
Chemistry and Biochemistry

Undergraduate chemistry at UMass Dartmouth provides the student with the theoretical and practical expertise necessary for success in a wide variety of careers, consistent with the nature of chemistry as the central science. Chemists pursue a broad spectrum of rewarding professional careers ranging from production supervisors in the chemical or petroleum industries to physicians and patent attorneys. The Department is professionally accredited by the American Chemical Society and provides individualized attention and instruction usually encountered only in a small-college setting. Class sizes, especially at the junior and senior levels, are usually small, affording the student ample opportunities for interaction with the faculty.

Teaching and research facilities of the Department of Chemistry and Biochemistry are equipped with modern instrumentation. Recent acquisitions include a Bruker 300MHz FT-NMR, a Bruker Vector 22 FT-IR Spectrometer, a Fluoromax-2 Fluorescence Spectrometer, a Microcal Microcalorimeter, a Midac M-2000 FT-IR with modified cell for protein analysis, a JASCO J-175 Circular Dichroism Spectrometer, a Finnigan MAT 4500 TSQ GC/MS/MS/DS Mass Spectrometer, a Finnigan MAT Isotope Ratio Mass Spectrometer, a Perkin-Elmer Atomic Absorption Spectrophotometer, an Instrumentation Lab. Flame AA/AE Spectrometer, several high performance liquid chromatographs, several UV-V Visible spectrometers, a Sippican/NRL Optical Fiber-Optic based Biosensor, a Cynosure SLL250 Dye Laser Spectrometer, a Antek Nitrogen Analyzer, spectrofluorometers, Pharmacia Biotech Electrophoresis systems, a Jordan Scientific DNA Sequencer, a Amicon Dialyzer/Protein Concentrator, an BAS 100BW3113300 Electrochemical Work Station, an SLM steady state spectrofluorometer, an ISSKO3 time-resolved spectrofluorometer, Waters HPLC systems with diode array detector, a CSC isothermal titration calorimeter, a Quanta 4000 capillary zone electrophoresis system. These new instruments augment existing equipment, which includes infrared, UV-Visible, atomic absorption NMR and mass spectrometers, a differential scanning calorimeter, a capillary gas chromatography, preparative and analytical gas and liquid chromatographs, ultracentrifuges, a voltametric analyzer, scintillation counter, microtiter plate reader and washer, Parr hydrogenation apparatus, electroanalytical

instrumentation and related apparatus for chemical and biochemical research. In addition, an electronics shop and electron microscope facilities are shared with other science departments.

The Department, consistent with university policies, emphasizes computer use. The Department maintains a variety of computers and accessories, including IBM and Macintosh microcomputers, terminals, plotters, and printers. The university maintains two Alpha 2100s (Model 4/275) and an Alpha 2000 (Model 4/200) for library research and instructional use. These Alpha computers provide 64 gigabytes of disk storage, operate on an FDDI network, and are full partners in our campus network.

The Department of Chemistry and Biochemistry at UMass Dartmouth also offers a graduate program leading to the degree of Master of Science in Chemistry.

In conjunction with UMass Lowell, this department offers a joint PhD program. This program combines the outstanding resources of the graduate chemistry programs at Lowell and Dartmouth in a new partnership in excellence. The combined areas of research and professional interest on the two campuses offer a rich range of opportunities for their advanced students.

The Department also participates cooperatively in a doctoral program with the University of Massachusetts Amherst. Cooperative Dartmouth/Amherst Chemistry PhD students are supported by assistantships from UMass Dartmouth and pursue their principal research with UMass Dartmouth faculty while they are matriculated degree students of UMass Amherst.

Faculty and Fields of Interest

Alan H. Bates inorganic and organometallic chemistry

Donald W. Boerth physical organic chemistry, theoretical chemistry

William L. Dills, Jr. (chairperson) biochemistry of carbohydrates, metabolism and metabolic effects of carbohydrate analogues

James A. Golen physical inorganic chemistry, synthesis and molecular spectroscopy of inorganic compounds

David Z. Goodson physical chemistry, theoretical chemical physics, environmental chemistry

Msolin Guo biochemical processes, drug design

Gerald B. Hammond organic chemistry, organofluorine chemistry, natural products, ethnomedicinal chemistry

Michele I. Mandrioli transition metal chemistry and magnetic resonance, computers in chemical education

Catherine C. Neto organic, agricultural, and food chemistry, isolation and elucidation of bioactive natural products

Vesa Nevalainen organic chemistry, catalytic and enantioselective reactions, synthetic and computational chemistry

Emmanuel C.A. Ojadi chemical physics, laser spectroscopy and photochemistry

Bal-Ram Singh physical biochemistry, structure-function relationships of biological macromolecules

Timothy C. K. Su physical chemistry, ion-molecule reactions, mass spectrometry

Dragic Vukomanovic analytical chemistry, electroanalytical chemistry, mass spectrometry, redox biochemistry

Yuegang Zuo analytical, marine, and environmental chemistry

Faculty Member with Chemistry and Biochemistry Joint Appointment
Primary Department

Mark A. Altabet
School of Marine Sciences and Technology

The programs for chemistry majors are designed to provide a solid foundation in the theoretical knowledge and practical laboratory skills necessary for a variety of professional careers. The programs prepare students for graduate study, medical or professional school, teaching, technical sales, technical writing, and industrial or government employment.

In order to fit the needs of the individual student, the department offers to chemistry majors four different options. The courses prescribed for each of these options and the career opportunities available upon completion of each major are described below.

Requirements for each option are shown on the following pages.

Chemistry Major

Chemistry Option

Requirements

This option prepares students for employment in the chemical industry as chemical technicians, salespersons, purchasing agents, market analysts, production supervisors, etc., or in education as secondary school teachers. In addition, this option prepares students for graduate work in fields of chemistry, both pure, such as organic, inorganic, physical, analytical, or biochemistry, and applied, such as clinical, forensic, polymer, marine, or environmental chemistry. It may also be supplemented by graduate work in law, library science, or business, leading to a career as a research chemist, chemical patent attorney, librarian, science illustrator, technical writer, or chemical industry executive. A number of free electives are included to provide flexibility in the program to suit the student's special interest. An appropriate course sequence is shown.

		Semester Credits	
		First	Second
First Year			
CHM 151, 152	Principles of Modern Chemistry	3	3
CHM 165, 166	Introduction to Experimentation	2	2
CHM 172	Intro. to Computer Applications for Chemists		1
MTH 111, 112	Analytical Geometry and Calculus I, II	4	4
ENL 101, 102	Critical Writing and Reading I, II	3	3
	Humanities or Social Science ¹	3	3
		15	16
Second Year			
CHM 251, 252	Organic Chemistry I, II	3	3
CHM 265, 266	Organic Chemistry Lab I, II	2	2
CHM 362	Introduction to Biochemistry		3
MTH 211	Analytical Geometry and Calculus III	4	
PHY 113, 114	Classical Physics I, II	4	4
	Humanities, Social Science or Literature	3	
	Free Elective		
		16	15
Third Year			
CHM 305	Modern Methods of Chemical Analysis	3	
CHM 307	Procedures of Chemical Analysis	2	
CHM 315, 316	Physical Chemistry I, II	4	4
CHM 318	Physical Chemistry Measurements I		2
CHM 422	Computer/Math Methods in Physical Science ²		3
	Humanities, Social Science or Literature	3	3
	Free Electives	3	3
		15	15
Fourth Year			
CHM 319	Physical Chemistry Measurements II	2	
CHM 401, 402	Chemistry Seminar	0.5	0.5
CHM 431	Principles of Inorganic Chemistry		3
CHM 433	Inorganic Chemistry Laboratory		1
	Humanities, Social Science or Literature ¹		6
	Advanced Chemistry Electives	6	3
	Free Electives	6	3
		14.5	16.5
	Total credits:		123

¹ The Humanities/Social Sciences requirement of 18 credits must consist of at least 6 credits of Humanities and 6 credits of Social Sciences. Note that there is no foreign language requirement for the BS degree. Literature requirement: 6 credits. Literature must be in the English language.

