

- **UG 455 Artificial Intelligence 3 cr.** Offered intermittently. Prereq., CS 242 or consent of instr. Using the computer to solve problems that require intelligence. Representation of knowledge, search techniques, symbolic programming in LISP, expert systems.
- **U 457 Introduction to Machine Learning 3 cr.** Offered intermittently. Prereq., M 171 (MATH 152) and programming experience or consent of instr. Introduction to the framework of learning from examples, various learning algorithms such as neural networks, and generic learning principles such as inductive bias, Occam's Razor, and data mining. Credit not allowed for both CS 457 and CS 557.
- **UG 458 Introduction to Bioinformatics 3 cr.** Offered autumn. Offered Autumn. Designed for attendance by both computer scientists and biologists. The course will explore the importance of interdisciplinary partnerships between these two fields. Students will learn to use various existing computational tools for investigating genomic and other biological data. This will include tools for performing sequence alignments and searches, building phylogenetic trees, predicting RNA secondary structure, and predicting protein tertiary structure. The underlying algorithmic approaches taken by these tools will be discussed, and in some cases, actually implemented by the class participants. The course will examine the data repositories where genomic and other biological data are stored. There will be some light programming required using PERL as the language of choice. It is assumed that the class participants have no experience programming in PERL and will learn this skill as part of the course. Credit not allowed for CS 558 and this course.
- **UG 475 Statistical, Dynamical, and Computational Modeling 3 cr.** Offered autumn odd-numbered years. Same as M 445 (MATH 475). Prereq., consent of instr. An interdisciplinary course on the integration of statistical and dynamical models with applications to biological problems. Linear and nonlinear models, estimation, systems of ordinary differential equations, numerical integration, bootstrapping, MCMC methods. Intended both for students in mathematics and natural sciences.
- **UG 476 User Interface Design 3 cr.** Offered spring. Prereq., CS 241 or consent of instr. Introduction to usability and key concepts of human behavior. Focus on the process of user-centered design, including requirements specification, prototyping, and methods of evaluation. Incorporation of regular design critiques of classmates' work, and emphasis on both oral and written communication skills. Credit not allowed for CS 576 and this course.
- **UG 477 Computer Simulation and Modeling 3 cr.** Offered spring. Prereq., M 172 (MATH 153), CS 132, or consent of instr. Matrix languages. ODE solving; Euler-Richardson, Runge-Kutta, PDE solving; finite differences, finite elements, multi-grid techniques. Discrete methods for solution, renormalization group method, critical phenomena. Emphasis on presentation of results and interactive programs. Credit not allowed for CS 577 and this course.
- **UG 486 Data Visualization 3 cr.** Offered intermittently. Prereq., M 171 (MATH 152); programming experience; and junior, senior, or graduate status; or consent of instr. Visualization fundamentals and applications using special visualization software; formulation of 3-D empirical models; translation of 3-D models into graphical displays; time sequences and pseudo-animation; interactive versus presentation techniques; special techniques for video, CD and other media.
- **UG 488 Computer Networks 3 cr.** Offered spring. Prereq., CS 241. Concepts and practice of computer networking, network protocol layers, switching, routing, flow, and congestion control. Network programming.
- **UG 494 Undergraduate Seminar Variable cr.** (R-6) Offered intermittently. Prereq., consent of instr. Guidance in special work.
- **UG 495 Special Topics Variable cr.** (R-6) Offered intermittently. Prereq., consent of instr. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.
- **UG 496 Independent Study Variable cr.** (R-6) Offered intermittently. Prereq., consent of instr.
- **UG 497 Research Variable cr.** (R-6) Offered intermittently. Prereq., consent of instr.
- **U 498 Internship Variable cr.** (R-3) Offered Intermittently. Prereq., consent of department. Business or government internship. Prior approval must be obtained from the faculty supervisor and the Internship Services office. Only three credits of CS 398 and/or CS 498 applicable to computer science major or minor. A maximum of 6 credits of Internship (198, 298, 398, 498) may count toward graduation.
- **U 499 Senior Thesis/Project 1-6 cr.** (R-6) Offered every term. Prereq., consent of thesis/project director and chair of the Computer Science Department. Senior thesis for computer science majors and/or Watkins scholars.
- **G 511 Analysis, Modeling, and Design 3 cr.** Offered infrequently. Prereq., CS 132 or 211 or significant programming experience; M 115 or 151 (MATH 117 or 121); CS 346 or software engineering experience; CS365 or database experience. Software requirements analysis, modeling, and specification. Human computer interface issues as they relate to usability, process support, productivity, and organizational goals.
- **G 512 Software Quality Assurance 3 cr.** Offered intermittently. Prereq., CS 132 or 221 or significant programming experience; M 115 or 151 (MATH 117 or 121); CS 346 or software engineering experience. Software quality assurance concepts and implementation Planning, execution, and assessment of quality assurance activities throughout the software project life cycle.
- **G 521 Information Technology Infrastructure 3 cr.** Offered infrequently. Prereq., CS 488 or IS 372 or consent of instr. Identification and classification of background environment, hardware, software, and service components in an enterprise IT environment; management and security concerns for each component; consideration of how the components fit together to form an enterprise information technology environment.
- **G 522 Globalization and Outsourcing 3 cr.** Offered infrequently. Prereq., CS 346 or IS 373 or consent of instr. Development of information technology on a global basis and the associated dynamics of outsourcing relating to intellectual property and national economics in a global context. Project sessions coordinated across two campuses, one at UM and one in an outsourcing environment such as a tribal college, an Indian technical college or Chinese technical college with the purpose of engaging both groups in understanding and resolving cross-cultural and technical problems.
- **G 531 Design and Analysis of Algorithms 3 cr.** Offered intermittently. Prereq., CS 332. Algorithm design, analysis, and correctness, with an emphasis on more advanced techniques than covered in CS 332. Design of algorithms by induction. Recurrences and their solutions. Parallel algorithms. Complexity theory: NP-hard and NP-complete problems. Approximation algorithms for intractable problems.
- **G 541 Software Science I: Requirements and Specifications 3 cr.** Offered intermittently. Prereq., M 225 (MATH 225); CS 241 and 242 or consent of instr. Requirements analysis, techniques for representing requirements, specification development techniques, and specification languages.
- **G 542 Software Science II: Design, Implementation and Testing 3 cr.** Offered intermittently. Prereq., CS 541. Continuation of CS 541. The design process. Major design methods such as composite/structured design, data structure driven design, structured analysis,

transfer of design to code, testing techniques, validation, verification, certification, and security.

