

2009-2010 Course Catalog

The University Of Montana

Department of Chemistry and Biochemistry

- [Special Degree Requirements](#)
- [Suggested Course of Study](#)
- [Courses](#)
- [Faculty](#)

Mark S. Cracolice, Chair

Chemistry is the central science that involves the study of atoms and molecules, their structures, their combinations, their interactions, and the energy changes accompanying chemical processes.

The Department offers the following degrees: B.S., B.A., M.S., and Ph.D.

A departmental honors program has been established for chemistry majors who attain a strong scholastic record. This program is based upon independent study and research with the direction of individual faculty members. In many cases financial support is available on a part-time research fellowship basis from research grants obtained by individual faculty members or from departmental endowment funds.

Prospective students desiring further information on any program of the Department of Chemistry and Biochemistry should contact the Chair by visiting the [Department of Chemistry](#) and Biochemistry.

High School Preparation: In addition to the general University admission requirements, it is strongly recommended that a student take four years of mathematics, four years of science, and a foreign language.

Refer to graduation requirements listed previously in the catalog. See index.

Special Degree Requirements

All chemistry and biochemistry majors must use the traditional letter grade option in registering for their required science and mathematics courses. The beginning mathematics course for a particular student depends upon a placement examination administered by the Department of Mathematical Sciences. Students are reminded of the University requirements that 39 of the 120 credits presented for graduation must be at the 300 or higher level, and that at least a 2.00 GPA must be earned in all credits attempted in the major. In addition, courses taken to satisfy the requirements of the major or minor must be completed with a grade of C- or better.

Bachelor of Science (American Chemical Society Certified)

The courses required for the B.S. degree provide a solid education in chemistry for the professional chemist and in preparation for graduate work in most areas of chemistry.

These requirements meet the latest certification standards of the American Chemical Society.

| Course | Credits |
|--|---------|
| CHMY 141N-143N (CHEM 161N-162N) College Chemistry I, II | 10 |
| CHMY 221-223 (CHEM 221-222) Organic Chemistry I, II | 6 |
| CHMY 222 (CHEM 223) Organic Chemistry I Laboratory | 2 |
| CHMY 225 (CHEM 264) Organic Chemistry Laboratory for Chemistry Majors (preferred) or 224 Organic Chemistry II Laboratory | 2-3 |
| CHMY 302E (CHEM 334) Chemistry Literature and Scientific Writing (satisfies the Upper-division Writing Expectation) | 3 |
| CHMY 311 (CHEM 341) Analytical Chem-Quant Analysis | 4 |
| CHMY 421 (CHEM 342) Advanced Instrumental Analysis | 4 |
| CHMY 373-371 (CHEM 371-372) Phys Chem-Kntcs & Thrmdynmcs & Phys Chem-Qntm Chm & Spctrscopy | 8 |
| CHMY 401-403 (CHEM 452-453) Advanced Inorganic Chemistry & Descriptive Inorganic Chem | 6 |
| BIOC 481 Biochemistry or equivalent | 3 |
| CHMY 402 (CHEM 455) Advanced Inorganic Chemistry Laboratory | 2 |
| Advanced Electives (from CHMY 391, 442, 445, 465, 491 and 3 credits maximum of 492, or 3 credit maximum of 499, or with consent of chemistry advisor, from advanced courses in chemistry, physics, geology, biochemistry, or mathematics (CHEM 395, 442, 445, 465, 495, 3 credits maximum of 497, or 3 credit maximum of 499, or with consent of chemistry advisor, from advanced courses in chemistry, physics, geology, biochemistry or mathematics)). | 3 |
| Cognate courses: | |
| CS 172 Computer Modeling (or similar computing experience with consent of chemistry advisor) | 3 |

| | |
|---|----|
| M 171-172 and 273 (MATH 152-153 and 251) Calculus I, II, III | 12 |
| M 311 (MATH 311) Ordinary Differential Equations and Systems or M 221 (MATH 221) Linear Algebra | 3 |
| PHYS 221N-222N General Physics I and II | 10 |
| Modern foreign language | 10 |
| WRIT 101 (ENEX 101) | 3 |

At the time of graduation a recipient of this degree has the option of taking two semesters of one modern foreign language which, as a departmental requirement, may be taken credit/no credit. Students not taking this option will be required to take 2 additional advisor-approved Chemistry & Biochemistry or related discipline electives for 3 credits each. This will bring the elective credits for this option to 9.

Bachelor of Science with a major in Chemistry, Option in Environmental Chemistry

| Course | Credits |
|---|---------|
| CHMY 141N-143N (CHEM 161N-162N) College Chemistry I, II | 10 |
| CHMY 221-223 (CHEM 221-222) Organic Chemistry and Laboratory I, II | 6 |
| CHMY 222 (CHEM 223) Organic Chemistry Laboratory I | 2 |
| CHMY 225 (CHEM 264) Organic Chemistry Laboratory for Chemistry Majors or 224 Organic Chemistry II Laboratory | 2-3 |
| CHMY 302E (CHEM 334) Chemistry Literature and Scientific Writing (satisfies the Upper-division Writing Expectation) | 3 |
| CHMY 311 (CHEM 341) Analytical Chem-Quant Analysis | 4 |
| CHMY 421 (CHEM 342) Advanced Instrumental Analysis | 4 |
| CHMY 360 (CHEM 370) Applied Physical Chemistry or CHMY 373 (CHEM 371) Phys Chem-Kntcs & Thrmodynms | 3-4 |
| CHMY 401 (CHEM 452) Advanced Inorganic Chemistry | 3 |
| BIOC 481 Biochemistry | 3 |
| BIOL 110N Principles of Biology or equivalent | 4 |
| BIOL 221 Cell and Molecular Biology | 4 |

| | |
|---|-----|
| BIOL 223 Genetics and Evolution | 4 |
| GEO 101N-102N (GEOS 100N-101N) General Geology and Laboratory | 3 |
| GEO 327 (GEOS 327) Geochemistry | 3 |
| Electives from CHMY 373, 371, 442, 445, 403, 402, 465, 466; (CHEM 371, 372, 442, 445, 453, 455, 465, 466); 3 credits maximum of 792 (CHEM 497); BIOL 340, 453, 454, 455, 497, 3 credits maximum of 497; GEO 320, 382, 431, 420 (GEOS 320, 382, 431, 480), 3 credits maximum of 497; MICB 300, 416, 3 credits maximum of 497; STAT 452 (MATH 445); Modern Foreign Language (5 credits maximum) | 8 |
| M 162 (MATH 150) Applied Calculus or 171 (MATH 152) Calculus I | 4 |
| M 274 (MATH 158) Applied Differential Equations or 172 (MATH 153), Calculus II | 3-4 |
| STAT 451, 457 (MATH 444, 447) Statistics | 4 |
| PHYS 121N-122N or 221N-222N General Physics I, II | 10 |