² Any of the following combinations of courses fulfill the CHM 422 requirement: MTH 212 (or MTH 204) and PHY 234; MTH 212 (or MTH 204) and MTH 221 or 227; MTH 212 (or MTH 204) and EGR 301. Students who fulfill the requirement by taking one of these alternative course combinations may not receive additional credit for CHM 422/522.

Chemistry Electives

CHM 352	Organic Preparations
CHM 411	Biochemistry I
CHM 412	Biochemistry II
CHM 414	Biochemistry Laboratory
CHM 421	Organic Mechanisms
CHM 426	Polymer Synthesis and Characterization
CHM 432	Organic Analysis
CHM 442	Applied Spectroscopy
CHM 491	Introduction to Research I
CHM 492	Introduction to Research II
CHM 510	Advanced Organic Chemistry
CHM 511	Biochemistry I
CHM 512	Biochemistry II
CHM 520	Advanced Inorganic Chemistry
CHM 521	Organic Mechanisms
CHM 523	Thermodynamics
CHM 525	Theoretical Organic Chemistry
CHM 526	Polymer Synthesis and Characterization
CHM 527	Electronic Structure of Atoms and Molecules
CHM 529	Physical Biochemistry
CHM 531	Chemical Kinetics
CHM 533	Statistical Mechanics
CHM 542	Quantum Chemistry
CHM 544	Applied Spectroscopy
CHM 550	Special Topics in Chemistry
CHM 551	Electroanalytical Chemistry
CHM 552	Instrumental Methods of Analysis
CHM 553	Nuclear and Radiochemistry
CHM 554	Molecular Spectra and Structure
CHM 555	Methods of Chemical Separation
CHM 556	Magnetic Resonance Spectroscopy
CHM 560	New Synthetic Methods
CHM 562	Natural Products

Departmental General Education Requirements

Students majoring in Chemistry will meet their departmentally-controlled General Education requirements as follows:

Area E: Students should select a course from the published list of available courses that satisfy this requirement.

Area I, Tier 2: Satisfied by CHM 172 or CHM 422

Area W, Tier 2: Satisfied by CHM 307, CHM 318, or CHM 412

Area O: Satisfied by CHM 401/402 and one additional course from : CHM 272, 431, or 412

Chemistry Major
Biochemistry Option

Requirements

The biochemistry option for the BS degree in chemistry is designed for those students with dual interests in biology and chemistry. A student receiving this degree will be qualified to enter industry as a BS biochemist or, with the selection of several education courses, will be well qualified as a high school science teacher. Students with the biochemistry option will be able to enter graduate school in any of the areas of chemistry, biochemistry, molecular biology, pharmacology, nutrition or other life science programs. The following curriculum conforms to that recommended by the American Society of Biochemistry and Molecular Biology for an undergraduate degree in biochemistry. An appropriate course sequence is shown.

		Semester Credits	
		First	Second
First Year			
CHM 151, 152	Principles of Modern Chemistry	3	3
CHM 165, 166	Introduction to Experimentation I, II	2	2
CHM 172	Intro. to Computer Applications for Chemists		1
MTH 111, 112	Analytical Geometry and Calculus I, II	4	4
ENL 101, 102	Critical Writing and Reading I, II	3	3
	Humanities or Social Science ¹	3	3
		15	16
Second Year			
CHM 251, 252	Organic Chemistry I, II	3	3
CHM 265, 266	Organic Chemistry Lab I, II	2	2
MTH 211	Analytical Geometry and Calculus III	4	
BIO 234	Biology of Cells ²	3	
BIO 244	Biology of Cells Lab ²	1	
PHY 113, 114	Classical Physics I, II	4	4
	Humanities, Social Science or Literature ¹		6
		17	15
Third Year			
CHM 315, 316	Physical Chemistry I, II	4	4
CHM 411, 412	Biochemistry I, II	3	3
CHM 414	Biochemistry Laboratory ³		3
CHM 305	Modern Methods of Chemical Analysis	3	
CHM 307	Procedures of Chemical Analysis	2	
	Free Elective		3
	Humanities, Social Science or Literature ¹	3	3
		15	16
Fourth Year			
CHM 529	Physical Biochemistry	3	
CHM 401, 402	Chemistry Seminar	0.5	0.5
	Biology/Chemistry Electives	6	3
	Humanities, Social Science or Literature ¹	3	3
	Free Electives	3	6
		15.5	12.5
		Total credits:	122
Biology Electives (2 required) ⁴			
BIO 321	General Microbiology		
BIO 327	Molecular Biology		
BIO 333, 334	General Genetics		
BIO 411	Proseminar: Current Topics in Biology		
BIO 419	Biological Scanning Electron Microscopy		
BIO 421	Developmental Biology		
BIO 460	Transmission Electron Microscopy		
Chemistry Electives (1 required)			
CHM 318	Physical Chemistry Measurements I		
CHM 319	Physical Chemistry Measurements II		
CHM 421	Organic Mechanisms		
CHM 422	Computer/Math Methods in Physical Science		
CHM 431, 433	Inorganic Chemistry		
CHM 442	Applied Spectroscopy		
CHM 552	Instrumental Methods of Analysis		
CHM 555	Methods of Chemical Separation		

1 The Humanities/Social Sciences requirement of 18 credits must consist of at least 6 credits Humanities and 6 credits of Social Sciences. Note that there is no separate foreign language requirement for the BS degree. It is strongly recommended that the humanities requirement be satisfied by taking at least 1 and preferably 2 years of French or German. Literature requirement: 6 credits.

2 Students with weak backgrounds in biology may need to take BIO 121, 122, 131, 132 before attempting subsequent biology courses.

3 Students who do not contemplate doing undergraduate research (CHM 491-492) may postpone CHM 414 until their senior year.

4 Other advanced biology or chemistry courses may be substituted with the prior written permission of the biochemistry advisor.

Chemistry Major

Environmental Chemistry Option

Requirements

The Environmental Chemistry Option is designed for students who are interested in the interface of chemistry and science of the environment. Students completing the Environmental Chemistry Option are well prepared for a variety of post baccalaureate careers. Typical career objectives might include those that entail environmental monitoring and analysis, regulatory monitoring and enforcement, industrial compliance and others. In addition, a student who selects the Environmental Chemistry Option is well prepared for graduate studies in chemistry, environmental science, marine science, environmental chemistry and other areas. The variety of environment-related course electives allows students to select a program of study that fits their interests, while the required chemistry courses ensure that they develop expertise within the fundamental areas of chemistry. An appropriate course sequence is shown.

