

CHEMISTRY AND BIOCHEMISTRY College of Science, Health & Engineering

Robin McRae, Chair			222 Science Building	509.359.2798
BA	BAE	BS	Minors	General Science Endorsement

Faculty:

P. Bilous, N. Burgis, J. Corkill, T. Denton, Y. Houndonougbo, D. Love, J. Manson, E. McGoran, R. McRae, J. Rahn, K. Raymond, W. Steiner

UNDERGRADUATE PROGRAMS

Chemistry occupies a unique position within the modern sciences. Ultimately, most of the phenomena in the biological, geological, physical, environmental and medical sciences can be expressed in terms of the chemical and physical behavior of atoms and molecules. Because of chemistry's key role, majors in chemistry and biochemistry are well prepared to pursue careers in a wide variety of disciplines.

The department offers programs leading to the Bachelor of Science and the Bachelor of Arts. These programs prepare students for careers in chemistry, biochemistry, biotechnology, medicine and related fields, forensic science, environmental science and education. The department's professional BS option is approved by the American Chemical Society. BS degrees are recommended for students planning professional careers in chemistry or related areas, while BA degrees are recommended for students with other career goals.

Students majoring in chemistry have the opportunity to engage in research projects with department faculty and to gain experience with modern instrumental techniques including gas and liquid chromatography; ultra-violet, visible, infra-red and atomic absorption spectrophotometry; nuclear magnetic resonance; x-ray diffraction; and laser photoacoustics. Upon graduation, our students are knowledgeable, experienced and independent laboratory workers.

General Admissions Requirements for Chemistry and Biochemistry: Students considering a major in Chemistry and Biochemistry should complete a high school chemistry course and mathematics courses through precalculus.

General Admissions Requirements for Transfer Students: Students transferring from other institutions are urged to consult with the department chair to plan their Eastern program of study.

Admissions Requirements for Chemistry Majors: Chemistry courses must be taken in proper sequence and with certain prerequisites satisfied. To graduate within four years, chemistry majors must take CHEM 151, 152 and 153 during their freshman year. The physics and mathematics supporting courses must also be started without delay. Students should complete MATH 161, 162 and 163 their first year. PHYS 151, 152 and 153 or PHYS 131, 132 and 133 and the lab courses PHYS 161, 162 and 163 should be completed prior to the junior year. Completion of a computer programming course is recommended before taking CHEM 431. Some graduate schools require that students be able to read scientific literature in a modern foreign language, so those planning graduate study are urged to complete two years of foreign language study.

Academic Policy: Due to the cumulative nature of chemistry courses, the department strongly recommends that students receive at least a 2.0 in all prerequisite chemistry courses.

Information Regarding Pre-Pharmacy School Courses: Students interested in this pre-professional program should contact a departmental advisor regarding the curriculum, application procedures, and professional aptitude examinations.

Required courses in the following programs of study may have prerequisites. Reference the course description section for clarification.

BACHELOR OF ARTS (BA)

STUDENT LEARNING OUTCOMES – STUDENTS WILL:

- demonstrate a knowledge of major concepts in the areas of inorganic, organic; analytical, and physical chemistry;
- demonstrate sufficient preparation in chemistry to successfully compete in a science-related career;
- demonstrate a capacity to use modern instrumentation and classical techniques for the analysis and/or separation of chemicals and an ability to interpret data;
- demonstrate effective oral and written communication skills and critical thinking skills as related to the field of chemistry;
- demonstrate knowledge of safe practices in the handling, usage and disposal of chemicals.

CHEMISTRY/BIOCHEMISTRY MAJOR WITH GENERAL OPTION (75-77 CREDITS)

General: This program features less concentration in chemistry than the bachelor of science and is not intended to prepare students for employment as a professional chemist.

Note: Two years of a single high school foreign language or one year of a single college level foreign language is required.

Required Courses (46-48 credits)

- CHEM 151 General Chemistry (5)
- CHEM 152 General Chemistry (5)
- CHEM 153 General Chemistry (5)
- CHEM 304 Quantitative Analysis (6)
- CHEM 351 Organic Chemistry (4)
- CHEM 352 Organic Chemistry (4)
- CHEM 372 Organic Chemistry Lab I (3)
- CHEM 421 Physical Chemistry (4)
- CHEM 422 Physical Chemistry (3)
- CHEM 431 Physical Chemistry Lab (1)
- CHEM 432 Physical Chemistry Lab (2)
- CHEM 491 Senior Thesis (4-6)

Required Supporting Courses (25 credits)

- MATH 161 Calculus I (5)
- MATH 162 Calculus II (5)
- PHYS 131 Introductory Physics I (4)
- PHYS 132 Introductory Physics II (4)
- PHYS 133 Introductory Physics III (4)
- or PHYS 151 General Physics I (4)
- PHYS 152 General Physics II (4)
- PHYS 153 General Physics III (4)
- PHYS 161 Mechanics Lab (1)
- PHYS 162 Heat and Optics Lab (1)
- PHYS 163 Instrumentation Lab I (1)

Electives (4 credits)

Select 300-level or above Chemistry and Biochemistry courses (exclusive of CHEM 390)

Suggested Supporting Course (See your chemistry/biochemistry advisor.)

Completion of a computer programming course is strongly recommended.

Required program credits	46-48 credits
Required supporting credits	25 credits
Elective credits	4 credits
Minimum total credits for above major	75 credits
Suggested supporting credits	5 credits

Note: A minor is advised but not required for the above option.