Bachelor of Science with a major in Chemistry, Option in Forensic Chemistry

The Chemistry B.S. degree with the option in Forensic Chemistry forms a solid base for students interested in careers in forensic chemistry or advanced work in chemistry including graduate school.

At the time of graduation a recipient of this degree has the option of taking two semesters of one modern foreign language which, as a departmental requirement, may be taken credit/no credit. Students not taking this option will be required to take 2 additional advisor-approved Chemistry & Biochemistry or related discipline electives for 3 credits each. This will bring the elective credits for this option to 9.

| Course | Credits |
|---|---------|
| CHMY 141N-143N (CHEM 161N-162N) College Chemistry I, II | 10 |
| CHMY 221-223 (CHEM 221-222) Organic Chemistry I, II | 6 |
| CHMY 222 (CHEM 223) Organic Chemistry I Laboratory | 2 |
| CHMY 225 (CHEM 264) Organic Chemistry Laboratory for Chemistry Majors of CHMY 223 (CHEM 223) Organic Chemistry II Laboratory | 2-3 |

| | |
|--|-----|
| CHMY 302E (CHEM 334) Chemistry Literature and Scientific Writing (satisfies the Upper-division Writing Expectation) | 3 |
| CHMY 311 (CHEM 341) Analytical Chem-Quant Analysis | 4 |
| CHMY 421 (CHEM 342) Advanced Instrument Analysis | 4 |
| CHMY 360 (CHEM 370) Applied Physical Chemistry or CHMY 373 (CHEM 371) Phys Chem-Kntcs & Thrmodynms | 3-4 |
| BIOC 481-482 Biochemistry or equivalent | 6 |
| CHMY 401 (CHEM 452) Advanced Inorganic Chemistry | 3 |
| CHMY 488 (CHEM 488) Forensic Research or CHEM 498 Internship | 3 |
| CHMY 489 (CHEM 489) Forensic Science Seminar | 1 |
| ANTH 286N Survey of Forensic Science | 3 |
| BIOL 110N General Biology | 4 |
| BIOL 221 Cell and Molecular Biology | 4 |
| COMM 111A Public Speaking | 3 |
| M 171-172 (MATH 152-153) Calculus I, II | 8 |
| STAT 451 (MATH 444) Statistical Methods | 3 |
| STAT 457 (MATH 447) Computer Data Analysis | 1 |
| PHYS 221N-222N Fundamentals of Physics I & II | 10 |
| SOCI 211S (SOC 230S) Criminology | 3 |
| SOCI 221 (SOC 235) Criminal Justice | 3 |
| Electives from CHMY 465, 466, 542 (CHEM 465, 466, 542); ANTH 488; BIOL 223, 440; PHAR 110. (at least 8 of these credits must be in courses numbered 300 and above) | 11 |

Bachelor of Science with a major in Chemistry, Option in Pharmacology

| Course | Credits |
|---|---------|
| CHMY 141N-143N (CHEM 161N-162N) College Chemistry I, II | 10 |

| | |
|--|-----|
| CHMY 221-223 (CHEM 221-222) Organic Chemistry and Laboratory I, II | 6 |
| CHMY 222 (CHEM 223) Organic Chemistry I Laboratory | 2 |
| CHMY 225 (CHEM 264) Organic Chemistry Laboratory for Chemistry Majors or 224 (CHEM 224)Organic Chemistry II Laboratory | 2-3 |
| CHMY 302E (CHEM 334) Chemistry Literature and Scientific Writing (satisfies the Upper-division Writing Expectation) | 3 |
| CHMY 311 (CHEM 341) Quantitative Analysis & Instrumental Methods | 4 |
| CHMY 421 (CHEM 342) Advanced Instrument Analysis | 4 |
| CHMY 360 (CHEM 370)Applied Physical Chemistry or CHMY 373 (CHEM 371) Phys Chem-Kntcs & Thrmdynmcs | 3-4 |
| CHMY 401 (CHEM 452) Advanced Inorganic Chemistry | 3 |
| BIOC 481-482 Biochemistry | 6 |
| BIOL 110N Principles of Biology or equivalent | 4 |
| BIOL 221 Cell and Molecular Biology | 4 |
| MICB 302 Medical Microbiology | 3 |
| PHAR 341-342 Applied Anatomy and Physiology | 8 |
| PHAR 443-444 Pharmacology and Toxicology | 8 |
| Electives from CHMY 373, 371, 442, 445, 403, 402, 465, 466 (CHEM 371, 372, 442, 445, 453, 455, 465, 466), 3 credits maximum of 492 (CHEM 497); BIOL 3 credits maximum of 497; PHAR 421, 422, 3 credits maximum of 497 | 3 |
| Cognate courses: | |
| M 162 (MATH 150)Applied Calculus or 171 (MATH 152) Calculus I | 4 |
| M 274 (MATH 158) Applied Differential Equations or 172 (MATH 153) Calculus II | 3-4 |
| PHYS 121N-122N or 221N-222N General Physics I, II | 10 |