		Semester Credits	
		First	Second
First Year			
CHM 151, 152	Principles of Modern Chemistry I, II	3	3
CHM 165, 166	Introduction to Experimentation I, II	2	2
CHM 172	Intro. to Computer Applications for Chemists		1
MTH 111, 112	Analytical Geometry and Calculus I, II	4	4
ENL 101, 102	Critical Writing and Reading I, II	3	3
	Humanities or Social Science ¹	3	3
		15	16
Second Year			
CHM 251, 252	Organic Chemistry I, II	3	3
3CHM 265, 266	Organic Chemistry Lab I, II	2	2
CHM 362	Introduction to Biochemistry		3
MTH 211	Analytical Geometry and Calculus III	4	
BIO 234	Biology of Cells ²	3	
PHY 113, 114	Classical Physics I, II	4	4
	Humanities, Social Science or Literature		3
		16	15
Third Year			
CHM 315, 316	Physical Chemistry I, II	4	4
CHM 355	Aquatic Environmental Chemistry	3	
CHM 356	Atmospheric/Terrestrial Environmental Chemistry		3
CHM 318	Physical Chemistry Measurements I		2
CHM 305	Modern Methods of Chemical Analysis	3	
CHM 307	Procedures of Chemical Analysis	2	
	Free Elective		3
	Humanities, Social Science or Literature	3	3
		15	15
Fourth Year			
CHM 401, 402	Chemistry Seminar	0.5	0.5
CHM 350	Chemical Oceanography	3	
CHM 431	Principles of Inorganic Chemistry		3
CHM 433	Inorganic Chemistry Laboratory		1
	Environment Related Course Elective	3	3
	Advanced Chemistry Elective ³	3	3
	Humanities, Social Science or Literature	6	3
	Free Electives		3
		15.5	16.5
	Total credits:		124

¹ The Humanities/Social Sciences requirement of 18 credits must consist of at least 6 credits of Humanities and 6 credits of Social Sciences. Note that there is no separate foreign language requirement for the BS degree. The College of Arts and Sciences Literature requirement is 6 credits in the English language beyond ENL 101 and 102. Courses taken to meet College requirements may also meet environment related course elective requirements and/or General Education requirements.

² Students with weak backgrounds in biology may need to take BIO 121, 122, 131, 132 before attempting subsequent biology courses.

³ Students who wish to be certified by the American Chemical Society must include among their advanced chemistry electives CHM 319, CHM 431, CHM 433, CHM 411 and CHM 552.

Environment Related Electives

An * indicates that this course will also meet College of Arts and Sciences Humanities/Social Sciences requirements. Students should note that these courses may meet multiple requirements (College, General Education or Departmental) although a total of 124 credits (minimum) will still be required for graduation.

BIO 316	Descriptive Oceanography
ECO 337	Environmental Economics*
PHL 320	Philosophy of Science*
PHY 351	Physics of the Environment I
PHY 352	Physics of the Environment II
PSC 345	Politics of Public Health*
PSC 347	Environmental Law*
PSC 348	Marine Policy and Law*
TES 350	Environmental Science and Industry Compliance
BIO 419	Biological Scanning Electron Microscopy
BIO 471	Marine Microbiology
ECO 472	Coastal Resource Economics*

Advanced Chemistry Electives

Recommended for the Environmental Chemistry Option

CHM 319	Physical Chemistry Measurements II
CHM 411	Biochemistry I
CHM 412	Biochemistry II
CHM 422	Computer/Math Methods in Physical Science
CHM 491, 492	Introduction to Research I, II
CHM 531	Chemical Kinetics
CHM 544	Applied Spectroscopy
CHM 550	Special Topics
CHM 551	Electroanalytical Chemistry
CHM 552	Instrumental Methods of Analysis
CHM 553	Nuclear and Radiochemistry
CHM 555	Methods of Chemical Separation
CHM 562	Natural Products

Chemistry Major
Premedical Option

Requirements

This option offers distinct advantages in efficiency, versatility, and rigor in preparation for students interested in further studies in a medical, dental, optometric, podiatric, osteopathic, or veterinary school. Programs for pre-med students should have the approval of Dr. Alan Bates, co-chairperson of the Pre-medical Advisory Committee. Premedical chemistry majors are certified for graduation by the Chemistry Department, just as are conventional majors.

Separately, premedical advising is offered for students in any major at UMass Dartmouth (see program description elsewhere in this *Catalogue*).

A wide variety of majors is appropriate for those intending to attend medical or veterinary school, with appropriate advising.

		Semester Credits	
		First	Second
First Year			
CHM 151, 152	Principles of Modern Chemistry	3	3
CHM 165, 166	Introduction to Experimentation	2	2
CHM 172	Intro. to Computer Applications for Chemists		1
MTH 111, 112	Analytical Geometry and Calculus I, II	4	4
ENL 101, 102	Critical Writing and Reading I, II	3	3
	Humanities, Social Sciences, or Literature ^{1, 5}	3	3
		15	16
Second Year			
CHM 251, 252	Organic Chemistry I, II	3	3
CHM 265, 266	Organic Chemistry Lab I, II	2	2
MTH 211	Analytical Geometry and Calculus III	4	
PHY 113, 114	Classical Physics I, II	4	4
BIO 234	Biology of Cells ¹	3	
BIO 244	Biology of Cells Lab	1	
BIO	Biology Elective ²		3 or 4
	Humanities, Social Sciences, or Literature		3
		17	15 or 16
Third Year			
CHM 305	Modern Methods of Chemical Analysis	3	
CHM 307	Procedures of Chemical Analysis	2	
CHM 315, 316	Physical Chemistry I, II	4	4
CHM 318	Physical Chemistry Measurements I		2
BIO 333	General Genetics	4	
	Science Elective ³		3 or 4
	Humanities, Social Sciences, or Literature	3	6
		16	15 or 16
Fourth Year			
CHM 401, 402	Chemistry Seminar	0.5	0.5
CHM 411	Biochemistry I	3	
CHM 431	Principles of Inorganic Chemistry		3
CHM 433	Inorganic Chemistry Laboratory		1
	Humanities, Social Sciences, or Literature	3	3
	Free Electives ⁴	6	6
		12.5	13.5
		Total credits:	123-125

¹ Students with weak backgrounds in biology may need to take Biology of Organisms (BIO 121, 122, 131, 132) before attempting subsequent biology courses. Therefore, these two H/SS courses may need to be moved to another year or to a summer session.

² Appropriate biology electives are BIO 320 (Embryology) or BIO 370 (Animal Physiology).

³ Appropriate electives would be CHM 422 (Computer and Mathematical Methods in Physical Science), CHM 442 (Applied Spectroscopy), CHM 552 (Instrumental Methods of Analysis), BIO 327 (Molecular Biology) or BIO 421 (Developmental Biology).