- **G 555 Applications in Artificial Intelligence 3 cr.** (R-6) Offered intermittently. Course can be repeated for credit at the discretion of the instructor. Prereq., consent of instr. One AI application area will be investigated, such as natural language processing, expert systems, and knowledge acquisition. LISP experience is required.
- **G 557 Machine Learning 3 cr.** Offered intermittently. Prereq., M 171 (MATH 152) and programming experience or consent of instr. Fundamentals of machine learning including neural networks, decision trees, Bayesian learning, instance-based learning, and genetic algorithms; inductive bias, Occam=s razor, and learning theory; data mining; software agents. Credit not allowed for CS 457 and CS 557.
- **G 558 Introduction to Bioinformatics 3 cr.** Offered autumn. Prereq., consent of instr. Introduction and use of biological data sources available in the post *human genome project* era. Topics include basic algorithms for alignment of genome sequences and prediction of protein structures, as well as more advanced representational and algorithmic issues in protein structure, genome sequence computation, and systems biology. Discussion of state of the art bioinformatics projects that are being developed between the Department of Computer Science and the School of Pharmacy.
- **G 565 Database Systems 3 cr.** Offered intermittently. Prereq., CS 242, 344, and 365, or consent of instr. Relational database theory, data models, user interfaces and query languages, security, and concurrency.
- **G 576 Human-Computer Interactions 3 cr.** Offered spring. Prereq., CS 241 or consent of instr. Principles of good design for interactive systems and web-based applications. User-centered design methodology including requirements specification, low and high-fidelity prototyping, heuristic evaluation, cognitive walkthrough, predictive modeling, and usability testing. Advanced HCI research project. Credit not allowed for both CS 476 and 576.
- **G 577 Computer Simulation and Modeling 3 cr.** Offered spring. Prereq., M 172 (MATH 153), CS 132, or consent of instr. Matrix languages. ODE solving; Euler-Richardson, Runge-Kutta, PDE solving; finite differences, finite elements, multi-grid techniques. Discrete methods for solution, renormalization group method, critical phenomena. Emphasis on presentation of results and interactive programs. Engagement with current scientific literature. Planning and execution of small scale modeling project derived from scientific literature. Model testing and validation.
- **G 580 Parallel Processing 3 cr.** Offered intermittently. Prereq., CS 241, 242, and 344. Parallel processing architectures and programming languages.
- **G 594 Graduate Seminar Variable cr.** (R-6) Offered intermittently. Prereq., consent of instr. Seminar on current research topics in computer science.
- **G 595 Special Topics Variable cr.** (R-6) Offered intermittently. Prereq., consent of instr. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offering of current topics.
- **G 596 Independent Study Variable cr.** (R-6) Offered intermittently. Prereq., consent of instr.
- **G 597 Research Variable cr.** (R-6) Offered intermittently. Prereq., consent of instr.
- **G 598 Internship Variable cr.** (R-3) Offered intermittently. Prereq., consent of department. Business or government internship. Prior approval must be obtained from faculty supervisor and the Internship Services office. Only three credits applicable to computer science major or minor.
- **G 599 Thesis/Project Variable cr.** (R-6) Offered every term. Prereq., consent of instr. Research for and preparation of the master thesis or professional paper.

## Faculty

### Professors

- Joel E. Henry, Ph.D., Virginia Polytechnic Institute and State University, 1993 (Chairman)

### Associate Professors

- Jesse V. Johnson, Ph.D., University of Maine, Orono, 2002
- Yolanda J. Reimer, Ph.D., University of Oregon, 2002

### Assistant Professors

- Min Chen, Ph.D., Florida International University, Miami, 2007
- Doug Raiford, Ph.D., Wright State University, Dayton, Ohio, 2008
- Mike Rosulek, Ph.D., University of Illinois, Urbana-Champaign, 2009

### Research Professor

- Alden H. Wright, Ph.D., University Wisconsin, 1969

### Professors on Assignment

- Ray Ford, Ph.D., University of Pittsburgh, 1980

### Lecturer

- Mike O'Conner, M.S., The University of Montana, 1996

## College of Arts and Sciences

## Christopher M. Comer, Dean

The largest and most broadly based academic unit of the University, the College of Arts and Sciences fulfills the central purpose for which the University was chartered in 1893:

*"To provide the best and most efficient manner of imparting...a liberal education and thorough knowledge of the different branches of literature, science and the arts."*

A liberal education gives students the means to test ideas, beliefs and facts. It empowers them to a variety of academic disciplines that will broaden and deepen their perspectives and enable them as educated citizens to continue the learning process. It teaches them how to apply what they have learned. By studying the ways of thinking and expression that are intrinsic to the arts, humanities, and social and natural sciences, students are prepared in scientific methods, critical thinking, analysis, synthesis, and cogent expression, and are helped to develop intellectual skills, humanistic understanding and aesthetic appreciation. Such an education increases the usefulness of career planning and specialization by laying a foundation for lifelong values.

A particular strength of the College is the breadth of its disciplines and programs. This breadth makes possible a varied and flexible curriculum that advances both general programs and specialized education on the undergraduate and graduate levels. Another strength is the quality of the faculty. Its members have a distinguished record of teaching, publication, service to professional societies and national organizations, and participation in consulting, extension and outreach programs. Their commitment to undergraduate liberal education is demonstrated by the quality of the graduates the College has produced. The pre professional education received here has enabled The University of Montana graduates to compete successfully for admission to graduate schools across the nation. A third strength of the College is its commitment to students as they pursue their academic studies at the University. This is reflected in close student/faculty relationships and in the continuous attention given by the College to the effect that policies, procedures, programs, and faculty and administrative structures have on students' educational experience.