Bachelor of Arts Degree

The courses required for the B.A. degree provide a less extensive training in chemistry than do the courses required for the American Chemical Society certified B.S. degree. This is to allow the student to supplement his or her program with courses that meet his or her specific needs. Thus this degree provides the core of traditional preparation in chemistry together with latitude for combination with an interdisciplinary field or the Teacher Preparation program. It is strongly advised that students using this degree obtain faculty advice in planning their program.

| Course | Credits |
|---|---------|
| CHMY 141N-143N (CHEM 161N-162N) College Chemistry I, II | 10 |
| CHMY 221-223 (CHEM 221-222) Organic Chemistry I, II | 6 |
| CHMY 222 (CHEM 223) Organic Chemistry I Laboratory | 2 |
| CHMY 225 (CHEM 264) Organic Chemistry Laboratory for Chemistry Majors or 224 (CHEM 224) Organic Chemistry II Laboratory | 2-3 |
| CHMY 302E (CHEM 334) Chemistry Literature and Scientific Writing (satisfies the Upper-division Writing Expectation) | 3 |
| CHMY 311 (CHEM 341) Analytical Chem-Quant Analysis | 4 |
| CHMY 421 (CHEM 342) Advanced Instrument Analysis | 4 |
| CHMY 373-371 (CHEM 371-372) Phys Chem-Kntcs & Thrmodynms & Phys Chem-Qntm Chm & Spctrscopy | 8 |
| * Advanced electives | 15 |
| Cognate courses: | |
| CS 172 Introduction to Computer Modeling (or similar computing experience with approval of Chemistry advisor) | 3 |
| M 171, 172, 273 (MATH 152, 153, 251) Calculus I, II and III | 12 |
| PHYS 221N-222N (preferred) or 121N-122N General Physics I and II | 10 |
| Modern Foreign Language | 10 |
| WRIT 101 (ENEX 101) Composition. | 3 |

*As preparation for teaching at the secondary level, students should elect CHMY 401, 403, 485 (CHEM 452, 453, and 485), BIOC 380, STAT 216 (MATH 241), SCI 350 and teaching certification requirements including C&I 426 and SCI 350. A student should consult his or her chemistry advisor for other options.

At the time of graduation a recipient of this degree must have completed two semesters of one foreign language. The Department of Chemistry waives the foreign language requirement for a student who completes the B.A. degree in preparation for secondary teaching and who meets the requirements for teaching certification, including the student teaching requirement. These students still must meet the foreign language/symbolic systems competency requirement (likely via M 171 and 172 (MATH 152 and 153) for General Education as described in the Academic Policies and Procedures section of this catalog.

Teacher Preparation in Chemistry

Major Teaching Field of Chemistry: For an endorsement in the major teaching field of Chemistry, a student must complete the requirements for the above B.A. degree with a major in Chemistry with appropriate electives but without the foreign language requirement, and with the addition of CHMY 401, 403, and 485 (CHEM 452, 453, and 485). Students also must complete BIOC 380, STAT 216 (MATH 241), SCI 350, and C&I 426, gain admission to Teacher Education and Student Teaching and meet the requirements for certification as a secondary teacher (see the School of Education section of this catalog).

Minor Teaching Field of Chemistry: For an endorsement in the minor teaching field of Chemistry, a student must complete CHMY 101N, 141N-143N, 221-222-223, 312, 360 or 373 and 485 (CHEM 101N, 161N-162N, 221-222-223, 341, 370 or 371, and 485); BIOC 380, CS 101 or 172, M 162 (MATH 150) and STAT 216 (MATH 241), PHYS 121N-122N or PHYS 221N-222N, and SCI 350. Students also must complete C&I 426, gain admission to Teacher Education and Student Teaching and meet other requirements for certification as a secondary teacher (see the School of Education section of this catalog).

Suggested Course of Study

For B.S. Degree (American Chemical Society Certified)

| | | | | |
|---|----|---|----|---|
| First Year | | A | | S |
| CHMY 141N-143N (CHEM 161N-162N) College Chemistry I, II | 5 | | 5 | |
| CS 172 Computer Modeling | - | | 3 | |
| M 171-172 (MATH 152-153) Calculus I, II | 4 | | 4 | |
| WRIT 101 (ENEX 101) Composition | 3 | | - | |
| Electives and General Education | 3 | | 3 | |
| | 15 | | 15 | |
| Second Year | | A | | S |

| | | | | |
|---|----|---|----|---|
| CHMY 221-223 (CHEM 221-222) Organic Chemistry I, II | 3 | | 3 | |
| CHMY 222 (CHEM 223) Organic Chemistry I Laboratory | 2 | | - | |
| CHMY 225 (CHEM 264) (or 224) Organic Chemistry Laboratory | - | | 3 | |
| M 273 (MATH 251) Calculus III | 4 | | - | |
| M 311 (MATH 311) Ordinary Differential Equations and Systems or M 221 (MATH 221) Linear Algebra | - | | 3 | |
| PHYS 221N-222N General Physics | 5 | | 5 | |
| Electives and General Education | - | | 3 | |
| | 14 | | 17 | |
| Third Year | | A | | S |
| CHMY 302E (CHEM 334) Chem Literature & Scientific Writing | 3 | | - | |
| CHMY 311 (CHEM 341) Analytical Chem-Quant Analysis | 4 | | - | |
| CHMY 421 (CHEM 342) Advanced Instrument Analysis | - | | 4 | |
| CHMY 373-371 (CHEM 371-372) Phys Chem-Kntcs & Thrmodynms & Phys Chem-Qntm Chm & Spctrscopy | 4 | | 4 | |
| General Education (one upper-division) | 6 | | 9 | |
| | 17 | | 17 | |
| Fourth Year | | A | | S |
| CHMY 401-403 (CHEM 452-453) Advanced Inorganic Chemistry | 3 | | 3 | |
| CHMY 402 (CHEM 455) Advanced Inorganic Chemistry Laboratory | - | | 2 | |

| | | |
|-------------------------|----|----|
| BIOC 481 Biochemistry | 3 | - |
| Advanced CHEM elective | 3 | 3 |
| General Education | - | 3 |
| Upper-division elective | 6 | 6 |
| | 15 | 17 |