⁴ Appropriate electives would be CHM 412 (Biochemistry II), CHM 431 (Principles of Inorganic Chemistry) or CHM 491-492 (Introduction to Research I, II).

⁵ The Humanities/Social Sciences requirement of 18 credits must consist of at least 6 credits of Humanities and 6 credits of Social Sciences. Note that there is no separate foreign language requirement for the BS degree. Literature requirement: 6 credits.

Chemistry Major

BS-MS Option

Requirements

This option offers advantages to capable students who are willing to devote their summers to furthering their education. For those going on to graduate work, it provides exposure to graduate courses and research, making the transition from BS to PhD level performance easier. For those going into teaching or industry, it yields a significant financial advantage.

Policy and Procedures

- Humanities/Social Sciences requirement of 18 credits must consist of at least 6 credits of Humanities and 6 credits of Social Sciences. Literature requirement: 6 credits.

- Should a student desire to lighten his/her course load in years three and four, Humanities/Social Sciences electives could be taken during Summer 2.

- The student should select the BS-MS option no later than the beginning of the fourth semester. Entrance into the program requires approval of the Chemistry Faculty. The student in the program may elect to terminate the program after the seventh semester with the completion of the BS requirements.

- Students who select the BS-MS program are eligible for teaching assistantships after completing the requirements for the BS degree (after the seventh semester) and for summer stipends during the fourth and fifth summers.

- At least 12 credits of the chemistry courses that count toward the MS degree must be at the 500 level.

- This program may be applied to the Biochemistry Option with appropriate modifications.

- Students in the BS-MS program must have and maintain a chemistry GPA of at least 3.00 and an overall GPA of 2.75.

		Semester Credits	
		First	Second
First Year			
CHM 151, 152	Principles of Modern Chemistry	3	3
CHM 165, 166	Introduction to Experimentation	2	2
CHM 172	Intro. to Computer Applications for Chemists		1
MTH 111, 112	Analytical Geometry and Calculus I, II	4	4
ENL 101, 102	Critical Writing and Reading I, II	3	3
	Humanities, Social Science or Literature	3	3
		15	16
Second Year			
CHM 251, 252	Organic Chemistry I, II	3	3
CHM 265, 266	Organic Chemistry Lab I, II	2	2
CHM 362	Introduction to Biochemistry		3
MTH 211	Analytical Geometry and Calculus III	4	
PHY 113, 114	Physics I, II	4	4
	Humanities, Social Science or Literature	3	3
	Free Elective		3
		16	18
Third Year			
CHM 305	Modern Methods of Chemical Analysis	3	
CHM 307	Procedures of Chemical Analysis	2	
CHM 315, 316	Physical Chemistry I, II	4	4
CHM 318	Physical Chemistry Measurements I		2
CHM 422	Computer/Math Methods in Physical Science		3
CHM 402	Chemistry Seminar		0.5
	Humanities, Social Science or Literature	6	3
	Free Electives	3	3
CHM 492	Introduction to Research		3
		18	18.5
Summer 3	Research		
	Free Elective		3
			3
Fourth Year			
CHM 401	Chemistry Seminar	0.5	
CHM 319	Physical Chemistry Measurements II	2	
	Advanced Chemistry Electives	6	6
CHM 431	Principles of Inorganic Chemistry		3
CHM 433	Inorganic Chemistry Laboratory		1
CHM 491	Introduction to Research	3	
	Humanities, Social Science or Literature	3	
	Free Elective	3	
		17.5	10
Summer 4	Research		
Fifth Year			
CHM 600	Thesis Research	6	6
CHM	Advanced Chemistry Electives	6	3
		12	9
Summer 5	Research and completion of thesis		
		Total credits:	153

Chemistry and Biochemistry Minors Requirements

Degree candidates who have a grade point average of at least 2.5 in the 100- and 200-level chemistry courses may request admission to the Chemistry or Biochemistry minors. This request must be approved by the Department Chairperson. A 2.0 grade point average in the courses listed will be required for completion of the minor.

Chemistry Minor		Credits
CHM 151, 152	Principles of Modern Chemistry I & II	6
CHM 161, 162, 166	Introduction to Applied Chemistry I & II and Introduction to Experimentation II OR	4
CHM 165, 166	Introduction to Experimentation I & II	
CHM 251, 252	Organic Chemistry I & II	6
CHM 263, 264 CHM 265, 266	Bio-Organic Chemistry Laboratory I & II OR Organic Chemistry Laboratory I & II	2-4
CHM 305	Modern Methods of Chemical Analysis	3
CHM 307	Procedures of Chemical Analysis Laboratory	2
CHM 315	Physical Chemistry I OR	4
CHM 316	Physical Chemistry II (by permission)	
Total		27-29

Biochemistry Minor		Credits
CHM 151, 152	Principles of Modern Chemistry I & II	6
CHM 161, 162, 166	Introduction to Applied Chemistry I & II and Introduction to Experimentation II OR	4
CHM 165, 166	Introduction to Experimentation I & II	
CHM 251, 252	Organic Chemistry I & II	6
CHM 263, 264 CHM 265, 266	Bio-Organic Chemistry Laboratory I & II OR Organic Chemistry Laboratory I & II	2-4
CHM 305	Modern Methods of Chemical Analysis OR	3 or 4
CHM 315	Physical Chemistry I*	
CHM 411, 412	Biochemistry I & II	6
Total		27-30

* CHM 316, Physical Chemistry II, may be substituted for CHM 315, with permission.

Combined Chemistry Major—Business Administration Minor

Requirements

This arrangement of courses is designed for the student who combines an interest in Chemistry with career goals in the business world. It is designed to enable the student to fulfill all requirements for the Chemistry Major and the Business Minor within the standard four-year curriculum. The student must be aware that deviations from the recommended course schedule will ensure that additional time in residence will be required. A comparable track is possible for the Biochemistry Option by substituting the appropriate courses.

		Semester Credits	
First Year		First	Second
CHM 151, 152	Principles of Modern Chemistry I, II	3	3
CHM 165, 166	Introduction to Experimentation	2	2
CHM 172	Intro. to Computer Applications for Chemists		
MTH 111, 112	Analytical Geometry and Calculus I, II	4	4
ENL 101, 102	Critical Writing and Reading I, II	3	3
ECO 231	Economics I		3
	Humanities, Social Sciences, or Literature Elective	3	
		15	16
Second Year			
CHM 251, 252	Organic Chemistry I, II	3	3
CHM 265, 266	Organic Chemistry Lab I, II	2	2
CHM 362	Introduction to Biochemistry		3
MTH 211	Analytical Geometry and Calculus III	4	
PHY 113, 114	Classical Physics I, II	4	4
ACT 211	Principles of Accounting I		3
	Humanities, Social Sciences, or Literature Elective	3	
		16	15
Third Year			
CHM 305	Modern Methods of Chemical Analysis	3	
CHM 307	Procedures of Chemical Analysis	2	
CHM 315, 316	Physical Chemistry I, II	4	4
CHM 318	Physical Chemistry Measurements I		2
CHM 422	Computer/Math Methods in Physical Science		3
MKT 211	Principles of Marketing	3	
MGT 311	Organizational Behavior		3
	Humanities, Social Sciences, or Literature Electives	3	3
		15	15
Fourth Year			
CHM 319	Physical Chemistry Measurements II	2	
CHM 401, 402	Chemistry Seminar	0.5	0.5
CHM 431	Principles of Inorganic Chemistry		3
CHM 433	Inorganic Chemistry Laboratory		1
	Advanced Chemistry Electives	3	6
	Humanities, Social Sciences, Literature or Business Electives	9	9
		14.5	16.5
	Total credits:		123

Business Minor Requirements: ECO 231, ACT 211, MKT 211, and MGT 311 are required courses for the Business Minor. ECO 231 also satisfies one of the College of Arts and Sciences Social Sciences requirements. Three courses (9 credits) from among ACT 212, BIS 315, FIN 312, MGT 312, MGT 365, MGT 346, MGT 347 are required to complete the Business Minor. The University requirements for a minor specify that 9 credits must be at the 300-level or above. Note that BIS 315, FIN 312, and MGT 346 have additional prerequisites.