BACHELOR OF ARTS IN EDUCATION (BAE)

STUDENT LEARNING OUTCOMES – STUDENTS WILL:

- demonstrate a knowledge of major concepts in the areas of inorganic, organic, analytical and physical chemistry;
- demonstrate knowledge and skills sufficient for them to safely teach chemistry in the secondary school setting;
- demonstrate a capacity to use modern instrumentation and classical techniques for the analysis and/or separation of chemicals and an ability to interpret data;
- demonstrate effective oral and written communication skills and critical thinking skills as related to the field of chemistry;
- demonstrate knowledge of safe practices in the handling, usage and disposal of chemicals.

CHEMISTRY/BIOCHEMISTRY/SECONDARY MAJOR (76 CREDITS)

This major satisfies the endorsement for grades 5–12.

Required Courses (51 credits)

CHEM 151 General Chemistry (5)
 CHEM 152 General Chemistry (5)
 CHEM 153 General Chemistry (5)
 CHEM 304 Quantitative Analysis (6)
 CHEM 316 Environmental Chemistry (5)
 CHEM 351 Organic Chemistry (4)
 CHEM 352 Organic Chemistry (4)
 CHEM 372 Organic Chemistry Lab I (3)
 CHEM 421 Physical Chemistry (4)
 CHEM 422 Physical Chemistry (3)
 CHEM 480 Biochemistry (5)
 CHEM 390 Chemistry Methods for the Secondary School (1)
 SCED 390 Secondary Science Teaching Methods (1)

Required Supporting Courses (25 credits)

MATH 161 Calculus I (5)
 MATH 162 Calculus II (5)
 PHYS 131 Introductory Physics I (4)
 PHYS 132 Introductory Physics II (4)
 PHYS 133 Introductory Physics III (4)
 or PHYS 151 General Physics I (4)
 PHYS 152 General Physics II (4)
 PHYS 153 General Physics III (4)
 PHYS 161 Mechanics Lab (1)
 PHYS 162 Heat and Optics Lab (1)
 PHYS 163 Instrumentation Lab I (1)

Required program credits **51 credits**

Required supporting credits **25 credits**

Credits for above major **76 credits**

Professional education requirements/secondary education: **46–47 credits**
See the Department of Education section of this catalog. Prerequisites may also apply.

Minimum total credits for above major and professional education **122 credits**

Note: a minor is advised but not required for the above option.

BACHELOR OF SCIENCE (BS)

STUDENT LEARNING OUTCOMES – STUDENTS WILL:

- demonstrate a broad-based knowledge of major concepts in the areas of inorganic, organic, analytical and physical chemistry;
- demonstrate sufficient preparation in chemistry to successfully compete in a graduate or professional program or to realize employment in a chemistry- or biochemistry-related career;
- demonstrate a capacity to use modern instrumentation and classical techniques for the analysis and/or separation of chemicals and an ability to interpret data;
- demonstrate effective oral and written communication skills and critical thinking skills as related to the field of chemistry;
- demonstrate knowledge of safe practices in the handling, usage and disposal of chemicals.

The Bachelor of Science majors are specifically recommended for students planning to go directly into governmental or industrial chemistry or related areas and for those who wish to pursue graduate work in chemistry or related fields.

CHEMISTRY/BIOCHEMISTRY MAJOR WITH BIOCHEMISTRY OPTION (119–121 CREDITS)

This program is recommended for students planning to go directly into professional fields of biochemistry, for students planning to attend graduate school in biochemistry, molecular biology or pharmacology and for students planning to enter professional schools such as medicine, veterinary medicine or pharmacy.

Required Courses (69–71 credits)

CHEM 151 General Chemistry (5)
 CHEM 152 General Chemistry (5)
 CHEM 153 General Chemistry (5)
 CHEM 304 Quantitative Analysis (6)
 CHEM 351 Organic Chemistry (4)
 CHEM 352 Organic Chemistry (4)
 CHEM 353 Organic Chemistry (3)
 CHEM 372 Organic Chemistry Lab I (3)
 CHEM 421 Physical Chemistry (4)
 CHEM 422 Physical Chemistry (3)
 CHEM 423 Physical Chemistry (3)
 CHEM 431 Physical Chemistry Lab (1)
 CHEM 480 Biochemistry (5)
 CHEM 481 Intermediary Metabolism (5)
 CHEM 482 Integrated Topics in Biochemistry and Biophysics (3)
 CHEM 483 Biochemistry Lab (2)
 CHEM 491 Senior Thesis (4–6)

Select one of the following four courses (4 credits)

CHEM 395 Internships (Var)
 CHEM 454 Clinical Chemistry (4)
 CHEM 498 Seminar (Var)
 CHEM 499 Directed Study (Var)

Required Supporting Courses (50 credits)

BIOL 171 Biology I (4)
 BIOL 172 Biology II (4)
 BIOL 173 Biology III (4)
 BIOL 270 Biological Investigation (3)
 BIOL 301 Microbiology (5)
 MATH 161 Calculus I (5)
 MATH 162 Calculus II (5)
 MATH 163 Calculus III (5)
 PHYS 151 General Physics I (4)
 PHYS 152 General Physics II (4)
 PHYS 153 General Physics III (4)
 PHYS 161 Mechanics Lab (1)
 PHYS 162 Heat and Optics Lab (1)
 PHYS 163 Instrumentation Lab I (1)

Suggested Supporting Course (See your chemistry/biochemistry advisor.)

Completion of a computer programming course is strongly recommended.

Required program credits **69–71 credits**

Required supporting credits **50 credits**

Minimum total credits for above major **119 credits**

Total suggested supporting credits **5 credits**

CHEMISTRY/BIOCHEMISTRY MAJOR WITH BIOCHEMISTRY/BIOTECHNOLOGY OPTION (135–138 CREDITS)

Chemistry and biology as well as biochemistry and molecular biotechnology classes introduce students to DNA cloning, cell hybridization, enzyme technology and fermentation. Student placement in technical, professional or commercial settings is intended.