For B.S. Degree, Option in Environmental Chemistry

| First Year | | A | | S |
|--|----|---|-------|---|
| CHMY 141N-143N (CHEM 161N-162N) College Chemistry I, II | 5 | | 5 | |
| M 162 (MATH 150) Applied Calculus or 171 (MATH 152) Calculus I | 4 | | - | |
| M 274 (MATH 158) Applied Differential Equations or MATH 153 Calculus II | - | | 3-4 | |
| BIOL 110N Principles of Biology or equivalent. | - | | 4 | |
| WRIT 101 (ENEX 101) Composition | 3 | | - | |
| Electives and General Education | 4 | | 2 | |
| | 16 | | 14-15 | |

| Second Year | | A | | S |
|--|---|---|---|---|
| CHMY 221-223 (CHEM 221-222) Organic Chemistry | 3 | | 3 | |
| CHMY 222 (CHEM 223) Organic Chemistry I Laboratory | 2 | | - | |
| CHMY 225 or 224 (CHEM - 264 or 224) Organic Chemistry Laboratory | - | | 3 | |
| PHYS 121N-122N or 221N-222N General Physics I and II | 5 | | 5 | |
| BIOL 221 Cell and Molecular Biology | 4 | | - | |
| BIOL 223 Genetics and Evolution | - | | 4 | |
| GEO 101N-102N (GEOS 100N-101N) General Geology and Laboratory | 3 | | - | |

| | | | | |
|--|----|---|-------|---|
| | 17 | | 15 | |
| Third Year | | A | | S |
| CHMY 302E (CHEM 334) Chem Literature & Scientific Writing | 3 | | - | |
| CHMY 311 (CHEM 341) Analytical Chem-Quant Analysis | 4 | | - | |
| CHMY 421 (CHEM 342) Advanced Instrument Analysis | - | | 4 | |
| CHMY 360 (CHEM 370) Applied Physical Chemistry or CHMY 373 (CHEM 371) Phys Chem-Kntcs & Thrmodynms | - | | 3-4 | |
| GEO 327 (GEOS 327) Geochemistry | 3 | | - | |
| Electives and General Education | 6 | | 9 | |
| | 16 | | 16-17 | |
| Fourth Year | | A | | S |
| BIOC 481-482 Biochemistry | 3 | | - | |
| CHMY 401 (CHEM 452) Advanced Inorganic Chemistry | 3 | | - | |
| CHMY 494 (CHEM 494) Seminar/Workshop | - | | 1 | |
| STAT 451/457 (MATH 444/447) Statistical Methods | 4 | | - | |
| Electives and General Education | 4 | | 15 | |
| | 17 | | 16 | |

For B.S. Degree, Option in Forensic Chemistry

| | | | | |
|---|---|---|---|---|
| First Year | | A | | S |
| CHMY 141N-143N (CHEM 161N-162N) College Chemistry I, II | 5 | | 5 | |
| M 171-172 (MATH 152-153) Calculus I, II | 4 | | 4 | |
| BIOL 110N Principles of Biology or equivalent | - | | 4 | |

| | | | | |
|--|----|---|----|---|
| COMM 111A Public Speaking | 3 | | - | |
| WRIT 101 (ENEX 101) Composition | - | | 3 | |
| Electives and General Education | 3 | | - | |
| | 15 | | 16 | |
| Second Year | | A | | S |
| CHMY 221-223 (CHEM 221-222) Organic Chemistry | 3 | | 3 | |
| CHMY 223 (CHEM 223) and CHMY 225 or 224 (CHEM 264 or 224) Organic Chemistry I Laboratory | 2 | | 2 | |
| PHYS 221N-222N Fundamentals of Physics with Calculus I and II | 5 | | 5 | |
| BIOL 221 Cell and Molecular Biology | 4 | | - | |
| SOCI 211S (SOC 230S) Criminology | 3 | | - | |
| ANTH 286N Survey of Forensic Science | - | | 3 | |
| General Education | - | | 3 | |
| | 17 | | 16 | |
| Third Year | | A | | S |
| CHMY 302E (CHEM 334) Chem Literature & Scientific Writing | 3 | | - | |
| CHMY 311 (CHEM 341) Analytical Chem-Quant Analysis | 4 | | - | |
| CHMY 421 (CHEM 342) Advanced Instrument Analysis | - | | 4 | |
| CHMY 360 (CHEM 370) Applied Physical Chemistry | - | | 3 | |
| STAT 451/457 (MATH 444/447) Statistical Methods | 4 | | - | |
| SOCI 221 (SOC 235) Criminal Justice | - | | 3 | |
| Electives and General Education | 6 | | 6 | |

| | | | | |
|--|----|---|----|---|
| | 15 | | 16 | |
| Fourth Year | | A | | S |
| BIOC 481-482 Biochemistry | 3 | | 3 | |
| CHMY 401 (CHEM 452) Advanced Inorganic Chemistry | 3 | | - | |
| CHMY 488 (CHEM 488) Forensic Research | - | | 3 | |
| CHMY 489 (CHEM 489) Forensics Research Seminar | 1 | | - | |
| Electives and General Education | 9 | | 9 | |
| | 16 | | 15 | |

For B.S. Degree, Option in Pharmacology

| | | | | |
|--|----|---|-------|---|
| First Year | | A | | S |
| CHMY 141N-143N (CHEM 161N-162N) College Chemistry I, II | 5 | | 5 | |
| M 162 (MATH 150) Applied Calculus or 171 (MATH 152) Calculus I | 4 | | - | |
| M 274 (MATH 158) Applied Differential Equations or M 172 (MATH 153) Calculus II | - | | 3-4 | |
| BIOL 110N Principles of Biology or equivalent | - | | 4 | |
| WRIT 101 (ENEX 101) Composition | 3 | | - | |
| Electives and General Education | 4 | | 2 | |
| | 16 | | 14-15 | |
| Second Year | | A | | S |
| CHMY 221-223 (CHEM 221-222) Organic Chemistry | 3 | | 3 | |
| CHMY 222 (CHEM 223) Organic Chemistry I Laboratory | 2 | | - | |
| CHMY 225 or 224 (CHEM - 264 or 224) Organic Chemistry Laboratory | - | | 3 | |