College of Arts and Sciences Requirements: Humanities/Social Science Requirements: 5 courses (besides ECO 231) which must include 2 humanities and one more social science course. Literature requirements: two courses.

General Education Requirements: Students should carefully plan their programs with their advisor to ensure that their courses selected for the Arts and Sciences requirements will also satisfy the appropriate General Education Requirements.

Gen Ed note: Chemistry courses satisfy the Natural Science and Technology requirement. Those marked **S** below are appropriate for non-science/engineering majors.

Chemistry and Biochemistry Courses

CHM 100 four administrative credits*

Preparation for College Chemistry

2 hours lecture, 1 hour recitation,
2 hours laboratory

Helps students overcome science, mathematics, and reasoning difficulties so that they may be successful in their required general chemistry course. The lecture and the laboratory are integrated to ensure that students have direct hands-on experience with most of the abstract ideas covered in the lecture.

CHM 101 three credits **S**

General Chemistry I

4 hours lecture and recitation

Pre- or Corequisite: MTH 101

An introduction to the fundamental chemical laws and theories covering inorganic and organic chemistry and biochemistry with some descriptive chemistry. For non-science majors, nurses and technologists.

CHM 102 three credits **S**

General Chemistry II

4 hours lecture and recitation

Prerequisite: At least a C- in CHM 101

Continuation of CHM 101.

CHM 130 three credits **S**

Chemistry and the Environment

3 hours lecture

Available to anyone in the university, this course provides substantial treatment, with demonstrations, of the chemistry involved in consumer concerns (food additives, medicines, detergents, etc.), air and water pollution, elementary biochemistry, and the general question of power generation and utilization (fuel cells, solar energy conversion, nuclear energy, etc.). No knowledge of chemistry is assumed, but it is hoped the student will have had high school chemistry or its equivalent.

CHM 131 three credits **S**

Environmental Issues from a Chemical Perspective

3 hours lecture

Examines some of the major environmental problems facing society and the knowledge of chemistry needed to comprehend the problem and evaluate possible solutions. The course is available to anyone in the university. It will cover issues associated with chemical industry such as hazardous waste

management and pesticide use as well as the risks and benefits of living in a chemical world.

CHM 132 three credits **S**

Chemistry in Nutrition and Health

3 hours lecture

Nutrition and health issues facing people today and the chemistry needed to understand them. Topics to be discussed include health efforts of toxic substances, the science of proper diet, and some of the biochemistry needed to understand diseases such as cancer and AIDS.

CHM 151 three credits **S**

Principles of Modern Chemistry I

4 hours lecture and recitation

Prerequisites: High school chemistry and algebra; and satisfactory score on departmental placement examination

Corequisite: MTH 131 or 111

Physical and chemical principles pertaining to the structure of chemical species and the nature, extent, and rates of chemical reactions. The details of stoichiometry, energy changes associated with chemical reactions, atomic and molecular structure, chemical bonding, and the phenomenon of chemical periodicity are emphasized and discussed in light of modern scientific theories. For science and engineering majors. Honors sections are offered.

CHM 152 three credits **S**

Principles of Modern Chemistry II

4 hours lecture and recitation

Prerequisite: At least a C- in CHM 151

A continuation of CHM 151. The details of the behavior of solids, liquids, & gases, the types of intermolecular forces, colligative properties, gaseous equilibrium, aqueous equilibrium, thermodynamics, electrochemistry, kinetics, and nuclear chemistry are emphasized and discussed in light of modern scientific theories. For science and engineering majors. Honors sections are offered.

CHM 153 three credits **S**

Principles of Modern Chemistry for Engineers

Combined lecture/laboratory format

Prerequisites: High school chemistry and algebra

Corequisite: MTH 113 or 111

Physical and chemical principles pertaining to the structure of chemical species and the nature, extent and rates of chemical reactions. The details of stoichiometry, energy changes associated with chemical reactions, atomic and molecular structure,

chemical bonding, chemical periodicity, and the application to materials are emphasized and explored in an interactive format.

CHM 161 one credit

Introduction to Applied Chemistry I

1 hour lecture, 2 hours laboratory

Prerequisites: High school chemistry (with laboratory) is strongly recommended.

Corequisite: CHM 151

An introduction to chemical laboratory techniques and methods with emphasis on preparation, purification, and identification of compounds, elemental analysis, reaction stoichiometry, chemical ionization, thermochemistry, spectrophotometric techniques, and selective descriptive inorganic chemistry. Most experiments involve the identification of unknowns and statistical analysis of data. The experiments in CHM 161 parallel the topics covered in CHM 151. A written laboratory report summarizing the procedure and results for each experiment is required. For science and engineering majors. Honors sections are offered.

CHM 162 one credit

Introduction to Applied Chemistry II

1 hour lecture, 2 hours laboratory

Prerequisites: At least a C- in CHM 151, 161

Corequisite: CHM 152

A continuation of CHM 161 with emphasis on molecular weight determination techniques, colligative properties, qualitative analysis, acid-base chemistry, properties of buffer solutions, chromatographic techniques, kinetics, solubility constant determination, and electrochemistry. Most experiments involve the identification of unknowns and statistical analysis of data. The experiments in CHM 162 parallel the topics covered in CHM 152. A written laboratory report summarizing the procedure and results for each experiment is required. For science and engineering majors. Honors sections are offered.

CHM 165 two credits

Introduction to Experimentation I

2 hours lecture, 4 hours laboratory

Pre- or Corequisite: CHM 151

Corequisite: MTH 131 or MTH 111

Laboratory for chemistry and textile chemistry majors. An introduction to the basic techniques, methods and theory of chemical experimentation, and the recording, analysis, interpretation and reporting of experimental results, based on qualitative and quantitative chemical procedures. Skills of professional quality, needed to use apparatus for the accurate

* Administrative credits do not count towards the total required for graduation.

measurement of mass, volume, color intensity, etc., will be developed.

CHM 166 two credits

Introduction to Experimentation II

2 hours lecture, 4 hours laboratory
Prerequisite: At least a C- in CHM 165
Pre- or Corequisite: CHM 152
Continuation of CHM 165.