Required Courses (57 credits)

CHEM 151 General Chemistry (5)
 CHEM 152 General Chemistry (5)
 CHEM 153 General Chemistry (5)
 CHEM 304 Quantitative Analysis (6)
 CHEM 351 Organic Chemistry (4)
 CHEM 352 Organic Chemistry (4)
 CHEM 372 Organic Chemistry Lab I (3)
 CHEM 420 Instrumental Analysis (5)
 CHEM 421 Physical Chemistry (4)
 CHEM 422 Physical Chemistry (3)
 CHEM 431 Physical Chemistry Lab (1)
 CHEM 432 Physical Chemistry Lab (2)
 CHEM 480 Biochemistry (5)
 CHEM 481 Intermediary Metabolism (5)

Required Supporting Courses (64 credits)

BIOL 171 Biology I (4)
 BIOL 172 Biology II (4)
 BIOL 173 Biology III (4)
 BIOL 270 Biological Investigation (3)
 BIOL 301 Microbiology (5)
 BIOL 310 Fundamentals of Genetics (5)
 BIOL 485 Molecular Biotechnology (5)
 BIOL 486 Molecular Biotechnology (5)
 BIOL 488 Molecular Biotechnology Lab (2)
 BIOL 489 Molecular Biotechnology Lab (2)
 MATH 161 Calculus I (5)
 MATH 162 Calculus II (5)
 PHYS 131 Introductory Physics I (4)
 PHYS 132 Introductory Physics II (4)
 PHYS 133 Introductory Physics III (4)
 PHYS 161 Mechanics Lab (1)
 PHYS 162 Heat and Optics Lab (1)
 PHYS 163 Instrumentation Lab I (1)

Select one of the following courses (5 credits)

BIOL 302 Botany (5)
 BIOL 303 Invertebrate Zoology (5)
 BIOL 304 Vertebrate Zoology (5)

Select one of the following courses (4–6 credits)

BIOL 490 Dept. Senior Capstone: Integrated Studies in Physiology-Plant (5)
 BIOL 490 Dept. Senior Capstone: Integrated Studies in Physiology-Microbial (5)
 BIOL 490 Dept. Senior Capstone: Integrated Studies in Physiology-Animal (5)
 CHEM 491 Senior Thesis (4–6)

Select one of the following courses (5–6 credits)

Completion of a computer programming course is required.
 (See your chemistry/biochemistry advisor.)

Required program credits

57 credits

Required supporting credits

78–81 credits

Minimum total credits for above major

135 credits

Note: chemistry majors completing BIOL 490 do not need to take CHEM 491 for graduation.

Note: the above option will require more than 12 terms (or 4 years) to complete at an average of 15 credits per term.

CHEMISTRY/BIOCHEMISTRY MAJOR WITH FORENSIC SCIENCE OPTION (151 CREDITS)

The forensic science option prepares students for entry-level positions in state and federal forensic science labs as well as for graduate and professional schools. Competitive internships at regional forensic labs are integrated into the curriculum along with research and independent study. Students must complete 46 hours of specified core courses (see footnote¹) with a combined minimum **GPA** of 3.0 before being eligible to declare the forensic major. For all internships with law enforcement agencies, students will be required to pass a thorough background check. It is assumed that the student will enter the program ready to take MATH 161. To finish in four years, students must take an average load of more than 15 credits per quarter.

Required Chemistry Courses (86 credits)

CHEM 140 Criminalistics and Forensic Chemistry (5)¹
 CHEM 151 General Chemistry (5)¹
 CHEM 152 General Chemistry (5)¹
 CHEM 153 General Chemistry (5)¹
 CHEM 304 Quantitative Analysis (6)¹
 CHEM 319 Modern Inorganic Chemistry (5)
 CHEM 351 Organic Chemistry (4)
 CHEM 352 Organic Chemistry (4)
 CHEM 353 Organic Chemistry (3)
 CHEM 372 Organic Chemistry Lab I (3)
 CHEM 373 Organic Chemistry Lab II (3)
 CHEM 420 Instrumental Analysis (5)
 CHEM 421 Physical Chemistry (4)
 CHEM 422 Physical Chemistry (3)
 CHEM 431 Physical Chemistry Laboratory (1)
 CHEM 445 Topics in Forensic Science (5)
 CHEM 450 Advanced Forensic Chemistry (5)
 CHEM 480 Biochemistry (5)
 CHEM 399/495/499 Internship/Research (5)
 CHEM 491 Senior Thesis (5)²

Required Supporting Courses (50 credits)

BIOL 171 Biology I (4)¹
 BIOL 172 Biology II (4)¹
 BIOL 173 Biology III (4)
 BIOL 270 Biological Investigation (3)¹
 BIOL 301 Microbiology (5)
 BIOL 310 Fundamentals of Genetics (5)
 BIOL 438 Molecular Biology (5)
 CRIM 300 Introduction to Criminal Justice (5)
 MATH 161 Calculus I (5)¹
 MATH 162 Calculus II (5)
 MATH 380 Elementary Probability and Statistics (5)

Physics courses—select one complete series (15 credits)

PHYS 131 Introductory Physics I (4)¹
 PHYS 132 Introductory Physics II (4)
 PHYS 133 Introductory Physics III (4)
 or PHYS 151 General Physics I (4)
 PHYS 152 General Physics II (4)
 PHYS 153 General Physics III (4)
 PHYS 161 Mechanics Laboratory (1)
 PHYS 162 Heat and Optics Laboratory (1)
 PHYS 163 Instrumentation Laboratory (1)

Suggested Supporting Courses (See your chemistry/biochemistry advisor.)

CMST 201 Public Speaking (5)
 CRIM 304 Forensic Inquiry (5)
 ENGL 205 Introduction to Technical Communication (5)
 GOVT 306 Basic Concepts of Criminal Law (5)

Required program credits

86 credits

Required supporting credits

65 credits

Total credits for above major

151 credits

Suggested supporting credits

5 credits

¹Core courses are to be completed before formal acceptance into the forensics major and enrollment in the forensic science internship course.