| | | | | |
|---|----|---|-------|---|
| PHYS 121N-122N or 221N-222N General Physics I and II | 5 | | 5 | |
| BIOL 221 Cell and Molecular Biology | 4 | | - | |
| Electives and General Education | - | | 6 | |
| | 17 | | 15 | |
| Third Year | | A | | S |
| CHMY 302E (CHEM 334) Chem Literature & Scientific Writing | 3 | | - | |
| CHMY 311 (CHEM 341) Analytical Chem-Quant Analysis | 4 | | - | |
| CHMY 421 (CHEM 342) Advanced Instrument Analysis | - | | 4 | |
| CHMY 360 (CHEM 370) Applied Physical Chemistry or CHMY 373 (CHEM 371) Phys Chem-Kntcs & Thrmdynmcs | - | | 3-4 | |
| MICB 302E Medical Microbiology | 3 | | - | |
| PHAR 341-342 Applied Anatomy and Physiology | 4 | | 4 | |
| Electives and General Education | 3 | | 6 | |
| | 17 | | 17-18 | |
| Fourth Year | | A | | S |
| BIOC 481-482 Biochemistry | 3 | | 3 | |
| CHMY 401 (CHEM 452) Advanced Inorganic Chemistry | 3 | | - | |
| PHAR 443-444 Pharmacology and Toxicology | 4 | | 4 | |
| Electives and General Education | 6 | | 7 | |
| | 16 | | 14 | |

For B.A. Degree

First Year A S

| | | | | |
|---|----|---|----|---|
| CHMY 141N-143N (CHEM 161N-162N) College Chemistry I, II | 5 | | 5 | |
| CS 172 Introduction to Computer Modeling | - | | 3 | |
| WRIT 101 (ENEX 101) Composition | 3 | | - | |
| M 171-172 (MATH 152-153) Calculus I and II | 4 | | 4 | |
| General Education or electives | 3 | | 3 | |
| | 15 | | 15 | |
| Second Year | | A | | S |
| CHMY 221-223 (CHEM 221-222) Organic Chemistry | 3 | | 3 | |
| CHMY 222 (CHEM 223) Organic Chemistry I Laboratory | 2 | | - | |
| CHMY 225 (CHEM 264) (or 224) Organic Chemistry Laboratory | - | | 3 | |
| M 273 (MATH 251) Calculus III | 4 | | - | |
| PHYS 221N-222N General Physics | 5 | | 5 | |
| General Education or electives | - | | 6 | |
| | 14 | | 17 | |
| Third Year | | A | | S |
| CHMY 302E (CHEM 334) Chem Literature & Scientific Writing | 3 | | - | |
| CHMY 311 (CHEM 341) Analytical Chem-Quant Analysis | 4 | | - | |
| CHMY 421 (CHEM 342) Advanced Instrument Analysis | - | | 4 | |
| CHMY 373-371 (CHEM 371-372) Phys Chem-Kntcs & Thrmdynmcs & Phys Chem-Qntm Chm & Spctrscopy | 4 | | 4 | |
| Advanced electives | 3 | | 3 | |
| General Education | 3 | | 6 | |

| | 17 | A | 17 | S |
|----------------------------------|----|---|----|---|
| Fourth Year | | | | |
| Advanced CHEM elective | 3 | | 3 | |
| General Education or elective | 3 | | - | |
| Modern Foreign Language | 5 | | 5 | |
| Upper-division elective | 6 | | 6 | |
| | 17 | | 14 | |

Requirements for a Minor To earn a minor in chemistry the student must complete CHMY 141N, 143N, 221, 222, 223, 311, 360 or 373 (CHEM 161N, 162N, 221, 222, 223, 341, 370 or 371) and at least two courses from one of the following groups:

(a) CHMY 422, 371, 442, 445, 401, 403, 465 (CHEM 342, 372, 442, 445, 452, 453, 465)

(b) If the student's major does not require biochemistry, BIOC 380 or 481 and 482

For teaching minor requirements, see the Teacher Preparation in Chemistry section above.

Courses

U = for undergraduate credit only, UG = for undergraduate or graduate credit, G = for graduate credit. R after the credit indicates the course may be repeated for credit to the maximum indicated after the R. Credits beyond this maximum do not count toward a degree.

Chemistry (CHMY)

U 101N (CHEM 101N) Chemistry for the Consumer 3 cr. Offered spring. An introduction to chemistry that emphasizes the influence of chemistry on one's everyday life.

Common household products, such as soap, aspirin, toothpaste, face cream and fertilizers are prepared in the lab.

U 104 (CHEM 104) Preparation for Chemistry 3 cr. Offered autumn. An introduction to chemistry for those who believe they have an inadequate background to enroll in CHMY 121N or 141N (CHEM 151N or 161N). Not appropriate toward chemistry requirement in any major.

U 121N (CHEM 151N) Intro to General Chemistry 3 cr. Offered autumn and spring. First semester of an introduction to general, inorganic, organic and biological chemistry.

U 122 (CHEM 153) Intro to General Chemistry Laboratory 1 cr. Offered autumn and spring. Prereq., Enrolled in the College of Technology ASRN program. Prereq. or coreq., CHMY 121N (CHEM 151N) or equivalent. A laboratory course emphasizing inorganic chemistry, quantitative relations and synthesis of inorganic and organic compounds.

U 123N (CHEM 152N) Intro Organic and Biological Chemistry 3 cr. Offered autumn and spring. Prereq., "C-" or equiv. in CHMY 121N (CHEM 151N) or consent of instr. Second semester of an introduction to general, inorganic, organic and biological chemistry.

U 124N (CHEM 154N) Intro Organic and Biological Chemistry Laboratory 2 cr. Offered autumn and spring. Prereq. or coreq., CHMY 123N (CHEM 152N). Laboratory to accompany CHMY 123N (CHEM 152N).