CHM 167 one credit

Introduction to Statistics for the Chemistry Lab

2 hours lecture and recitation
Statistics at an introductory level as applied to experiments in a college freshman level chemistry laboratory. Topics covered include the nature of distributions of data, histograms, basic statistical calculations, the normal distribution, t-distributions, statistical tests appropriate for small samples of data criteria for rejection of data, analysis of data and reporting of result and an introduction to propagation of errors. Credit cannot be received for both CHM 165 and CHM 167.

CHM 172 one credit

Introduction to Computer Applications for Chemists

1 hour lecture, 1 hour recitation
Prerequisites: At least a C- in CHM 151, 165
Corequisites: CHM 152, 166
Approaches to chemistry problem-solving using microcomputers. Spreadsheets and other commonly-available applications will be used to study mathematical concepts related to chemistry, to solve problems on topics from the chemistry majors' lecture and lab courses, and to analyze data obtained in the lab. Students also will be taught to search for chemical information on the World Wide Web.

CHM 251 three credits

Organic Chemistry I

4 hours lecture and recitation
Prerequisite: At least a C- in CHM 152
A survey of the chemistry of carbon compounds and introduction to the basic principles of organic chemistry.

CHM 252 three credits

Organic Chemistry II

4 hours lecture and recitation
Prerequisite: At least a C- in CHM 251
Continuation of CHM 251.

CHM 263 one credit

Bio-organic Chemistry Laboratory I

1 hour lecture, 3 hours laboratory
Prerequisites: At least a C- in CHM 152, 162
Corequisite: CHM 251

The synthesis of organic compounds and an introduction to the organic methods of separation, purification and identification. This course is coordinated with CHM 251 and is designed for biology and medical laboratory science majors.

CHM 264 one credit

Bio-organic Chemistry Laboratory II

1 hour lecture, 3 hours laboratory
Prerequisites: At least a C- in CHM 251, 263
Corequisite: CHM 252
Continuation of CHM 263.

CHM 265 two credits

Organic Chemistry Laboratory I

1 hour lecture, 3 hours laboratory
Prerequisites: At least a C- in CHM 152, 166; or CHM 162
The synthesis of organic compounds and an introduction to the organic methods of separation, purification and identification. This course is coordinated with CHM 251 and is designed for chemistry and textile chemistry majors.

CHM 266 two credits

Organic Chemistry Laboratory II

1 hour lecture, 3 hours laboratory
Prerequisites: At least a C- in CHM 251, 265
Corequisite: CHM 252
Continuation of CHM 265.

CHM 272 four credits

Descriptive Inorganic Chemistry

2 hours lecture, 3 hours laboratory
Prerequisites: At least a C- in CHM 152, 166
A survey of the preparations and reactions of selected representative elements and transition metals. For each element the following points are treated: physical and chemical properties of the element; occurrence of the element in nature, its extraction and uses; important compounds and their uses, including industrial processes. An introduction to transition metal complexes. An advanced treatment of ionic equilibria including precipitation and complex-formation reactions.

CHM 298 one to six credits

Experiential Learning

Prerequisites: At least sophomore standing; permission of the instructor, department chairperson, and college dean
Work experience at an elective level supervised for academic credit by a faculty member in an appropriate academic field. Conditions and hours to be arranged. Graded CR/NC. For specific procedures and regulations, see section of catalogue on Other Learning Experiences.

CHM 305 three credits

Modern Methods of Chemical Analysis

3 hours lecture, 1 hour recitation
Prerequisites: At least a C- in CHM 252, 266, 166; recommended: CHM 272
Introduction to chemical and instrumental analytical techniques. The theory of neutralization reactions in aqueous and nonaqueous systems. Oxidation-reduction and complex formation equilibria. Basic theory of electronic circuitry. Introduction to electrochemical methods. Introduction to chromatographic and spectrophotometric techniques.

CHM 307 two credits

Procedures of Chemical Analysis

1 hour lecture, 4 hours laboratory
Corequisite: CHM 305
Laboratory experimentation designed to develop the techniques and illustrate applications of analytical procedures to the solution of chemical problems.

CHM 315 four credits

Physical Chemistry I

4 hours lecture, 1 hour recitation
Prerequisites: At least a C- in CHM 152, MTH 211, two semesters of college physics
An introduction to the theoretical principles underlying chemical phenomena; applications of thermodynamics to chemical phenomena.

CHM 316 four credits

Physical Chemistry II

4 hours lecture, 1 hour recitation
Prerequisite: At least a C- in CHM 315
An introduction to quantum mechanics, symmetry, spectroscopy, chemical kinetics and transport processes.

CHM 318 two credits

Physical Chemical Measurements I

1 hour lecture, 4 hours laboratory
Prerequisites: At least a C- in CHM 305, 307, 315
Corequisite: CHM 316
Experiments in physical chemistry designed to test established theoretical principles which have been introduced in CHM 315 and 316. The experiments provide the student with basic experience in obtaining precise physical measurements of chemical interest.

CHM 319 two credits

Physical Chemical Measurements II

1 hour lecture, 4 hours laboratory
Prerequisites: At least a C- in CHM 305, 307, 316
Continuation of CHM 318.

Gen Ed note: Chemistry courses satisfy the Natural Science and Technology requirement. Those marked **S** below are appropriate for non-science/engineering majors.

CHM 350 three credits **S**

Chemical Oceanography

Prerequisites: At least a C- in CHM 151, 152
Chemical oceanography, with an overview of the interaction between marine chemistry and oceanic physics, biology, and geology. The fundamental processes controlling the distribution of chemical species in the ocean will be explored and implications for global environmental change highlighted.

CHM 352 three credits

Organic Preparations

1 hour lecture, 4 hours laboratory
Prerequisites: At least a C- in CHM 252, 266
A study of the more intricate synthetic procedures of organic chemistry including use of the literature for choice of optimum methods.

CHM 355 three credits

Aquatic Environmental Chemistry

Prerequisites: At least a C- in CHM 151, 152 or permission of instructor
Fundamentals of aquatic environmental chemistry. Topics include dissolved gases chelation, complexation, role of humic substances in the aquatic environment, oxidation-reduction phenomena, chemical speciation, phase equilibria and chemistry related to water pollution issues.

CHM 356 three credits

Atmospheric/Terrestrial Environmental Chemistry

Prerequisite: At least a C- in CHM 355
Fundamentals of atmospheric and terrestrial environmental chemistry. Topics include physical and chemical characteristics of the atmosphere, reactions involving oxygen, nitrogen, carbon dioxide, water and particulates in the atmosphere, gaseous organic and inorganic pollutants. Additional topics include fundamentals of soil chemistry, organic and inorganic soil contaminants and environmental biochemistry and toxicology.

CHM 362 three credits

Introduction to Biochemistry

3 hours lecture
Prerequisite: At least a C- in CHM 251
An introduction to the chemical properties of compounds of biological interest; bioenergetics and enzymology. A survey of the metabolism of proteins, carbohydrates, lipids, nucleic acids and other bio-substances.

CHM 370 three credits

Introduction to Chemical Engineering

3 hours lecture

Prerequisites: At least a C- in CHM 152, 315, or EGR 232

An introduction to the principles of chemical processes, with a special emphasis on material and energy balances. Departmental elective for majors in chemistry and mechanical engineering.