## Biology

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

The Division offers an undergraduate degree in biology that provides a solid foundation in core areas of the biological sciences and in supporting physical sciences and mathematics. Several options are provided within the biology degree. Options in cellular and molecular biology, ecology, field ecology, and organismal biology, and human biological sciences allow specialization in biological subdisciplines and are appropriate background for certain employment opportunities and for continued graduate or professional study:

**Cellular and molecular biology:** For students interested in the cellular and molecular aspects of biology. This option is also appropriate for students interested in medical school.

**Ecology and organismal biology:** For students interested in the biology of organisms (plants and animals), and populations. This option is also appropriate for students interested in veterinary school.

**Human biological sciences:** Provides a strong background in the biological sciences for students interested in pursuing further study in a health sciences professional program.

**Natural history:** Designed especially for students wishing to combine basic natural history and biological sciences with another field such as art, journalism, or creative writing. Option is not suitable for students planning a traditional career in the biological sciences.

**Teacher preparation in biology, Teacher preparation in general science:** Two separate options designed for students interested in a career teaching biology or broad-field science at the secondary level.

**High School Preparation:** In addition to general University admission requirements, chemistry, mathematics through precalculus, and a modern foreign language are recommended.

## Special Degree Requirements

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

**Upper-Division Writing Expectation:** To meet the Upper-Division Writing Expectations for the major, biology students must take two or three partial writing courses (either three 1/3 writing courses or one 2/3 writing course plus one 1/3 writing course). Courses that are approved as 2/3 partial writing include: BIOC 486, BIOL 341, MICB 404, and MICB 411. Courses that are approved as 1/3 partial writing include: BIOC 482, BIOC 499, BIOL 304, BIOL 306, BIOL 316, BIOL 366, BIOL 403, BIOL 406, BIOL 445, BIOL 499, MICB 410, MICB 412, and MICB 499.

## Option in Ecology and Organismal Biology

Forty-three credits in biology, biochemistry, and microbiology including BIOL 108N-109N, 110N, 221, 223, 340-341; one organismal course chosen from BIOL 301, 403, 435, 444-445; one course with a focus on a group of organisms chosen from BIOL 304, 306, 308, 316, 350, 400-401, 410, 418, MICB 300-301; one ecology course chosen from BIOL 366, 430, 442, 446, 447, 448, MICB 422, WBIO 470; one evolutionary biology course chosen from 405, 406, 480, 482, 484. Other recommended courses include BIOC 380 or 481-482, MICB 423.

Also required: M 162 (MATH 150) or M 171 (MATH 152); one semester of statistics STAT 216 (MATH 241) or a full year of statistics STAT 451-457; 452-458 (MATH 444-447, 445-448); one year of chemistry CHMY 121N, 123N-124N (CHEM 151N, 152N-154N) or two years of chemistry CHMY 141N, 143N, 221-222, 223-224 (CHEM 161N, 162N, 221-223, 222-224); PHYS 111N/113N, 112N/114N.

### **Option in Field Ecology**

Forty-three credits in biology and microbiology including BIOL 108N-109N, 110, 221, 223, 342 or 340/341. Major courses chosen from the Aquatic Emphasis, BIOL 451, 453, 454, 452, 492; or the Terrestrial Emphasis, BIOL 451, 458, 459, 452, 492. Choose an additional 8 credits of upper division BIOL or MICB, with at least one being from each category from BIOL 304, 306, 308, 316, 350, 400/401, 410, 418, MICB 300/301; or Evolutionary Biology, BIOL 405, 406, 480, 482 or 484. One of these classes must be an Upper Division Writing course. Other required courses are M 162, STAT 216 (MATH 150, MATH 241) or STAT 451/457 and STAT 452/458 (MATH 444/447 and MATH 445/448); CHMY 121N & 123N/124N (CHEM 151N and 152N/154N) or CHMY 141N, 143N 221-222 and 223-224 (CHEM 161N, 162N, 221/222 and 223/224); and PHYS 111N/113N, 112N/114N.

Students in Track A will also spend two summers at the Flathead Lake Biological Station

### **Option in Cellular and Molecular Biology**

Forty-four to forty-nine credits in biochemistry, biology and microbiology including BIOC 481-482; BIOL 108N-109N, 110N, 221, 223, 301, 340, and 464; MICB 300-301; one course chosen from MICB 410 or 420; one course chosen from BIOL 435, 440, 444-445, MICB 404, or 450; and two lab courses chosen from BIOC 486, MICB 405, 411, 451, or 497.

M 162 (MATH 150); CHMY 141N-143N, 221-222-223-224 (CHEM 161N-162N, 221-222-223-224); one course chosen from CHMY 311, 360, 373 (CHEM 341, 370, 371); PHYS 111N/113N, 112N/114N or PHYS 211N/213N, 212N/214N are also required.

### **Option in Human Biological Sciences**

Forty-two to forty-three credits in biology, biochemistry, and microbiology including BIOL 108N-109N, 110N, 221, 223, 301, 312, 313, 340-341, 460 or 464. MICB 300-301 (or MICB 302) and the remaining credits at the 300 or 400 level, including one writing course.

One year of chemistry CHMY 121N, 123N-124N (CHEM 151N, 152N-154N) or two years of chemistry CHMY 141N, 143N, 221-222-223-224 (CHEM 161N, 162N, 221-223-222-224); M 162 (MATH 150), STAT 216 (MATH 241); PHYS 111N/113N, 112N/114N or PHYS 211N/213N, 212N/214N; PSYX 110S, 230S or 340S (PSYC 100S, 240S or 330S) also are required.

Recommended Courses: Some graduate schools in the health professions also may require course work in these areas: BIOL 400, General Parasitology; BIOC 380 or 481, 482, Biochemistry; COMM 111A, Introduction to Public Speaking; HHP 236N, Nutrition; HHP 377-378, Physiology of Exercise and Laboratory; SOCI 101S (SOC 110S) Principles of Sociology.

### **Option in Natural History**

Forty-two to forty-four credits in biology including BIOL 108N-109N, 110N, 221, 223, 316, 340-341, 350, 410; one course chosen from 304, 306, or 356; one course chosen from 405 or 406.