U 141N (CHEM 161N) College Chemistry I 5 cr. Offered autumn and spring. Prereq., high school algebra. For science majors and other students intending to take more than one year of chemistry. Properties of elements, inorganic compounds, liquid solutions, chemical equilibria and chemical kinetics. Includes laboratory.

U 143N (CHEM 162N) College Chemistry II 5 cr. Offered spring and summer. Prereq., "C-" or better in CHMY 141N (CHEM 161N) or consent of instr. A continuation of CHMY 141N. Includes Laboratory.

U 191 (CHEM 195) Special Topics Variable cr. (R-6) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.

U 221 (CHEM 221) Organic Chemistry I 3 cr. Offered autumn. Prereq., CHMY 123N or 143N (CHEM 152N or 162N). The chemical and physical properties of organic compounds.

U 222 (CHEM 222) Organic Chemistry I Laboratory 2 cr. Offered autumn. Coreq., CHMY 221 (CHEM 221); prereq., one semester of 100-level laboratory. Microscale techniques are emphasized.

U 223 (CHEM 223) Organic Chemistry II 3 cr. Offered spring. Prereq., CHMY 221 (CHEM 221). Continuation of 221.

U 224 (CHEM 224) Organic Chemistry II Laboratory 2 cr. Offered spring. Prereq., CHMY 223 (CHEM 223); prereq. or coreq., CHMY 222 (CHEM 222).

U 225 (CHEM 264) Organic Chemistry Laboratory for Chemistry Majors 3 cr. Offered spring. Prereq., CHMY 223 (CHEM 223); coreq., CHMY 222 (CHEM 222). Second semester of organic chemistry laboratory for chemistry majors only. Incorporates larger-scale techniques and instrumental organic analysis.

U 291 (CHEM 295) Special Topics 1-6 cr. (R-6) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.

U 292 (CHEM 297) Independent Study cr. (R-10) Offered autumn and spring. Prereq., one semester of chemistry and consent of instr. Laboratory investigations and research in the laboratory of a faculty member.

U 302E (CHEM 334) Chemistry Literature and Scientific Writing 3 cr. Offered autumn. Prereq., CHMY 223 (CHEM 222) and chemistry major. Presentation and discussion of current literature in chemistry. Use of library and search tools. Workshop for developing and improving skills in scientific writing and evaluation. Use of on-line data bases and the interface of these with PC-based word processing and scientific graphics programs.

U 311 (CHEM 341) Analytical Chem-Quant Analysis 4 cr. Offered autumn. Prereq., one year of college chemistry, including laboratory. Classroom and laboratory work in gravimetric, volumetric, colorimetric and electrochemical methods of analysis; theory of errors; ionic equilibria in aqueous solutions.

UG 360 (CHEM 370) Applied Physical Chemistry 3 cr. Offered spring. Prereq., CHMY 123 OR 143 AND M 162 (CHEM 152 or 162 and MATH 150). Basic thermodynamics

and chemical kinetics with applications in the biological and environmental sciences. Credit not allowed for both 360 and 373 (CHEM 370 and 371).

UG 371 (CHEM 372) Physical Chemistry Qntm Chm & Spctrscopy 4 cr. Offered spring. Prereq., CHMY 373 (CHEM 371). Systematic treatment of the laws and theories relating to chemical phenomena.

UG 373 (CHEM 371) Physical Chemistry Kntcs & Thrmdynmcs 4 cr. Offered autumn. Prereq., CHMY 143 (CHEM 162), M 273 (MATH 251), PHYS 122 or 222. Systematic treatment of the laws and theories relating to chemical phenomena. Credit not allowed for both CHMY 360 and 373 (CHEM 370 and 371).

U 391 (CHEM 395) Special Topics Variable cr. (R-9) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.

U 397 (CHEM 380) Teaching Chemistry 1 cr. Offered every term. Prereq., CHMY 141N-143N (CHEM 161N-162N) with B or better and consent of instr. Methods of peer-led team learning as applied to general chemistry instruction. Review of concepts from general chemistry. Student leaders mentor a team of general chemistry students in working toward constructing chemistry knowledge and developing problem-solving skills.

U 398 (CHEM 398) Internship Variable cr. Offered autumn and spring. Prereq., consent of department. Extended classroom experience which provides practical application of classroom learning during placements off campus. Prior approval must be obtained from the faculty supervisor and the Internship Services office. A maximum of 6 credits of Internship (198, 298, 398, 498) may count toward graduation.

UG 401 (CHEM 452) Advanced Inorganic Chemistry 3 cr. Offered autumn. Prereq., CHMY 223 AND 360 OR 373 (CHEM 222 and 370 or 371) or consent of instr. Theory and principles of inorganic chemistry and a systematic coverage of descriptive inorganic chemistry in the context of the periodic table.

UG 402 (CHEM 455) Advanced Inorganic Chemistry Laboratory 2 cr. Offered spring. Prereq., CHMY 224 AND 360 or 373 (CHEM 224 and 370 or 371) and consent of instr. Preparation of inorganic and coordination compounds. Isolation and characterization by ion exchange, column chromatography, IR, UV-VIS, derivatives, MP, and BP.

U 403 (CHEM 453) Descriptive Inorganic Chemistry 3 cr. Offered spring. Prereq., CHMY 221-222, 360 or 373-371, and 401 (CHEM 221-223, 370 or 371-372 and 452). A survey of the chemistry of the elements including transition metal reaction mechanisms, redox chemistry, organometallic chemistry, bioinorganic chemistry.

UG 421 (CHEM 342) Advanced Instrumental Analysis 4 cr. Offered spring. Prereq., CHMY 311 (CHEM 341). Theory and use of instrumental methods in the study of analytical and physical chemistry.

UG 442 (CHEM 442) Aquatic Chemistry 3 cr. Offered autumn odd-numbered years. Prereq., CHMY 311 (CHEM 341) or consent of instr. Application of chemical equilibria theory for understanding and modeling chemical processes in natural waters with an emphasis on spreadsheet computations. In depth examination of concepts such as pH, alkalinity, buffering, and solubility as they apply to natural waters.