²Students are required to do research on a forensic project and to take it for 5 credits (catalog description states 4–6 credits). Projects must be approved by the forensic science program advisor.

Note: the above option will require more than 12 terms (or 4 years) to complete at an average of 15 credits per term.

CHEMISTRY/BIOCHEMISTRY MAJOR WITH PRE-MED/PRE-DENT/PRE-VET OPTION (133 CREDITS)

This course of study is recommended for students planning a career in medicine, dentistry or veterinary medicine. The option also satisfies requirements for graduate study in related fields of chemical and biological integration, e.g., medicinal chemistry, pharmacology, etc. With respect to medical/dental/veterinary school, coursework outlined for the initial three years is specifically designed to meet basic entrance requirements as well as provide optimum preparation for pre-entrance aptitude examinations (MCAT or DAT or GRE). Additional information can be found under "Pre-professional Programs" in the Fields of Study section of this catalog.

Required Courses (68 credits)

- BIOL 471 Pre-Med, Dent, Vet and Pharm Preparation (1)
- CHEM 151 General Chemistry (5)
- CHEM 152 General Chemistry (5)
- CHEM 153 General Chemistry (5)
- CHEM 304 Quantitative Analysis (6)
- CHEM 351 Organic Chemistry (4)
- CHEM 352 Organic Chemistry (4)
- CHEM 353 Organic Chemistry (3)
- CHEM 357 Neuropharmacology (2)
- CHEM 372 Organic Chemistry Lab I (3)
- CHEM 373 Organic Chemistry Lab II (3)
- CHEM 395 Internships (1)
- CHEM 421 Physical Chemistry (4)
- CHEM 422 Physical Chemistry (3)
- CHEM 431 Physical Chemistry Lab (1)
- CHEM 432 Physical Chemistry Lab (2)
- CHEM 471 Pre-Med, Dent, Vet and Pharm Preparation (1)
- CHEM 480 Biochemistry (5)
- CHEM 481 Intermediary Metabolism (5)
- CHEM 482 Integrated Topics in Biochemistry and Biophysics (3)
- CHEM 483 Biochemistry Lab (2)

Required Supporting Courses (65 credits)

- BIOL 171 Biology I (4)
- BIOL 172 Biology II (4)
- BIOL 173 Biology III (4)
- BIOL 270 Biological Investigation (3)
- BIOL 301 Microbiology (5)
- BIOL 302 Botany (5)
- BIOL 304 Vertebrate Zoology (5)
- or BIOL 303 Invertebrate Zoology (5)
- BIOL 310 Fundamentals of Genetics (5)
- BIOL 490 Dept. Senior Capstone: Integrated Studies in Physiology-Animal (5)
- MATH 161 Calculus I (5)
- MATH 162 Calculus II (5)
- PHYS 131 Introductory Physics I (4)
- PHYS 132 Introductory Physics II (4)
- PHYS 133 Introductory Physics III (4)
- or PHYS 151 General Physics I (4)
- PHYS 152 General Physics II (4)
- PHYS 153 General Physics III (4)
- PHYS 161 Mechanics Lab (1)
- PHYS 162 Heat and Optics Lab (1)
- PHYS 163 Instrumentation Lab I (1)

Suggested Supporting Courses

- CHEM 454 Clinical Chemistry (4)
- CHEM 499 Directed Study (Var)
- ENGL 205 Introduction to Technical Communication (5)
- PHIL 445 Biomedical Ethics (5)

One of the following courses (See your chemistry/biochemistry advisor.)

Completion of a computer programming course is strongly recommended.

Required program credits **68 credits**

Required supporting courses **65 credits**

Total credits for above major **133 credits**

Minimum suggested supporting credits **variable credits**

Note: The following should be completed prior to or concurrent with taking the MCAT Exam: CHEM 151, 152, 153; 351, 352, 353, 372, 373, 304, 480, 481; BIOL 171, 172, 173, 270, 301, 302, 304, 310, 490; MATH 161, 162 and PHYS (131, 132, 133 or 151, 152, 153) and 161, 162, 163.

Note: chemistry majors completing BIOL 490 do not need to take CHEM 491 for graduation.

Note: the above option will require more than 12 terms (or 4 years) to complete at an average of 15 credits per term.

CHEMISTRY/BIOCHEMISTRY MAJOR WITH PROFESSIONAL OPTION (110-112 CREDITS)

This program is approved by the American Chemical Society and it is recommended for those students who plan to become professional chemists. It provides a broad and strong background in the fundamentals of chemistry and an excellent foundation for graduate school or a career in industry.

Required Courses (77-79 credits)

- CHEM 151 General Chemistry (5)
- CHEM 152 General Chemistry (5)
- CHEM 153 General Chemistry (5)
- CHEM 304 Quantitative Analysis (6)
- CHEM 319 Modern Inorganic Chemistry (5)
- CHEM 351 Organic Chemistry (4)
- CHEM 352 Organic Chemistry (4)
- CHEM 353 Organic Chemistry (3)
- CHEM 372 Organic Chemistry Lab I (3)
- CHEM 373 Organic Chemistry Lab II (3)
- CHEM 419 Advanced Inorganic Chemistry (5)
- CHEM 420 Instrumental Analysis (5)
- CHEM 421 Physical Chemistry (4)
- CHEM 422 Physical Chemistry (3)
- CHEM 423 Physical Chemistry (3)
- CHEM 431 Physical Chemistry Lab (1)
- CHEM 432 Physical Chemistry Lab (2)
- CHEM 433 Physical Chemistry Lab (2)
- CHEM 480 Biochemistry (5)
- CHEM 491 Senior Thesis (4-6)

Select from the following courses (3 credits)

- CHEM 498 Seminar (1)
- CHEM 499 Directed Studies (1-3)

Required Supporting Courses (30 credits)

- MATH 161 Calculus I (5)
- MATH 162 Calculus II (5)
- MATH 163 Calculus III (5)
- PHYS 151 General Physics I (4)
- PHYS 152 General Physics II (4)
- PHYS 153 General Physics III (4)
- PHYS 161 Mechanics Lab (1)
- PHYS 162 Heat and Optics Lab (1)
- PHYS 163 Instrumentation Lab I (1)

Suggested Supporting Course (See your chemistry/biochemistry advisor.)