CHMY 121N, 123N-124N (CHEM 151N-152N, 154N) and GEO 101N-102N (GEOS 100N-101N) are required. Students also must complete at least 20 credits in cognate areas of anthropology, chemistry (excluding CHMY 121N, 123N-124N (CHEM 151N-152N, 154N)), geography, geology (excluding GEO 101N-102N (GEOS 100N-101N)), forestry, mathematics, physics/astronomy, and wildlife biology. No more than 10 credits from any one of these areas can be applied toward the 20-credit requirement. Students interested in combining this option with another subject area may, with the advisor's permission, substitute 20 credits in English-writing, journalism, photography, art, foreign language, business management, or other appropriate field.

### **Teacher Preparation in Biology**

Option in Biological Education Major Teaching Field of Biology: This option is designed for students seeking an endorsement in the major teaching field of biology.

A student must complete thirty-four credits in biology and microbiology including BIOL108N-109N, 110N, 221, 223, 340-341, 444 & 445; MICB 300-301 and one course chosen from BIOL 301 or 435.

M 162 or M 171 (MATH 150 or 152) and STAT 216 (MATH 241) are required; CHMY 121N-123N, 124N, 485 (CHEM 151N-152N, 154N, 485); PHYS 111N/113N; C&I 426; and one course chosen from GEO109N or GEO 301 also are required.

For endorsement to teach biology, a student also must gain admission to Teacher Education and Student Teaching and meet all the requirements for certification as a secondary teacher (see the School of Education section of this catalog).

Biology qualifies for a single-field endorsement. However, there is a limited demand in most Montana high schools for teachers with a single endorsement in biology, and students are advised to complete the requirements for a second teaching endorsement (major or minor).

Minor Teaching Field of Biology: For an endorsement in the minor teaching field of biology, a student must complete BIOL 108N-109N, 110N, 221, 223; MICB 300-301; C&I 426; GEO 109N or GEO 301; M 162 or 171 (MATH 150 or 152), STAT 216 (MATH 241); and CHMY 121N-123N, 485 (CHEM 151N-152N, 485). A student also must gain admission to Teacher Education and Student Teaching and must meet the requirements for certification as a secondary teacher (see the School of Education section of this catalog).

### Teacher Preparation in General Science

Extended Major Teaching Field of General Science: A student is awarded a B.A. with a major in biology with an ecology option by completing the following 60 credits in astronomy, biology, chemistry, geology, mathematics and physics: ASTR 131N, 134N; BIOL 108N-109N, 110N, 221, 223, 340-341; CHMY 123N, 141N-143N, 485 (CHEM 152N, 161N-162N, 485); GEO 101N-102N, 301 (GEOS 100N-101N, 301); M 162 or 171 (MATH 150 or 152), STAT 216 (MATH 241 and PHYS 111N/113N, 112N/114N). C&I 426 also is required

Highly recommended are BIOL 435, MICB 300-301, and CHMY 101N (CHEM 101N).

For an endorsement in the extended major teaching field of General Science, a student must gain admission to Teacher Education and Student Teaching, complete C&I 426 and meet the requirement for certification as a secondary teacher (see the School of Education section of this catalog.)

### Suggested Course of Study

#### Biological Education Option

##### First Year

BIOL 108N-109N Diversity of Life and Laboratory	5	-
BIOL 110N Principles of Biology	-	4
CHMY 121N (CHEM 151N) Introduction to General Chemistry	3	-
CHMY 123N (CHEM 152N) Organic and Biochemistry	-	3
CHMY 124N (CHEM 154N) Intro to Organic and Biochemistry Laboratory	-	2
WRIT 101 (ENEX 101) College Writing I	3	-
M 162 (MATH 150) Applied Calculus	4	-
PSYX 100S (PSYC 100S) Introduction to Psychology	-	4
General Education	-	3
	15	16

##### Second Year

BIOL 221 Cell and Molecular Biology	4	-
BIOL 223 Genetics and Evolution	-	4
CHMY 485 (CHEM 485) Laboratory Safety	1	-
STAT 216 (MATH 241) Introduction to Statistics	4	-
MICB 300-301 General Microbiology & Laboratory	-	5
Lower-division writing course	-	3
General Education/Native American Studies Course	6	3
	15	15

##### Third Year

BIOL 340-341 Ecology and Laboratory	-	5
PHYS 111N/113N General Physics I	5	-
BIOL 444/445 Plant Physiology and Lab	-	4
C&I 200 Exploring Teaching	1	-
C&I 303 Educational Psychology and Measurement	3	-
C&I 306 Instructional Media and Computer Applications	3	-
C&I 410 Exceptionality and Classroom Management	3	-
HHP 233 Health Issues of Children and Adolescents	-	3
Elective	-	2
	15	14

##### Fourth Year

C&I 301 or 302 Field Experience	1	-
C&I 407E Ethics and Policy Issues	3	-
C&I 426 Teaching Science in the Middle and Secondary School	3	-

C&I 427 Literary Strategies in Content Areas	3 -
C&I 482 Student Teaching: Secondary	- 14
C&I 494 Professional Portfolio	- 1
BIOL 435 Comparative Animal Physiology	3 -
GEO 109N Environmental Geoscience (or GEO 301 Environmental Geology)	2 -
	15 15

### Cellular and Molecular Biology Option

#### First Year

BIOL 108N-109N Diversity of Life and Laboratory	5 -
BIOL 110N Principles of Biology	- 4
CHMY 141N-143N (CHEM 161N-162N) Introduction to General Chemistry	5 5
WRIT 101 (ENEX 101) College Writing I	- 3
M 162 (MATH 150) Applied Calculus	4 -
General Education	- 3
Elective	1 -
	15 15

#### Second Year

BIOL 221 Cell and Molecular Biology	4 -
BIOL 223 Genetics & Evolution	- 4
CHMY 221-222, 223-224 (CHEM 221-222, 223-224) Organic Chemistry and Laboratory	5 5
MICB 300-301 General Microbiology and Laboratory	- 5
Lower-division writing course	3 -
General Education	3 -
Elective	- 1
	15 15

#### Third Year

BIOC 481-482 Biochemistry	3 3
MICB 404 Microbial Genetics (or BIOL 345, 440, 444, 495; MICB 450)	- 3
MICB 405 Molecular Genetics Laboratory (or 405, 411, 451, 497, or BIOC 486)	- 1
PHYS 111N/113N, 112N/114N General Physics	5 5
General Education	3 3
Electives	4 -
	15 15

