences behind these processes will be the focus of this course.

CHEM 305 COMPUTER APPLICATIONS IN CHEMISTRY (1)
One hour of activity per week.
Prerequisite: CHEM 122 with a grade of C or better.
Introduction to using computer applications to solve chemical problems and present scientific information. The course introduces the student to on-line journals and literature searches, reading and understanding the scientific literature, computer modeling of molecules, and website development. Lab fee required.
Gen Ed. – B4

CHEM 311 ORGANIC CHEMISTRY I (3)
Three hours lecture per week
Prerequisite: CHEM 122 with a grade of C or better

The structure and reactions of simple organic molecules and spectroscopic techniques (NMR, GC-MS, IR, and UV-visible) used to characterize molecules. Lab fee required.

CHEM 312 ORGANIC CHEMISTRY I LABORATORY (1)
Three hours laboratory per week
Prerequisite: CHEM 311 (or taken concurrently) with a grade of C or better
A laboratory course designed to provide students with an exposure to the techniques and instrumentation (NMR, GC, GC-MS, LC, IR, and UV-visible) used to purify and characterize organic molecules resulting from organic reactions. Lab fee required.

CHEM 313 ORGANIC CHEMISTRY I LEARNING COMMUNITY (1)
One-hour recitation per week
Co-requisite: CHEM 311
Interactive problem-solving session for students in CHEM 311 where students work in small groups on problems related to the content in CHEM 311.

CHEM 314 ORGANIC CHEMISTRY II (3)
Three hours lecture per week
Prerequisite: CHEM 311 with a grade of C or better
An examination of the structure, reactions, and spectroscopy of organic compounds containing one or more functional groups, and the structures and reactions of biologically relevant molecules.

CHEM 315 ORGANIC CHEMISTRY II LABORATORY (1)
Three hours laboratory per week
Prerequisite: CHEM 311, 312, and 314 (or taken
concurrently) with grades of C or better
A laboratory course designed to provide students with experience in single-step and multi-step syntheses and characterization of organic molecules with hands-on access to instrumentation (NMR, GC, GC-MS, LC, IR, and UV-visible). Lab fee required.

CHEM 316 ORGANIC CHEMISTRY II LEARNING COMMUNITY (1)
One-hour recitation per week
Co-requisite: CHEM 314
Interactive problem-solving session for students enrolled in CHEM 314 where students work in small groups on problems related to the content in CHEM 314.

CHEM 341 DRUG DISCOVERY AND DEVELOPMENT (3)
Three hours lecture per week
How are drugs discovered? What determines the price for a drug? What is the difference between a generic and non-generic drug? These questions will be examined with an interdisciplinary approach. Topics include the isolation of compounds from natural sources, the screening of compounds for biological activity, structure-activity relationships of drugs, computer-assisted drug design, combinatorial chemistry, bioinformatics, the FDA approval process for new drugs, and the economic and business

aspects of pharmaceutical investment and development. Same as BUS 341 and ECON 341.
GenEd: B1, D and Interdisciplinary

CHEM 343 FORENSIC SCIENCE (3)
Two hours of lecture and one three-hour lab per week. Lab fee required.
Prerequisite: None
A survey of the various chemical and biological techniques used in obtaining and evaluating criminal evidence. Topics include: chromatography; mass spectrometry (LC-MS, GC-MS); atomic absorption spectrometry; IR, UV, fluorescence, and X-ray spectroscopies; fiber comparisons; drug analysis; arson/ explosive residue analysis; toxicological studies; psychological profiling; blood typing; DNA analysis; population genetics; firearm identification; and fingerprint analysis.
Same as BIOL 343. GenEd-ID: B1

CHEM 344 ENERGY AND SOCIETY (3)
Three hours lecture per week
Survey of the physical, chemical, and engineering principles involved in the production of energy from current and potential sources and the economical, environmental, and political issues surrounding energy production. The course will also examine factors that influence worldwide energy policy. Examples of topics included: energy conservation, efficient usage and transportation of energy, energy resources, fossil fuels, active and passive solar energy, biomass, fuel cells, nuclear (fission and fusion) processes, and hydroelectric, tidal, geothermal, and wind power. Same as PHYS 344
GenEd: B1 and Interdisciplinary

CHEM 346 SCIENTIFIC AND PROFESSIONAL ETHICS (3)
Three hours lecture per week
Discussion of ethical issues and societal challenges derived from scientific research and professional activities. Examines the sources, fundamental principles, and applications of ethical behavior; the relationship between personal ethics and social responsibility of organizations; and the stakeholder management concept. Applies ethical principles to different types of organizations: business, non-profits, government, health care, science/technology, and other professional groups. Topics also include integrity of scientific research and literature and responsibilities of scientists to society, intellectual property, ethical practices in professional fields, ethical dilemmas in using animal or human subjects in experimentation, gene cloning, animal cloning, gene manipulation, genetic engineering, genetic counseling, and ethical issues of applying biotechnology in agricultural fields. Emphasizes cases to explore ethical issues. Same as BIOL 346 and MGT 346
GenEd: D and Interdisciplinary

CHEM 371 PHYSICAL CHEMISTRY (3)
Three hours lecture per week.
Prerequisite: CHEM 122 with a grade of C or better, PHYS 101 or PHYS 201, and MATH 150.