Completion of a computer programming course is strongly recommended.

Required program credits **80-82 credits**

Required supporting credits **30 credits**

Minimum total credits for above major **110 credits**

Total suggested supporting credits **5 credits**

CHEMISTRY/BIOCHEMISTRY MAJOR WITH STANDARD OPTION (95-97 CREDITS)

This major program provides the normal preparation in chemistry for students planning employment as chemists and considerable chemical background in preparation for careers outside chemistry. It is appropriate for some students who plan to enter professional schools such as dentistry, or public and environmental health.

Required Courses (54-56 credits)

- CHEM 151 General Chemistry (5)
- CHEM 152 General Chemistry (5)
- CHEM 153 General Chemistry (5)
- CHEM 304 Quantitative Analysis (6)
- CHEM 351 Organic Chemistry (4)
- CHEM 352 Organic Chemistry (4)
- CHEM 353 Organic Chemistry (3)
- CHEM 372 Organic Chemistry Lab I (3)
- CHEM 421 Physical Chemistry (4)
- CHEM 422 Physical Chemistry (3)
- CHEM 423 Physical Chemistry (3)
- CHEM 431 Physical Chemistry Lab (1)
- CHEM 432 Physical Chemistry Lab (2)
- CHEM 433 Physical Chemistry Lab (2)
- CHEM 491 Senior Thesis (4-6)

Select one of the following courses (5 credits)

- CHEM 418 Modern Analytical Chemistry (5)
- CHEM 419 Advanced Inorganic Chemistry (5)
- CHEM 420 Instrumental Analysis (5)

Required Supporting Courses (30 credits)

- MATH 161 Calculus I (5)
- MATH 162 Calculus II (5)
- MATH 163 Calculus III (5)

PHYS 151 General Physics I (4)
 PHYS 152 General Physics II (4)
 PHYS 153 General Physics III (4)
 PHYS 161 Mechanics Lab (1)
 PHYS 162 Heat and Optics Lab (1)
 PHYS 163 Instrumentation Lab I (1)

Electives (6 credits)

Choose 300-level or above Chemistry and Biochemistry courses (exclusive of CHEM 390.)

Suggested Supporting Course (See your chemistry/biochemistry advisor.)

Completion of a computer programming course is strongly recommended.

Required program credits	59-61 credits
Required supporting credits	30 credits
Elective credits	6 credits
Minimum total credits for above major	95 credits
Total suggested supporting credits	5 credits

MINORS

CHEMISTRY/BIOCHEMISTRY MINOR (30 CREDITS)

Required Courses (15 credits)

CHEM 151 General Chemistry (5)
 CHEM 152 General Chemistry (5)
 CHEM 153 General Chemistry (5)

Electives (15 credits)

Select 15 credits of upper-division Chemistry and Biochemistry courses (exclusive of CHEM 390)

Required program credits	15 credits
Elective credits	15 credits
Total credits for above minor	30 credits

Note: with regard to electives, CHEM 397, 497 and 597 as well as other special courses, must be approved by the department chair.

CHEMISTRY/BIOCHEMISTRY SECONDARY MINOR (26 CREDITS)

This minor satisfies the endorsement for grades 5-12.

Required Courses (17 credits)

CHEM 151 General Chemistry (5)
 CHEM 152 General Chemistry (5)
 CHEM 153 General Chemistry (5)
 CHEM 390 Chemistry Methods for the Secondary School (1)
 SCED 390 Secondary Science Teaching Methods (1)

Select from the following courses (9 credits minimum)

CHEM 304 Quantitative Analysis (6)
 CHEM 316 Environmental Chemistry (5)
 CHEM 319 Modern Inorganic Chemistry (5)
 CHEM 351 Organic Chemistry (4)
 CHEM 352 Organic Chemistry (4)
 CHEM 372 Organic Chemistry Lab I (3)
 CHEM 421 Physical Chemistry (4)
 CHEM 480 Biochemistry (5)

Total credits for above minor	26 credits
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Note: Some graduate courses may be substituted for electives, in consultation with advisor.

ENVIRONMENTAL CHEMISTRY MINOR (32 CREDITS)

Required Courses (23 credits)

CHEM 151 General Chemistry (5)
 CHEM 152 General Chemistry (5)
 CHEM 153 General Chemistry (5)
 CHEM 316 Environmental Chemistry (5)
 CHEM 416 Advanced Environmental Chemistry (3)

Electives-Select from the following courses (9 credits)

Note: only one of these courses can be a CHEM course regardless of credit hours.