#### Fourth Year

BIOL 340 Ecology	- 3
BIOL 301 Developmental Biology	- 3
BIOL 464 Adv. Cell Biology	- 3
CHMY 311 (CHEM 341) Analytic Chemistry-Quantitative Analysis	4 -
MICB 410-411 Immunology and Laboratory	5 -
Upper-division elective	3 3
General Education	3 3
	15 15

### Ecology and Organismal Biology Option with One Year of Chemistry

#### First Year

BIOL 108N-109N Diversity of Life and Laboratory	5 -
BIOL 110N Principles of Biology	- 4
CHMY 121N (CHEM 151N) Introduction to General Chemistry	3 -
CHMY 123N (CHEM 152N) Introduction to Organic and Biochemistry	- 3
CHMY 124N (CHEM 154N) Introduction to Organic and Biochemistry Laboratory	- 2
WRIT 101 (ENEX 101) College Writing I	3 -
M 162 (MATH 150) Applied Calculus	4 -
General Education Requirement	- 3
Electives	- 3

	15 15
<b>Second Year</b>	
BIOL 221 Cell and Molecular Biology	4 -
BIOL 223 Genetics and Evolution	- 4
PHYS 111N/113N-112N/114N General Physics I, II	5 5
Lower-division writing course	3 -
Elective	3
General Education	3 6
	15 15

<b>Third Year</b>	
STAT 451/457 (MATH 444/447) Statistical Methods I and Comp. Lab	4 -
STAT 452/458 (MATH 445/448) Statistical Methods II and Comp. Lab	- 4
BIOL 340-341 Ecology and Laboratory	5 -
BIOL 306 Mammalogy (or BIOL 304, 308, 316, 350, 400/401, 410 and MICB 300/301)	4 -
BIOL 406 Behavior and Evolution (or BIOL 405, 480, 482, 484)	- 4
BIOL 446 Wildlife Physiological Ecology (or BIOL 366, 430, 442, 447, 448, MICB 422, or WBIO 470)	- 3
General Education Requirement	- 3
Electives	3 -
	16 14

<b>Fourth Year</b>	
BIOL 316 Plant Form and Function (or UD BIOL elective)	- 5
BIOL 403 Vertebrate Design and Evolution (or BIOL 301, 435, 444/445)	5 -
Upper-division elective	5 -
General Education Requirement	3 3
Electives	1 8
	14 16

**Ecology and Organismal Biology Option with Two Years of Chemistry**

<b>First Year</b>		<b>A S</b>
BIOL 108N-109N Diversity of Life and Laboratory	5 -	
BIOL 110N Principles of Biology	- 4	
CHMY 141N (CHEM 161N) College Chemistry	5 -	
CHMY 143N (CHEM 162N) College Chemistry Laboratory	- 5	
WRIT 101 (ENEX 101) College Writing I	- 3	
M 162 (MATH 150) Applied Calculus	4 -	
STAT 216 (MATH 241) Statistics	- 4	
	14 16	

<b>Second Year</b>		<b>A S</b>
BIOL 221 Cell and Molecular Biology	4 -	
BIOL 223 Genetics & Evolution	- 4	
CHMY 221-222-223-224 (CHEM 221-222-223-224) Organic Chemistry and Laboratory	5 5	
Writing course	3 -	
General Education	3 6	
	15 15	

<b>Third Year</b>		<b>A S</b>
BIOC 481-482 Biochemistry I and II	3 -	
BIOL 301 Developmental Biology(or BIOL 345, 403, 444/445)	- 3	
BIOL 340-341 Ecology and Laboratory	5 -	
PHYS 111N/113N, 112N/114N General Physics I, II	5 5	
General Education	- 3	
Elective	2 -	
Upper-division electives	- 4	
	15 15	

<b>Fourth Year</b>		<b>A S</b>
BIOL 405 Animal Behavior (or BIOL 406, 480,482, 484)	- 5	

BIOL 448 Terrestrial Plant Ecology (or BIOL 366, 430, 446, 447, 495, MICB 422, WBIO 470)	4	-
MICB 300/301 General Microbiology & Lab (or BIOL 304, 306, 308, 316, 350, 400/401, 410, 418)	-	5
General Education Requirement	6	-
Upper-division elective	4	5
Elective	1	1
	15	15

### Ecology Option for Teacher Preparation in General Science

#### First Year

BIOL 108N-109N Diversity of Life and Laboratory	5	-
BIOL 110N Principles of Biology	-	4
CHMY 141N-143N (CHEM 161N-162N) College Chemistry	5	5
WRIT 101 (ENEX 101) College Writing I	-	3
M 162 (MATH 150) Applied Calculus	4	-
PSYX 100S (PSYC 100S) Introduction to Psychology	-	4
	14	16

#### Second Year

ASTR 131N, 134N Elementary Astronomy and Laboratory	4	-
BIOL 221 Cell and Molecular Biology	4	-
BIOL 223 Genetics and Evolution	-	4
CHMY 123N (CHEM 152N) Introduction to Organic and Biochemistry	-	3
GEO 101N-102N (GEOL 100N-101N) Introduction to Physical Geology	-	3
STAT 216 (MATH 241) Statistics	4	-
General Education/Native American Studies course	-	3
Lower-division writing course	3	-
Elective	-	1
	15	14

#### Third Year

CHMY 485 (CHEM 485) Laboratory Safety	1	-
C&I 200 Exploring Teaching	-	1
C&I 303 Educational Psychology and Measurement	-	3
C&I 306 Instructional Media and Computer Applications	-	3
C&I 410 Exceptionality and Classroom Management	-	3
GEO 301 (GEOS 301) Environmental Geology	3	-
PHYS 111N/113N-112N/114N General Physics I, II	5	5
General Education	6	-
	15	15

#### Fourth Year

BIOL 340-341 Ecology and Laboratory	5	-
C&I 301 or 302 Field Experience	1	-
C&I 407E Ethics and Policy Issues	3	-
C&I 426 Teaching Science in the Middle and Secondary School	3	-
C&I 427 Literary Strategies in Content Areas	3	-
HHP 233 Health Issues of Children and Adolescents	-	3
Upper-division biology writing course	-	4
General Education	-	3
Electives	-	5
	15	15