CHM 401 one-half credit

Chemistry Seminar I

1 hour lecture

Lectures on current topics in chemistry from guest lecturers and students. Majors must enroll for two semesters out of four in the junior and senior years.

CHM 402 one-half credit

Chemistry Seminar II

1 hour lecture

Continuation of CHM 401.

CHM 411 three credits

Biochemistry I

3 hours lecture

Prerequisite: At least a C- in CHM 252, recommended BIO 234
Students may not receive credit for both CHM 362 and CHM 411, 412
See description under CHM 511.

CHM 412 three credits

Biochemistry II

Prerequisite: At least a C- in CHM 411
See description under CHM 512.

CHM 414 three credits

Biochemistry Laboratory

1 hour lecture, 6 hours laboratory

Prerequisite: At least a C- in CHM 264 or 266; CHM 411

Pre- or Corequisite: CHM 412

Recommended: CHM 305, 307;

BIO 234, 244

Basic biochemical techniques and methods including spectrophotometry, electrophoresis, chromatography, ultracentrifugation and radioisotopic techniques and their application to amino acids and proteins, lipids and membranes, enzymes and nucleic acids.

CHM 421 three credits

Organic Mechanisms

Pre- or Corequisite: At least a C- in CHM 315

See description under CHM 521.

CHM 422 three credits

Computer and Mathematical Methods in Physical Science

Prerequisite: At least a C- in CHM 172, 315; two semesters of college physics, three semesters of calculus; or permission of

instructor

Recommended corequisite: CHM 316
See description under CHM 522.

CHM 426 three credits

Polymer Synthesis and Characterization

2 hours lecture, 4 hours laboratory

Prerequisites: At least a C- in CHM 252, 315; recommended, TEC 410

See description under CHM 526.

CHM 431 three credits

Principles of Inorganic Chemistry

Prerequisite: One year of physical chemistry with grades of C- or better

The application of physico-chemical principles to inorganic systems. Discussion of chemistry of the representative elements utilizing thermodynamic principles and the modern theories of bonding and structure. Introduction to coordination chemistry.

CHM 432 four credits

Organic Analysis

Prerequisites: Organic and analytical chemistry with grades of C- or better
Quantitative elemental and group determination on a microscale followed by a study of the systematic identification of organic compounds. Extensive laboratory work on unknowns is required.

CHM 433 one credit

Inorganic Chemistry Laboratory

Prerequisite: At least a C- in CHM 316; corequisite: CHM 431

Synthetic and instrumental techniques currently used by inorganic chemists, including electrolytic, inert atmosphere, tube furnace and organometallic syntheses; ultraviolet-visible, nuclear magnetic resonance, infrared and mass spectrometry, magnetic susceptibility determination, as applied to a range of inorganic materials.

CHM 442 three credits

Applied Spectroscopy

3 hours lecture

Prerequisites: At least a C- in CHM 252, 266, 315

See description under CHM 544.

CHM 449 three credits

Theory and Applications of One- and Two-Dimensional Fourier Transform Nuclear Magnetic Resonance

Prerequisites: At least a C- in CHM 251/252 and CHM 315

See description under CHM 549.

CHM 491 three to six credits

Introduction to Research I

Note: Some graduate courses may be open to undergraduates. Please consult your department chairperson. See the Graduate Catalogue for graduate general and program requirements.

9 to 18 hours laboratory

Prerequisite: Departmental permission
Chemistry majors who are doing well in formal course work and who have indicated research potential are encouraged to undertake an original investigation under the direction of a member of the chemistry faculty.

CHM 492 three to six credits
Introduction to Research II

9 to 18 hours laboratory
Continuation of CHM 491.

CHM 495 variable credit
Independent Study

Prerequisites: Upper-division standing; permission of instructor, department chairperson, and college dean
Study under the supervision of a faculty member in an area not otherwise part of the discipline's course offerings. Terms and hours to be arranged.

CHM 196, 296, 396, 496 variable credit
Directed Study

Prerequisites: Permission of the instructor, department chairperson, and college dean
Study under the supervision of a faculty member in an area covered in a regular course not currently being offered. Terms and hours to be arranged.

Graduate Courses in Chemistry and Biochemistry

CHM 510 three credits
Advanced Organic Chemistry

Prerequisites: One year of physical chemistry and CHM 521 with grades of C- or better
A study of mechanisms and stereo-chemical aspects of chemical reactions including considerations of chemical kinetics and reactivity in terms of modern bonding theory and structural concepts.

CHM 511 three credits
Biochemistry I

Prerequisite: One year of organic chemistry with grades of C- or better; recommended, cell biology or equivalent
A comprehensive study of biochemistry including amino acid and protein chemistry, enzymology, enzyme kinetics, bioenergetics, metabolism of carbohydrates, lipids, amino acids, nucleotides; biosynthesis of nucleic acids and proteins.

CHM 512 three credits
Biochemistry II

Prerequisite: At least a C- in CHM 511
A continuation of CHM 511.

CHM 514 three credits
Biochemistry Laboratory

1 hour lecture, 6 hours laboratory
Basic biochemical techniques and methods including spectrophotometry, electrophoresis, chromatography, ultracentrifugation and radioisotopic techniques and their application to amino acids and proteins, lipids and membranes, enzymes and nucleic acids.

CHM 520 three credits
Advanced Inorganic Chemistry

Prerequisites: At least a C- in CHM 316 and CHM 431
Selected topics in modern inorganic chemistry.

CHM 521 three credits
Organic Mechanisms

Prerequisite: CHM 252. Prerequisite or Corequisite: One semester of physical chemistry
The first part of the course provides a background in the various areas of physical organic chemistry such as thermodynamics, kinetics, acid-base theory, structure-reactivity relationships and dipole moments. This is followed by a systematic study of reaction mechanisms.

CHM 522 three credits
Computer and Mathematical Methods in Physical Science

Prerequisites: One semester physical chemistry; two semesters of college physics, three semesters of calculus, or permission of instructor. Recommended Pre- or Corequisite: CHM 316, or equivalent
Selected topics in applied mathematics and computer science with applications to physical chemistry, organic chemistry, and bioinformatics. Includes introduction to differential equations, linear algebra, computer programming, curve and surface fitting, numerical integration, trajectory calculations, molecular modeling, quantum chemistry, computational molecular biology, and biological data analysis.

CHM 523 three credits
Chemistry of the Mind

Prerequisite: CHM 315, or equivalent
Exploration of the states of matter as understood by mind by considering reductionist and holistic approaches. Fundamental assumptions in developing scientific principles are examined with examples of kinetic theory of gases, ideal gas equation, and laws of thermodynamics. Application of thermodynamic laws to biological systems to model mind and brain activities. Structure, evolution, and functioning of the nervous system and neurological and metaphysical understanding of mind and consciousness are examined.

CHM 525 three credits
Theoretical Organic Chemistry

Prerequisites or Corequisites: One year each of organic and physical chemistry
Molecular orbital theory of organic molecules; applications of molecular orbital theory; reactivity, ESR, Carbon-13 NMR, photoelectron spectroscopy, etc.; orbital symmetry in electrocyclic reactions, cycloadditions, and sigmatropic reactions.