UG 445 (CHEM 445) Industrial Chemistry and Its Impact on Society 3 cr. Offered every other autumn semester. Prereq., CHMY 143 or 123 (CHEM 162 or 152). A course based on local Montana chemical industries involving field trips to chemical plants,

visits by company personnel and an overall evaluation of the company=s economic and environmental impact on the community.

UG 465 (CHEM 465) Organic Spectroscopy 3 cr. Offered intermittently. Prereq., CHMY 360 or 373 (CHEM 370 or 371) and one year of organic chemistry or consent of instr. Theory and interpretation of the NMR, IR, UV, and mass spectra of organic compounds with the goal of structure identification.

U 466 (CHEM 466) FT-NMR Operation for Undergraduate Research 1 cr. Offered intermittently. Prereq., CHMY 221-222 (CHEM 221-223); research project using NMR; consent of instr. Operation of the FT-NMR spectrometer and brief background of NMR spectroscopy.

U 480 (CHEM 441) Techniques of Glass Manipulation 1 cr. Offered intermittently. Fabrication and repair of laboratory glassware. Basic operations include cutting glass, bending, end seals, joining (same and different diameters), T-seals, bulbs, ring or inner seals, condensers.

UG 485 (CHEM 485) Laboratory Safety 1 cr. Offered autumn. Prereq., one year of college chemistry. Awareness of and methods of control of hazards encountered in laboratory work. Awareness of legal constraints on work with chemicals. Sources of information regarding chemical hazards.

U 488 (CHEM 488) Forensic Research 3 cr. Offered autumn, spring and summer. Prereq., consent of instr. Laboratory investigations and research on forensic chemistry topics under the direction of a faculty member.

U 489 (CHEM 489) Forensic Research Seminar 1 cr. Offered autumn. Prereq., CHMY 421 (CHEM 342) and ANTH 286N. Seminar speakers on forensic science topics in the areas of ethics, law, anthropology and criminology; tours of the Montana State Crime Laboratory.

U 490 (CHEM 497) Undergraduate Research 1-9 cr. Undergraduate Research Variable cr (R-9). Offered autumn, spring, and summer. Prereq., consent of instr. Laboratory investigations and research in the laboratory of a faculty member.

UG 491 (CHEM 495) Special Topics Variable cr. (R-9) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses or one-time offerings of current topics.

UG 492 Independent Study cr. (R-9) Offered autumn and spring. Prereq., consent of instr. Laboratory investigations and research in the laboratory of a faculty member.

UG 494 (CHEM 494/497) 1-9 cr. (R-9) Offered autumn and spring. Prereq., consent of instr. Laboratory investigations and research in the laboratory of a faculty member.

U 498 (CHEM 498) Internship 1-6 cr. Prereq., consent of department. Extended non-classroom experience which provides practical application of classroom learning during placements off campus. Prior approval must be obtained from the faculty supervisor and the Internship Services office. A maximum of 6 credits of Internship (198, 298, 398, 498) may count toward graduation.

U 499 (CHEM 499) Senior Thesis 3 cr. Offered autumn and spring. Prereq., CHMY 490 or consent of instr. and senior standing. Students complete and report on undergraduate research initiated as CHEM 490 or equivalent research experience. Reports are both oral and written.

G 501 (CHEM 501) Teaching University Chemistry 1 cr. Offered autumn. Preparation for teaching chemistry at the college level. A survey of teaching fundamentals and educational psychology as applied to chemistry instruction.

G 541 (CHEM 541) Environmental Chemistry 3 cr. Offered intermittently. Prereq., CHMY 360 OR 373 (CHEM 370 or 371). Chemical principles and reactions in natural systems: Fate of chemical contaminants in the environment; partitioning of contaminants between phases (air/water/soil); chemistry of atmospheric pollutants; computer modeling of equilibrium and kinetic processes; degradation and transformation of organic contaminants.

G 542 (CHEM 542) Separation Science 3 cr. Offered autumn odd-numbered years. Prereq., CHMY 421 (CHEM 342), CHMY 360 (CHEM 370) or 373 (CHEM 371). Theory, method development, and application of analytical separations; solvent extraction; solid phase extraction; various forms of chromatography; electrophoresis.

G 544 (CHEM 544) Applied Spectroscopy 3 cr. Offered intermittently. Prereq., CHMY 421 (CHEM 342) or consent of instr. The function and application of optical (ultraviolet to infrared) chemical instrumentation. Specific topics include optics, light sources, detectors and a wide variety of spectrochemical methods with an emphasis on methods not typically covered in undergraduate instrumental analysis courses.

G 553 (CHEM 553) Inorganic Chemistry and Current Literature 4 cr. Offered spring. Prereq., CHMY 401 (CHEM 452). A survey of the elements including transition metal reaction mechanisms, redox chemistry, organometallic chemistry, bioinorganic chemistry. Oral and written presentations on primary literature.

G 561 (CHEM 561) Bioorganic Chemistry of Antibiotic and Natural Product Biosynthesis 3 cr. Offered intermittently. Prereq., one year of organic chemistry; preferred prereq. or coreq., biochemistry. Comprehensive study of the bioorganic chemistry of antibiotic and natural product production in bacteria, plants, and higher animals, focusing on polyketide, shikimate, alkaloid, terpene, and nitrogen-containing/non-alkaloid compounds. Natural product diversity, drug screening and dereplication, combinatorial biochemistry, and pathway manipulation to produce "non-natural" natural products.

G 562 (CHEM 562) Organic Structure and Mechanism 3 cr. Offered intermittently. Prereq., one year of organic chemistry. Topics may include: stereochemistry, conformational analysis, aromaticity, transition state theory, isotope effects, solvent effects, substitution and elimination reactions, and mechanisms that involve carbocations, carbanions, radicals and carbenes as reactive intermediates.

G 563 (CHEM 563) Organic Synthesis 3 cr. Offered intermittently. Prereq., CHMY 221-223 (CHEM 221, 222). Theoretical treatise of the common methods used in organic synthesis including: oxidation, reduction, organometallics, C-C bond forming reactions, synthetic strategies and total synthesis.