#### Fifth Year

		<b>A</b>
C&I 482 Student Teaching: Secondary	14	
C&I 494 Professional Portfolio	1	

### Field Ecology Option (Track A, two summers)

#### First Year

		<b>A S</b>
BIOL 108N Diversity of Life	3	-



BIOL 109N Diversity of Life Lab	2	-
CHMY 121N (CHEM 151N) Introduction to General Chemistry	3	-
M 162 (MATH 150) Applied Calculus	3	-
WRIT 101 (ENEX 101) College Writing I	3	-
Elective	1	1
BIOL 110N Principles of Biology	-	4
CHMY 123N (CHEM 152N) Introduction to Organic and Biochemistry	-	3
CHMY 124N (CHEM 154N) Introduction to Organic and Biochemistry Lab	-	2
General Education Requirement	-	3
Lower Division Writing Requirement	-	3
	16	16

**Second Year**

BIOL 221 Cell and Molecular Biology	4	-
STAT 451/457 (MATH 444/447) Statistical Methods/Computer Analysis	4	-
General Education Requirement	3	-
Electives	5	-
BIOL 223 Genetics and Evolution	-	4
STAT 452/458 (MATH 445/448) Statistical Methods/Computer Analysis	-	4
General Education Requirement	-	6
Elective	-	2
	16	16

**Third Year**

**Summer (at Biological Station)**

BIOL 342 Field Ecology and Lab	5	
Upper Division Electives	5	10
BIOL 484 Planet Evolution	3	
PHYS 111N (PHYS 121N) Fundamentals of Physics I	5	-
General Education Requirement	6	-
Electives	2	-
BIOL 316 Plant Form & Function	-	5
PHYS 112N (PHYS 122N) Fundamentals of Physics II	-	5
Electives	-	7
	16	17

**Summer (at Biological Station)**

BIOL 451 Landscape Ecology of Mntn Ecosystems	3	
BIOL 458 Ecology of Forests & Grasslands	3	
BIOL 459 Alpine Ecology	3	
BIOL 452 Conservation Biology & Ecology	3	
BIOL 492 Seminars in Ecology & Resource Management	1	
	13	

**Field Ecology Option (Track B one summer)**

**First Year**

**A S**

BIOL 108N Diversity of Life	3	-
BIOL 109N Diversity of Life Lab	2	-
CHMY 141N (CHEM 161N) College Chemistry I	5	-
M 162 (MATH 150) Applied Calculus	4	-
Elective	1	-
BIOL 110N Principles of Biology	-	4
CHMY 143N (CHEM 162N) College Chemistry II	-	5
WRIT 101 (ENEX 101) College Writing I	-	3
General Education Requirement	-	3
	15	15

**Second Year**

BIOL 221 Cell and Molecular Biology	4	-
-------------------------------------	---	---

CHMY 221/222 (CHEM 221/222) Organic Chemistry I & Lab	5	-
STAT 216 (MATH 241) Introduction to Statistics	4	-
Lower Division Writing Requirement	3	-
BIOL 223 Genetics and Evolution	-	4
CHMY 222/224 (CHEM 222/224) Organic Chemistry II & Lab	-	5
General Education	-	6
	16	15

### Third Year

BIOL 340/341 Ecology and Lab	5	-
PHYS 111N/113N Fundamentals of Physics I	5	
Electives	2	-
PHYS 112N/114N (PHYS 122N) Fundamentals of Physics II	-	5
General Education Requirements	-	6
Electives	-	1
	12	12

### Summer Semester at Flathead Lake Biological Station

BIOL 451 Landscape Ecology	3	
BIOL 453 Lake Ecology	3	
BIOL 454 Stream Ecology	3	
BIOL 452 Conservation Ecology	3	
BIOL 492 Seminar in Ecology & Res. Management	1	
	13	

### Fourth Year

BIOL 308 Biology and Management of Fishes	4	-
Upper Division electives	8	-
BIOL 406 Behavior and Evolution	-	4
Upper-division elective	-	5
General Education	-	3
	12	12

## Human Biological Sciences Option with Two Years of Chemistry

### First Year

BIOL 108N-109N Diversity of Life and Laboratory	5	-
BIOL 110N Principles of Biology	-	4
CHMY 141N-143N (CHEM 161N-162N) College Chemistry	5	5
WRIT 101 (ENEX 101) College Writing I	-	3
M 162 (MATH 150) Applied Calculus	4	-
PSYX 100S (PSYC 100S) Introduction to Psychology	-	4
	14	16

### Second Year

BIOL 221 Cell and Molecular Biology	4	-
BIOL 223 Genetics and Evolution	-	4
CHMY 221-222-223-224 (CHEM 221-222-223-224) Organic Chemistry and Laboratory	5	5
MICB 300-301 General Microbiology and Laboratory	-	5
Lower-division writing course	3	-
STAT 216 (MATH 241) Introduction to Statistics	4	-
	16	14

### Third Year

BIOL 312, 313 Anatomy and Physiology I and II	4	4
BIOL 301 Developmental Biology	-	3
PHYS 111N/113N-112N/114N General Physics I, II	5	5
PSYX 340S (PSYC 330S) Abnormal Psychology or PSYX 230S (PSYC 240S) (if PSYC 230S OR PSYC 240S, must have 3 more upper-division credits)	-	3
Upper-division elective	3	-
General Education	3	-

**Fourth Year**

BIOL 340-341 Ecology and Laboratory	-	5
BIOL 464 Adv. Cell Biology	-	3
MICB 410 Immunology or other upper-division biology or microbiology elective that meets the biology Writing requirement	3	-
General Education	6	3
Elective	-	4
Upper-division elective	6	-
	15	15

**Natural History Option****First Year**

BIOL 108N -109N Diversity of Life and Laboratory	5	-
BIOL 110N Principles of Biology	-	4
CHMY 121N (CHEM 151N) Introduction to General Chemistry	3	-
CHMY 123N (CHEM 152N) Introduction to Organic and Biochemistry	-	3
CHMY 124N (CHEM 154N) Introduction to Organic and Biochemistry Laboratory	-	2
WRIT 101 (ENEX 101) College Writing I	3	-
M 115 (MATH 117) Probability and Linear Mathematics	3	-
General Education	-	6
Elective	1	-
	15	15