CHM 526 four credits
Polymer Synthesis and Characterization

Prerequisites: At least a C- in CHM 252, CHM 315; recommended, TEC 410
Laboratory synthesis of polymers and copolymers by different methods with an emphasis on the practical aspects of polymer synthesis. A discussion of various techniques of polymer characterization in terms of basic principles, experimental procedure, and interpretation of results. A selected number of experiments will be conducted on a class-project basis.

CHM 527 three credits

Electronic Structure of Atoms and Molecules

Prerequisite: One year of physical chemistry with grades of C- or better

Fundamental quantum mechanical principles of electronic structure. Angular momentum, the hydrogen atom problem, helium ground and excited states, electron spin and antisymmetrization, many electron atoms, bonding theory, valence bond and molecular orbital theory of diatomic and polyatomic molecules, applications of group theory to molecular orbital calculations, the self-consistent field method.

CHM 529 three credits

Physical Biochemistry

Prerequisite: One year each of physical chemistry and biochemistry with grades of C- or better

Physico-chemical principles governing structures of biological macromolecules. Topics include energetics and kinetics of biochemical processes, including binding, catalysis, diffusion/transport, and folding/unfolding; behavior of macromolecules in aqueous medium; and application of spectroscopic methods in biochemistry.

CHM 531 three credits

Chemical Kinetics

Prerequisite: One year of physical chemistry with grades of C- or better

Principles and selected topics, including analysis of reaction rates, kinetic and transition state theories, reactions in gas and liquid phases, unimolecular reactions, fast reactions, trajectory calculations, ion-molecule reactions, enzyme kinetics, and polymer kinetics.

CHM 533 three credits

Statistical Methods

Prerequisite: One year of physical chemistry with grades of C- or better

Introduction to the principles and methods of statistical mechanics. Classical and quantum partition functions applied to the calculation of thermodynamic properties.

CHM 542 three credits

Quantum Chemistry

Prerequisite: One year of physical chemistry with grades of C- or better

Fundamental concepts of quantum mechanics; wave properties, Schrodinger equation, and operators. Basic application to free particles, harmonic oscillator, hydrogen atom. Perturbation theory and variation method. Applications to many-electron systems and time-dependent problems.

CHM 544 three credits

Applied Spectroscopy

Prerequisites: One year each of organic and physical chemistry with grades of C- or better

A study of spectroscopic methods of determination of structure of organic compounds, especially infrared, ultraviolet, visible, nuclear magnetic resonance, and mass spectrometry, with extensive applications to individual cases.

CHM 549 three credits

Theory and Applications of One- and Two-Dimensional FT-NMR

Prerequisites: At least a C- in CHM 251/252 and 315, or equivalent

Fundamentals of Fourier Transform Nuclear Magnetic Resonance (FT-NMR) spectroscopy, including one- and two-dimensional techniques discussed from the perspective of structural determination. Generation of NMR signals and parameter optimization using a 300 MHz FT-NMR spectrometer will complement the analysis of NMR signals generated in situ.

CHM 550 three credits

Special Topics in Chemistry

Prerequisite: Permission of instructor
An advanced treatment of special topics in chemistry with an emphasis on recent developments. The subject matter varies from year to year.

CHM 551 four credits

Electroanalytical Chemistry

Prerequisite: One year of physical chemistry with grades of C- or better

The development of the fundamental mathematical relationships upon which electrochemical methods are based. The interpretation of the kinetics of electrode reactions and the transfer of material to and from electrodes under various conditions. The interpretation of data of direct analytical significance generated by the methods and techniques of modern electrochemistry.

CHM 552 four credits

Instrumental Methods of Analysis

Prerequisites: Quantitative analysis and one year of physical chemistry with grades of C- or better

The theory and practice of modern analysis utilizing optical and electrochemical instrumentation in the solution of chemical problems. Topics discussed include ultraviolet, visible, and infrared spectrophotometry, fluorimetry, flame emission and atomic absorption spectroscopy, plasma

emission spectroscopy, potentiometry utilizing ion specific electrodes, radiochemistry, thermoanalytical methods, voltammetry including polarography, amperometry, and coulometry; liquid chromatography, electron spectroscopy, x-ray fluorescence analysis, and neutron activation analysis.

CHM 553 three credits

Nuclear and Radiochemistry

Prerequisite: One year of physical chemistry with grades of C- or better

Application of nuclear and radiochemical methods. Topics include fundamentals of radioactive decay, radiation safety, interaction of radiation with matter, instrument design and function, radiotracers, radioanalytical methods, and related non-destructive methods for quantitative analysis.

CHM 554 three credits

Group Theory and Spectroscopy

Prerequisite: One year of physical chemistry with grades of C- or better, CHM 272, or equivalent

Introduction to theory and its applications in MO theory, spectroscopy, ligand field theory, and molecular structure.

CHM 555 three credits

Methods of Chemical Separation

Prerequisites: Analytical and physical chemistry with grades of C- or better

A survey and practice of modern separation methods. Topics include liquid, gas, thin layer and ion exchange chromatography; electrophoresis; sample preparation and extraction.

CHM 556 three credits

Theory of Magnetic Resonance Spectroscopy

Prerequisite: One year of physical chemistry with grades of C- or better; quantum mechanics recommended

Introduction to the theory of electron paramagnetic resonance and nuclear magnetic resonance; applications in the study of molecular structure.

CHM 560 three credits

New Synthetic Methods

Prerequisite: One year of organic chemistry with grades of C- or better; some biochemistry recommended

Survey of preparative methods in organic chemistry and their application to the synthesis of complex molecules.

CHM 562 three credits

Natural Products

Prerequisite: One year of organic chemistry with grades of C- or better

Isolation, structure elucidation, total synthesis, biosynthetic pathways, metabolism, and physiological importance and pharmacological uses of natural products.

CHM 595 three credits

Graduate Independent Study

Prerequisites: Graduate standing; permission of instructor, graduate director, and college dean

Study under the supervision of a faculty member in an area not otherwise part of the discipline's course offerings. Terms and hours to be arranged.

CHM 596 three credits

Graduate Directed Study

Prerequisites: Graduate standing; permission of instructor, graduate director, and college dean

Study under the supervision of a faculty member in an area covered in a regular course not currently being offered. Terms and hours to be arranged. Terms and hours to be arranged.

CHM 600 three to nine credits per term

Thesis Research

Prerequisite: Departmental permission
Original chemical research and preparation of thesis. Required for Plan A master's degree. Graded P/F.

CHM 610 two to five credits per term

Project Research

Prerequisite: Departmental permission
Original chemical research, required for Plan B master's degree. Written project report required. Graded P/F.

CHM 620 two to five credits per term

Library Research

Prerequisite: Departmental permission
Survey of a particular topic in the chemical literature. Written final summary report required. Graded P/F.

CHM 650 one credit

Graduate Seminar

Lectures on current topics in chemistry from guest lecturers and students. The graduate student will present a total of two seminars, one of which will be the thesis seminar. Each graduate student is required to enroll in this course for each semester in residence. This course will not count toward the 30 credits of course work and research required for the degree.