G 564 (CHEM 564) Organic Reactions 3 cr. Offered intermittently. Prereq., one year of organic chemistry. Reactions such as alkylation of nucleophilic carbons, reactions of carbon nucleophiles with carbonyl groups, functional group interconversions by nucleophilic substitution reactions, electrophilic additions to carbon-carbon multiple bonds, and select oxidations/reductions.

G 566 (CHEM 566) FT-NMR Operation for Graduate Researchers 1 cr. Offered intermittently. Prereq., CHMY 221-222 (CHEM 221-223); research project using NMR; consent of instr. Operation of the FT-NMR spectrometer and brief background of NMR spectroscopy.

G 568 (CHEM 568) Organometallic Chemistry 3 cr. Offered intermittently in autumn. Prereq., CHMY 221, 223, 401, 403 (CHEM 221, 222, 452, 453). Survey of the reactivity and structure of main group and transition metal organometallic compounds with an emphasis on applications to organic synthesis and catalysis.

G 569 (CHEM 569) Medicinal Chemistry 3 cr. Offered intermittently. Prereq., CHMY 221, 223 (CHEM 221, 222); BIOC 380 or equiv. Same as BMED 621. Introduction to the historical and contemporary discoveries in medicinal chemistry.

G 573 (CHEM 573) Advanced Physical Chemistry 3 cr. Offered autumn. Prereq., CHMY 371-373 (CHEM 371-372). Fundamental principles of physical chemistry and special applications.

G 580 (CHEM 580) Advanced Graduate Student Research Seminars 1 cr. (R-10) Offered every term. Prereq., consent of instr. Formal oral and written presentations of research results and selected literature topics in a designated area.

G 581 (CHEM 581) Chemical Biology 3 cr. Offered intermittently. Prereq., consent of instr. Synthesis and structure of native and modified biomolecules such as antisense phosphothioate oligonucleotides, modified nucleosides and nucleotides designed for antiviral activity, and PNAs (protein nucleic acids). Emphasis on the interaction of biomolecules and A "small" organic and inorganic molecules and their chemical impact on native structure and function.

G 593 (CHEM 593) Professional Project 3 cr. Offered autumn and spring. Prereq., consent of instr.

G 595 (CHEM 595) Special Topics Variable cr. (R-9) Offered intermittently. Prereq., consent of instr. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.

G 596 (CHEM 596) Independent Study Variable cr. (R-9) Offered autumn and spring. Prereq., consent of instr.

G 597 (CHEM 597) Research Variable cr. (R-open) Offered autumn and spring. Prereq., consent of instr.

G 598 (CHEM 598) Cooperative Education Experience Variable cr. (R-8) Offered autumn and spring. Prereq., consent of department. Extended non-classroom experience which provides practical application of classroom learning during placements off campus. Prior approval must be obtained from the faculty supervisor and the Internship Services office.

G 599 (CHEM 599) Thesis Variable cr. (R-6) Offered autumn and spring. Prereq., consent of instr.

G 630 (CHEM 630) Seminar 1 cr. (R-open) Offered autumn and spring. Prereq., graduate standing in chemistry or biochemistry, or consent of instr.

G 640 (CHEM 640) Introductory Graduate Seminar 1 cr. (R-open) Offered autumn. Prereq., graduate standing in chemistry or biochemistry or consent of instr. Seminar to acquaint new graduate students with departmental research.

G 650 (CHEM 650) Graduate Chemistry Seminar 1 cr. (R-open) Offered spring. Prereq., graduate standing.

G 697 (CHEM 697) Research Variable cr. (R-open) Offered autumn and spring. Prereq., consent of instr.

G 699 (CHEM 699) Dissertation Variable cr. (R-10) Offered autumn and spring.

Faculty

Professors

Bruce E. Bowler, Ph.D., Massachusetts Institute of Technology, 1986
Mark S. Cracolice, Ph.D., University of Oklahoma, 1994 (Chair)
Michael D. DeGrandpre, Ph.D., University of Washington, 1990
Christopher P. Palmer, Ph.D., University of Arizona, 1991
Nigel D. Priestley, Ph.D., Southampton University, 1991
Edward Rosenberg, Ph.D., Cornell University, 1970
J.B.A. (Sandy) Ross, Ph.D., University of Washington, 1976
Garon C. Smith, Ph.D., Colorado School of Mines, 1983
Kent Sugden, Ph.D., Montana State University, 1992

Associate Professors

- Trina J. Valencich, Ph.D., University of California, Irvine, 1974 (Adjunct)

Assistant Professors

- David Bolstad, Ph.D., The University of Montana, 2006
- Klara Briknarova, Ph.D., Carnegie Mellon University, 1999
- Xi Chu, Ph.D., University of Kansas, 2001
- Valeriy Smirnov, Ph.D., University of Nebraska, 2004

Lecturer

- Holly A. Thompson, Ph.D., Kansas State University, 1982

Research Professor

- Robert Yokelson, Ph.D., Yale University, 1991

Research Associate Professors

- William R. Laws, Ph.D., The Johns Hopkins University, 1977
- Brooke D. Martin, Ph.D., Dartmouth College, 1998

Research Assistant Professors

- Earle R. Adams, Ph.D., Montana State University, 1994
- Ted J. Christian, Ph.D., The University of Montana, 1999

Emeritus Professors

- James W. Cox, Ph.D., Montana State University, 1969
- Ralph J. Fessenden, Ph.D., University of California, 1958

- Richard J. Field, Ph.D., University of Rhode Island, 1968
- Donald E. Kiely, Ph.D., University of Connecticut, 1965
- R. Keith Osterheld, Ph.D., University of Illinois, 1950
- Geoffrey N. Richards, Ph.D., D.Sc., University of Birmingham, 1964
- Wayne P. Van Meter, Ph.D., University of Washington, 1959
- Edward E. Waali, Ph.D., University of Wyoming, 1970
- George W. Woodbury, Jr., Ph.D., University of Minnesota, 1964