**Second Year**

BIOL 221 Cell and Molecular Biology	4	-
BIOL 223 Genetics & Evolution	-	4
BIOL 350 Rocky Mountain Flora	-	3
GEO 101N-102N (GEOL 100N-101N) Introduction to Physical Geology and Laboratory	3	-
Lower-division writing course	3	-
General Education	-	3
Modern/Classic Language	5	5
	15	15

**Third Year**

BIOL 340 Ecology	3	-
BIOL 341 Ecology Laboratory	2	-
BIOL 316 Plant Form and Function	-	5
Cognate course	3	4
Upper-division cognate course	-	7
General Education	6	-
	14	16

**Fourth Year**

BIOL 306 Mammalogy or 304, 356	4	-
BIOL 406 Behavior and Evolution or 405	-	4
BIOL 410 Insect Biology	-	4
Cognate course	3	-
Upper-division electives	3	4
General Education	3	-
Electives	2	3
	15	15

**Requirements for a Minor**

To earn a minor in biology, the student must complete a minimum of 25 credits in biology including BIOL 108N-109N, 110N, 221 and 223 and 8 credits in Biology at the 300-400 level. All courses must be taken for a traditional letter grade.

**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.

## **Biology (BIOL)**

**U 100N The Science of Life 3 cr.** Offered every term. Contemporary exploration of the organization and complexity of living organisms and the systems in which they live. The central question of biology--relationship between form and function, acquisition and use of energy, and continuity between generations will be addressed through lectures and laboratory investigations. Credit not allowed toward a major in biology. Credit not allowed for both BIOL 100N and 110N.

**U 106N Elementary Medical Microbiology 3 cr.** Offered spring. Infectious diseases, including concepts of virulence, resistance, prevention and control of microbial diseases in the individual and in the community. If laboratory experience is desired, the student may enroll concurrently in BIOL 107. Credit not allowed toward a major in microbiology.

**U 107 Elementary Microbiology Laboratory 1 cr.** Offered spring. Prereq. or coreq., BIOL 106N. Same as MICB 107. Observation of live microorganisms, their characteristics and activities. Experience with microbiological techniques. Credit not allowed toward a major in microbiology.

**U 108N Diversity of Life 3 cr.** Offered autumn and summer. Survey of the diversity, evolution and ecology of life including prokaryotes, viruses, protista, fungi, plants and animals.

**U 109N Diversity of Life Laboratory 2 cr.** Offered autumn and summer. Coreq., BIOL 108N. The diversity of life including prokaryotes, viruses, protista, fungi, plants and animals including structure and evolutionary relationships.

**U 110N Principles of Biology 4 cr.** Offered spring and summer. Unifying principles of biological structure-function relationships at different levels of organization and complexity. Consideration of reproduction, genetics, development, evolution, ecosystems, as well as the inter-relationships of the human species to the rest of life. Lab experiences illustrate biological principles underlying growth, reproduction, development, genetics and physiology. Credit not allowed for both BIOL 100N and 110N.

**U 112 Introduction to Human Form and Function I 3cr.** Offered autumn. Explores the fundamentals of structure and function at basic cellular and tissue levels, in addition to the anatomy and physiology of the integumentary, musculoskeletal, and nervous systems.

**U 113 Introduction to Human Form and Function II 3 cr.** Offered spring. Explores the fundamental structures and functions of the endocrine, cardiovascular, respiratory, digestive, urinary and reproductive systems.

**U 120N General Botany 3 cr.** Offered spring. Prereq., consent of instr. Introduction to the plant kingdom including anatomy, physiology and ecology.

**U 121N Introductory Ecology 3 cr.** Offered autumn. An introduction to ecological principles, stressing the structure and function of natural communities and examining human's role in these ecosystems.

**U 130N Evolution and Society 3 cr.** Offered spring. A focus on relationships between evolutionary biology and important social issues, including the evolution of drug-resistant diseases, the construction and use of genetically-modified organism, human evolutionary biology, and experimental laboratory evolution.

**U 135N Biology of Yellowstone Hot Springs. 3 cr.** Offered autumn. A field and laboratory based exploration of the microbial diversity of the thermal features of our first national park. Topics to be discussed include how these communities are shaped by the physical and chemical conditions of the environment and how microorganisms can thrive at life's extremes. Includes a field trip to Yellowstone National Park.

**U 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 198 Internship Variable cr.** Offered intermittently. Prereq., consent of Division. Extended classroom experience that provides practical application of learning during placement 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 201N Montana Wildlife 3 cr.** Offered autumn. Prereq., one course in biology. Interpreting biological patterns associated with selected Montana wildlife species, including mammals, birds, reptiles and amphibians.

**U 221 Cell and Molecular Biology 4 cr.** Offered autumn. Prereq., BIOL 110N or equiv. and one year of college chemistry. Description and analysis of biological structures and processes at the cellular and subcellular levels including molecular genetics, energy, metabolism and cell differentiation.

**U 223 Genetics and Evolution 4 cr.** Offered spring. Prereq., BIOL 221. Principles and mechanisms of inheritance and evolution. Population genetics, fossil record, macroevolution, speciation, extinction, systematics, molecular evolution.

**U 240 Introduction to Biostatistics (Honors) 3 cr.** Offered autumn even-numbered years. Prereq., calculus and consent of instr. Same as WBIO 240. Introduction to statistical ecology: distributions, hypothesis testing, and fitting models to data with emphasis on problems in

ecological sampling.

**U 265 Human Sexuality 3 cr.** Offered autumn. Same as ANTH 201. Biological, behavioral, cross-cultural aspects of human sexuality to help students place their own sexuality and that of others in a broader perspective. Includes sexual anatomy, physiology, development, reproduction, diseases, determination, as well as gender development and current issues.

**U 295 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 298 Internship Variable cr.** Offered intermittently. Prereq., consent of Division. Extended classroom experience that provides practical application of learning during placement 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 301 Developmental Biology 3 cr.** Offered spring. Prereq., BIOL 221; BIOL 223 recommended. An analysis of the origin and development of form and patterns in organisms, stressing the processes of growth and differentiation in plants and animals. Graded traditional letter grade only.