BIOL 301 Microbiology (5)
 BIOL/GEOG 312 Fundamentals of Soil Science (4)
 BIOL 440 Ecology (4)
 BIOL 441 Ecology Lab (2)
 BIOL 442 Conservation Biology (4)
 CHEM 304 Quantitative Analysis (6)
 CHEM 319 Modern Inorganic Chemistry (5)
 CHEM 351 Organic Chemistry (4)
 CHEM 352 Organic Chemistry (4)
 CHEM 372 Organic Chemistry Lab I (3)
 CHEM 373 Organic Chemistry Lab II (3)
 CHEM 418 Modern Analytical Chemistry (5)
 CHEM 419 Advanced Inorganic Chemistry (5)
 CHEM 420 Instrumental Analysis (5)
 CHEM 421 Physical Chemistry (4)

CHEM 422 Physical Chemistry (3)
 CHEM 423 Physical Chemistry (3)
 CHEM 431 Physical Chemistry Lab (1)
 CHEM 432 Physical Chemistry Lab (2)
 CHEM 433 Physical Chemistry Lab (2)
 CHEM 440 Advanced Physical Chemistry (4)
 CHEM 465 Advanced Organic Chemistry (2)
 CHEM 480 Biochemistry (5)
 ECON 457 Natural Resource Economics (5)
 GEOG 314 Weather and Climate (5)
 GEOG 315 Surface Hydrology (4)
 GEOG 317 Resources and Conservation (3)
 GEOG 325 Wetlands Science I (4)
 GEOG 328 Geographic Information Systems I (5)
 GEOG 329 Air Photo Interpretation (5)
 GEOL 220 Environmental Geology (4)
 GEOL 463 Environmental Geochemistry (5)
 MATH 380 Elementary Probability and Statistics (5)
 PLAN 406 Planning Law and Legislation (4)
 PLAN 430 Environmental Planning (5)
 PLAN 431 Environmental Impact Statements (3)

Required program credits	23 credits
Elective credits	9 credits
Total credits for above minor	32 credits

HEALTH SCIENCE MINOR (30 CREDITS)

Required Courses

BIOL 232 Human Anatomy and Physiology for Non-Biology Majors (5)
 BIOL 233 Human Anatomy and Physiology for Non-Biology Majors (5)
 BIOL 234 Human Anatomy and Physiology for Non-Biology Majors (5)
 CHEM 161 General Chemistry for the Health Sciences (5)
 CHEM 162 Organic Chemistry for the Health Sciences (5)
 CHEM 163 Biochemistry Chemistry for the Health Sciences (5)

Total credits for above minor	30 credits
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Course Requirements for Teacher Certification/Add-on Endorsements
 (For students who currently possess a Washington State Teaching Certificate)

GENERAL SCIENCE/ADD-ON ENDORSEMENT (65 CREDITS)

To improve the marketability of the science teacher, students may wish to complete this option in addition to their BAE in Biology, Chemistry, Earth and Space Science or Physics. This add-on satisfies the endorsement and allows teachers to teach any science for grades 5-12.

Required Courses (65 credits)

BIOL 171 Biology I (4)
 BIOL 172 Biology II (4)
 BIOL 173 Biology III (4)
 BIOL 270 Biological Investigation (3)
 BIOL 390 Biology Teaching Methods (1)
 CHEM 151 General Chemistry (5)
 CHEM 152 General Chemistry (5)
 CHEM 153 General Chemistry (5)
 CHEM 390 Chemistry Methods for the Secondary School (1)
 GEOG 314 Weather and Climate (5)
 GEOL 120 Physical Geology-The Solid Earth (5)
 GEOL 121 Physical Geology-Surficial Processes (5)
 GEOG/GEOL 390 Earth Science Teaching Methods (1)
 PHYS 121 Descriptive Astronomy (5)
 PHYS 131 Introductory Physics I (4)
 PHYS 132 Introductory Physics II (4)
 PHYS 161 Mechanics Lab (1)
 PHYS 162 Heat and Optics Lab (1)
 PHYS 390 Physics Teaching Methods (1)
 SCED 390 Secondary Science Teaching Methods (1)

Total credits for above add-on endorsement	65 credits
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GRADUATE PROGRAM

Robin McRae, Chair	222 Science Bld.	509.359.2798
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The Department of Chemistry does not offer a graduate degree program but does offer graduate-level coursework.

Chemistry Courses

Terms offered: fall, winter, spring, summer (FWSU). If no terms are indicated check with the department or EagleNET.

CHEM 100 Introduction to Chemistry (5) FWS

This course prepares those who have not had a satisfactory background in high school chemistry to take CHEM 151 or 161. Topics include the scientific method, SI and metric systems, unit conversions, atomic structure, periodic table, bonding and stoichiometry. Laboratory work is included.

CHEM 121 Chemistry and its Role in Society (5) FWS

[satisfies the GEGR for natural sciences, chemistry.]

Basic chemical principles are used to examine some of the chemistry that most directly impacts individuals and society on a day-to-day basis. The course is designed to develop in students an appreciation for the chemical basis of their bodies and their environment. Emphasis is placed on the dynamic nature of the field of chemistry and efforts are made to dispel many of the common misconceptions that nonscientists often have about chemistry and other natural sciences. Laboratory work is included.

CHEM 140 Criminalistics and Forensic Chemistry (5) WS

Prerequisite: two semesters of high school science or the equivalent are strongly recommended.

This course provides an overview of forensic science and criminalistics including history and the modern role of forensic science in the judicial system. Topics covered include DNA typing, trace evidence analysis, firearms and tool marks and impression evidence. Laboratory work is included. Labs will focus on current forensic techniques.

CHEM 151, 152, 153 General Chemistry (5, 5, 5) FWS

[The completion of CHEM 151 satisfies a GEGR for natural sciences, chemistry. The completion of CHEM 151 and 152 satisfies a second GEGR for natural sciences, chemistry.]

Prerequisites: completion of MATH 104B or MATH 105 or MATH 115 or equivalent for CHEM 151, CHEM 151 for CHEM 152, CHEM 152 for CHEM 153. For CHEM 151, CHEM 100 or a high school chemistry course is strongly recommended.

Topics will include stoichiometry, periodic table and chemical bonding, structure of matter, solutions, equilibrium, thermodynamics, oxidation and reduction, transition metal complexes, nuclear chemistry, kinetics and quantitative laboratory techniques. Laboratory work is included. A placement exam will be given during the first week of CHEM 151.