Designed to introduce the student to thermodynamics and kinetics. Areas covered will include the laws of thermodynamics, changes in state, chemical equilibrium, gas kinetic theory and rates of reactions. The will also be discussion on experimental methods used to determine chemical reaction rates.

CHEM 372 PHYSICAL CHEMISTRY LABORATORY (1)
Three hours lab per week.
Prerequisite: CHEM 371 (or concurrent registration)
Designed to introduce the student to experimental physical chemistry determining thermodynamics and kinetics. This class will provide a laboratory for the material covered in CHEM 371. Lab fee required.

CHEM 373 PHYSICAL CHEMISTRY II (3)
Three hours lecture per week.
Prerequisite: CHEM 122 with a grade of C or better, PHYS 101 or PHYS 201, and MATH 150.
Designed to introduce the student to quantum mechanics, atomic and molecular structure, spectroscopy, and statistical mechanics.

CHEM 410 ADVANCED ORGANIC SYNTHESIS (4)
Three hours lecture and three hours laboratory per week
Prerequisite: CHEM 314, CHEM 315, and CHEM 305 (or concurrent or consent of instructor)
Modern synthetic reactions and approaches in the design of complex organic molecules. Laboratory expands on content in CHEM 312 and 315 and introduces students to advanced synthetic reactions and techniques, including inert-atmosphere techniques. Lab fee required.

CHEM 415 MOLECULAR STRUCTURE DETERMINATION (4)
Three hours lecture and three hours laboratory per week
Prerequisite: CHEM 314, CHEM 315, and CHEM 305 (or concurrent or consent of instructor)
Modern techniques for the determination of organic, inorganic, and biological molecular structure using X-ray crystallography, nuclear magnetic resonance spectroscopy, mass spectrometry, infrared spectroscopy, ultraviolet spectroscopy, and molecular modeling. Lab fee required.

CHEM 450 INSTRUMENTAL ANALYSIS AND LABORATORY (4)
Three hours lecture and three hours lab per week.
Prerequisite: CHEM 250, CHEM 251, CHEM 305 (or concurrent or consent of instructor), and CHEM 315 with a grade of C or better
Designed to introduce the student to chemical analysis using instrumental methods. Areas covered will include atomic and molecular spectroscopy, chromatography, and mass spectroscopy. Lectures will focus on theory and application of these techniques to organic, inorganic, and biochemical analysis. There will also be attention paid to experimental design, materials used in scientific apparatus, vacuum science and

electronic circuits. The laboratory experiments are designed to complement the lecture material. Students will design some of their own experiments in this class. Lab fee required.

CHEM 460 BIOCHEMISTRY I (4)
Three hours lecture and three hours laboratory per week.
Prerequisite: CHEM 314 with a grade of C or better
Introduction to the physical and chemical properties of proteins and enzymes, and enzymatic catalysis and inhibition. Lab fee required.

CHEM 461 BIOCHEMISTRY II (4)
Three hours lecture and three hours laboratory per week.
Prerequisite: CHEM 460 with a grade of C or better; CHEM 305 (or concurrent or consent of instructor)
Introduction to the biosynthesis of proteins and nucleic acids, biosynthetic and metabolic pathways, photosynthesis, and gene expression. Lab fee required.

CHEM 465 BIOINORGANIC CHEMISTRY (3)
Three hours lecture.
Prerequisite: CHEM 314 with a grade of C or better, and CHEM 305 (or concurrent or consent of instructor)
The inorganic chemistry of biological systems including the role of metals such as zinc, iron, copper, manganese, and molybdenum in protein/ enzyme function. The course will discuss principles of coordination chemistry, protein and DNA functional groups and their metal-binding ability, and the role of metal ions in the reaction mechanisms of metalloenzymes.

CHEM 490 SPECIAL TOPICS IN CHEMISTRY (1-3)
Prerequisite: Consent of instructor
Specialized topics from the fields of Chemistry and Biochemistry. Repeatable by topic.

CHEM 492 INTERNSHIP/SERVICE LEARNING (1-3)
Prerequisite: Consent of instructor
Provides student credit for internship work and/or service learning in the community that culminates in a written and oral report. Repeatable.

CHEM 494 INDEPENDENT RESEARCH (1-3)
Prerequisite: Consent of instructor
Provides student credit for independent research (laboratory or library) that culminates in a written and oral report. Repeatable.

CHEM 497 DIRECTED STUDIES (1-3)
Prerequisite: Consent of instructor
Provides student credit for curricular activities under the direction of a Chemistry faculty member. Repeatable.

CHEM 499 CHEMISTRY CAPSTONE COLLOQUIUM (1)
Prerequisite: CHEM 371; CHEM 305 and CHEM 492 or 494 (or concurrent registration)
Oral and written presentation of work completed or work-in progress projects of CHEM 492 or 494 courses. Graded credit/no-credit.