CHEM 161 General Chemistry for the Health Sciences (5) FWS

Prerequisite: Concurrent enrollment in or completion of MATH 104B or MATH 105 or MATH 115 or equivalent. A high school chemistry course or CHEM 100 is highly recommended.

[satisfies a GEGR for natural sciences, chemistry.]

Course includes a survey of inorganic chemistry for pre-nursing, pre-dental hygiene and allied health science students. Topics include atomic structure, the periodic table, stoichiometry, solutions, equilibrium, acids and bases. Laboratory work is included. A placement exam will be given during the first week of classes.

CHEM 162 Organic Chemistry for the Health Sciences (5) FWS

Prerequisite: CHEM 161.

[satisfies a GEGR for natural sciences, chemistry.]

The course is a survey of organic chemistry for pre-nursing, pre-dental hygiene and allied health science students. Topics include naming, properties and reactions of hydrocarbons, alcohols, ethers, amines and carbonyl compounds. Laboratory work is included.

CHEM 163 Biochemistry for the Health Sciences (5) FWS

Prerequisite: CHEM 162.

This course is a survey of biochemistry for pre-nursing, pre-dental hygiene and allied health science students. Topics include amino acids, proteins, enzymes, lipids, carbohydrates, nucleic acids, biotechnology and metabolic pathways. Laboratory work is included.

CHEM 297 Workshops, Short Courses (1-10)**CHEM 304 Quantitative Analysis (6) FW**

Prerequisite: CHEM 153.

Theory and practice of gravimetric and volumetric analysis with an introduction to some elements of instrumental analysis.

CHEM 316 Environmental Chemistry (5) S

Prerequisites: CHEM 151-153 or 161-163.

The course is an introduction to environmental chemistry covering both fundamental chemical principles and societal implications. Emphasis will be placed on local issues such as the Hanford Nuclear Reservation and the environmental impact of mining. Laboratory work is included.

CHEM 319 Modern Inorganic Chemistry (5) W

Prerequisite: CHEM 153.

Representative and nonmetallic elements; metallic structures and alloys; transition elements and coordination compounds; reaction mechanisms, hard and soft; acids and bases.

CHEM 338 Discovering Women in Science (1)

The course uses several scientific themes to rediscover from the past and find in contemporary research, the women who have made significant contributions to science. (Cross-listed BIOL/GEOL/HIST/PHYS/PSYC/WMST 338)

CHEM 350 Principles of Pharmacology (2) S

Prerequisites: CHEM 163, BIOL 233 or equivalent.

The course is primarily intended for the athletic training or other allied health science students. The course presents a review of the actions of over-the-counter drugs and an introduction to the principles of pharmacological action from the integrated foundations of physiology, organic chemistry and biochemistry.

CHEM 351, 352 Organic Chemistry (4, 4) F(351)W(351, 352)S(352)

Prerequisite: CHEM 153 for 351; CHEM 351 for CHEM 352.

An integrated study of fundamental organic chemistry for chemistry majors and students planning on careers in medicine, dentistry, pharmacology, engineering, or related fields. Emphasizes nomenclature, bonding, reactivity, stereochemistry, synthetic methods, reaction mechanisms, physical properties and spectrometric identification of the principal classes of organic compounds, including biochemical examples.

CHEM 353 Organic Chemistry (3) FS

Prerequisite: CHEM 352.

A comprehensive study of the chemistry of polyfunctional carbon compounds.

CHEM 357 Neuropharmacology (2) S

Prerequisites: CHEM 163 and BIOL 233 or equivalent, or permission of the instructor.

The course is primarily intended for pre-medical, pre-dental, pre-pharmacy or other science students. Topics covered include CNS neurotransmitters and their pharmacology, various biochemical hypotheses for neurological disorders and the pharmacology of a variety of psychoactive drug classes of use or abuse.

CHEM 372 Organic Chemistry Laboratory I (3) WS

Prerequisite: CHEM 351.

This course is an introduction to the elementary techniques of the organic laboratory; including synthesis, application of chromatography and spectrometry. This is a laboratory course.

CHEM 373 Organic Chemistry Laboratory II (3) FS

Prerequisites: CHEM 352 and 372.

This course emphasizes spectrometry, synthesis, structure determination and advanced techniques in isolation, purification and analysis. This is a laboratory course.

CHEM 390 Chemistry Methods for the Secondary School (1) F

Prerequisite: CHEM 153 and concurrent enrollment in SCED 390, or permission of the instructor.

This course is for chemistry majors planning to teach in the secondary schools. It includes organization of lesson materials and techniques and evaluation methods. Laboratory work is included.

CHEM 395 Internships (1-10) FWS

Prerequisite: permission of the instructor, department chair and college dean.

CHEM 397 Workshops, Short Courses, Conferences (1-10) FWS**CHEM 399 Directed Study (1-10) FWS**

Prerequisite: permission of the instructor, department chair and college dean.

Library or laboratory study of a chemical problem.

CHEM 416 Advanced Environmental Chemistry (3) S

Prerequisites: CHEM 304, 316 and 352 (or concurrent), or permission of the instructor.

This course includes a detailed study of atmospheric, soil, water and waste water chemistry. Aspects of environmental/analytical chemistry will be introduced. Laboratory work will cover aspects of sampling, instrumental and automated analysis and regulatory requirements. Students will concentrate in the area of their particular interest, leading to a comprehensive written research report and presentation. Laboratory work is included.

CHEM 418 Modern Analytical Chemistry (5) F

Prerequisite: CHEM 304.

Principles of recently developed methods of analytical chemistry.

CHEM 419 Advanced Inorganic Chemistry (5) S

Prerequisite: CHEM 319 and CHEM 422, or permission of the instructor.

This course covers ionic, covalent and metallic bonding, complexes, acids and bases, molecular structure, symmetry and thermodynamics of inorganic reactions. It also introduces mechanisms of inorganic reactions and organometallic chemistry of selected groups of elements. Laboratory work is included.

CHEM 420 Instrumental Analysis (5) S

Prerequisite: CHEM 422 or permission of the instructor.

This course introduces instrumental methods of analysis. This is a laboratory course.

CHEM 421, 422, 423 Physical Chemistry (4, 3, 3) F(421)W(422)S(423)

Prerequisites: CHEM 304, PHYS 133 or 153, MATH 162 for CHEM 421; CHEM 421 for CHEM 422; CHEM 422 for CHEM 423.

Classical and statistical thermodynamics, electrochemistry, quantum theory, kinetics, symmetry, spectroscopic and diffraction methods of structure determination.

CHEM 431, 432, 433 Physical Chemistry Laboratory (1, 2, 2) F(431)W(432)S(433)

Prerequisites: concurrent enrollment in CHEM 421, 422 and 423. For CHEM 421, completion of a computer programming course is strongly recommended. (See your Chemistry/Biochemistry advisor.)

These courses cover data treatment, current physicochemical techniques, computer applications to chemical systems. These are laboratory courses.

CHEM 440 Advanced Physical Chemistry (4) S
Prerequisite: concurrent enrollment or completion of CHEM 423.

Further development of principles underlying molecular symmetry, group theory and quantum chemistry, with applications to molecular orbitals and molecular spectroscopy. Introduction to semi-empirical calculations of electronic properties of molecules and analysis of spectroscopic data.

CHEM 445 Topics in Forensic Chemistry (5) S
Prerequisite: acceptance into BS forensic option.

This course includes a detailed investigation of current topics in forensic chemistry and forensic science. Topics will include courtroom testimony, laboratory accreditation and analyst certification. Laboratory work is included.

CHEM 450 Advanced Forensic Chemistry (5) F
Prerequisites: acceptance into BS forensic option.

This course includes a detailed examination of the techniques of forensic chemistry including organic, inorganic and instrumental analysis. Topics include gunshot residue, drugs and toxicology, paint, arson and explosives and biochemical methods such as electrophoresis. Advanced topics in crime scene procedures, chain-of-custody and quality assurance, will be discussed. Laboratory work is included.

CHEM 454 Clinical Chemistry (4) F
Prerequisites: CHEM 304 and 352.

This course is an introduction to both the methodologies involved in the analyses of diagnostically important compounds in clinical chemistry, (i.e., spectroscopy, ion-selective electrodes, enzymology, immunoassays and liquid chromatography) and the biochemical and physiological correlations of normal and disease states. This is intended for medical technology and chemistry majors and students with interests in medical sciences.

CHEM 465 Advanced Organic Chemistry (2) S
Prerequisites: CHEM 353 and 421 or permission of the instructor.

This course is an in-depth study of the mechanisms of organic reactions in vitro and in vivo, coupled to a detailed investigation of current techniques in structural analysis of organic compounds.

CHEM 466 Structural Analytical Techniques in Organic Chemistry (2) S
Prerequisites: CHEM 353 and 421, or permission of the instructor.

This course is an in-depth study of modern analytical techniques used in the structural analysis of organic compounds. This course will comprise both theory and practical experience with the instruments. Topics covered include UV, IR, NMR, mass spectrometry and chromatography. This is a laboratory course with lecture included.

CHEM 471 Pre-Med, Dent, Vet and Pharm Preparation (1-2)
Prerequisites: CHEM 480, or permission of the instructor.

Prepares students for their application to medical, dental, veterinary or pharmacy school and for professional activities.

CHEM 480 Biochemistry (5) FS
Prerequisite: CHEM 352.

Elements of biochemistry are covered, including the structure and function of the major classes of proteins, nucleic acids, carbohydrates and lipids.

CHEM 481 Intermediary Metabolism (5) W
Prerequisite: CHEM 480.

Biosynthesis and metabolism of nucleotides, carbohydrates, lipids, amino acids and steroids; regulation and integration of biochemical pathways.

CHEM 482 Integrated Topics in Biochemistry and Biophysics (3) S
Prerequisite: CHEM 480.

Explores energy pathways, signal transduction pathways and genetic information pathways in living organisms. Provides a chemical perspective of the key principles of bioenergetics and membrane transport. Specific topics, discussed at a molecular level, are selected from, but not limited to the following: electron transport, proton pumping and ATP production in mitochondria and chloroplasts; hormone induced signal transduction; RNA synthesis and processing and protein synthesis and processing.

CHEM 483, 484 Biochemistry Laboratory (2, 2) W(483)S(484)

Prerequisite: CHEM 480.
 Experiments include basic analytical and separatory techniques applied to problems in nucleotide identification, lipid turnover, photosynthesis, enzyme kinetics and cell fractionation.

CHEM 491 Senior Thesis (4-6) FWS
Prerequisite: senior standing.

[satisfies senior capstone university graduation requirement] Directed research in your area of chemistry leading to an oral presentation and written report. See your advisor for further information.

CHEM 495 Chemistry Internship (1-10) FWSU
Prerequisite: permission of the instructor, department chair and college dean.

Supervised chemistry-related experiences with a professional or business organization.

CHEM 497 Workshops, Short Courses, Conferences (1-10)

CHEM 498 Seminar (1-2)
Prerequisite: permission of the instructor.
 Oral presentation of a chemical topic.

CHEM 499 Directed Study (1-10) FWS
Prerequisite: permission of the instructor, department chair and college dean.
 Research on a chemical problem.

CHEM 539 Special Studies (variable)

CHEM 599 Independent Study (variable)
Prerequisite: permission of the instructor, department chair and college dean.