**UG 304 Ornithology 4 cr.** Offered spring. Prereq., BIOL 108N, 109N and 223. The classification, structure, evolution, behavior and ecology of birds.

**UG 306 Mammalogy 4 cr.** Offered autumn. Prereq., BIOL 108N, 109N and 223. The evolution, systematics, anatomy, physiology and ecology of mammals.

**UG 308 Biology and Management of Fishes 4 cr.** Offered autumn. Prereq., BIOL 108N, 109N, 223 and one year of college mathematics. Diversity, adaptations and ecology of fishes. Analysis and management of fish populations and communities.

**U 312 Anatomy and Physiology I 4 cr.** Offered autumn. Prereq. or coreq., CHMY 121N (CHEM 151N) or CHMY 141N (CHEM 161N); BIOL 110N or BIOL 112 or BIOL 113. Introduction to basic cellular structure and function. The fundamental facts and concepts of the anatomy and physiology of the integumentary, musculoskeletal, nervous and endocrine systems.

**U 313 Anatomy and Physiology II 4 cr.** Offered spring. Prereq., BIOL 312. The fundamental facts and concepts of the anatomy and physiology of the endocrine, circulatory, respiratory, digestive, urinary and reproductive systems.

**UG 315 Peer Advising 1 cr.** (R-6) Offered every term. Prereq., consent of instr. Supervised training and internship for peer advisors who will gain knowledge and ability to communicate degree requirements and relate the various degree offerings to professional and career goals. No more than two credits are allowed toward upper-division major requirements.

**U 316 Plant Form and Function 5 cr.** Offered spring. Prereq., BIOL 108N-109N, 221. Prereq. or coreq., BIOL 223. Anatomy, morphology, ecology and physiology of photosynthetic organisms.

**U 339 Listening to Ecology 2 cr.** Offered autumn. Preparatory readings and attendance at seminars on a wide variety of ecological and wildlife management topics followed by critiques.

**UG 340 Ecology 3 cr.** Offered autumn and spring. Prereq., BIOL 223 and one year of college mathematics including STAT 216 (MATH 241) or equiv. Analysis of the distribution and abundance of plants and animals. Includes individual, population and community-level processes (e.g., population growth and regulation, competition, predation, succession, nutrient cycling, energy flow and community organization).

**UG 341 Ecology Laboratory 2 cr.** Offered autumn and spring. Coreq., BIOL 340. Methods of describing and testing alternative explanations for patterns in nature. The use of scientific methodology in ecology.

**U 342 Field Ecology 5 cr.** Offered summers only at Flathead Lake Biological Station. Prereq., BIOL 223 and one year of college math, including statistics. The principles and practices of the study of animals and plants in their natural environments, including human influences, with focus on the Crown of the Continent area of the Rock Mountains and taught entirely outdoors.

**U 343 Ecological Methods and Analysis 5 cr.** Offered summers only at Flathead Lake Biological Station. Prereq., BIOL 342 or BIOL 340/341. The methods and tools for conducting observational and experimental research in field ecology with emphasis on experimental design, hypothesis testing, data gathering and analysis and presentation of scientific research in ecology.

**U 347 Introduction to Neuroscience 3 cr.** Offered autumn. Prereq., introductory chemistry and biology. Same as BMED 347. The molecular and cellular physiology of the human nervous system. Topics range from the basis of electrical and chemical signaling in neurons to the organization of the nervous system and its functions in generating behavior.

**U 350 Rocky Mountain Flora 3 cr.** Offered spring. Prereq., one college-level course in BIOL or consent of instr. Elements of the evolution, geography and natural affinities of flowering plants. Identification using a manual of native plants of Montana.

**UG 356 Ecology of Birds 4 cr.** Prereq., BIOL 223 or equiv. Offered summers only at Flathead Lake Biological Station. The identification, natural history, and behavior of western Montana birds.

**UG 366 Freshwater Ecology 5 cr.** Offered autumn. Prereq., BIOL 108N, 109N and one year of college chemistry. Physical and chemical dynamics of lakes and streams. Diversity, distribution and dynamics of freshwater organisms.

**U 395 Special Topics Variable cr.** (R-10) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.

**U 397 Research 1-10 cr.** (R-10) Offered every term. Prereq., consent of instr. Independent research under the direction of a faculty member. Graded credit/no credit.

**U 398 Internship 1-6 cr.** Offered intermittently. Prereq., consent of the Division. Extended classroom experience that provides practical application of learning during placement 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 400 General Parasitology 2 cr.** Offered autumn. Prereq., BIOL 223. Same as MICB 400. Parasitism as a biological phenomenon, origin of parasitism, adaptations and life cycles, parasite morphology, fine structure, physiology, parasites and their environment.

**UG 401 General Parasitology Laboratory 2 cr.** Offered autumn. Coreq., BIOL 400. Same as MICB 401. Taxonomy, morphology and identification of parasitic protozoa, helminths and arthropods.

**UG 403 Vertebrate Design and Evolution 5 cr.** Offered autumn. Prereq., BIOL 108N, 109N and 223 and PHYS 111N/113N or 211N/213N. Evolutionary patterns of animal morphology and the importance of body size on life history patterns. Phylogenetic study of major extant and extinct vertebrate groups. Laboratory includes systematic study of organ systems and workshops in experimental functional morphology.

**UG 405 Animal Behavior 3 cr.** Offered spring alternate years. Prereq., BIOL 223, senior standing or consent of instr. The description and evolutionary interpretation of animal behavior under natural conditions. Laboratory involves observation and recording of animal behavior.

**UG 406 Behavior and Evolution 4 cr.** Offered spring. Prereq., BIOL 223. Diversity of animal behavior in an evolutionary context including inheritance of behavior, diets, avoidance responses, mating systems and sexual selection, parental care, and evolution of animal groups and societies. Discussion sections examine both landmark and recent literature.

**UG 407 Global Biogeochemical Cycles 3 cr.** Offered spring odd numbered years. Same as FOR 408, GEO/CCS 407. Exploration of how variations in the availability or utilization of critical Earth elements influences the atmosphere, the oceans, and the terrestrial biosphere including the natural and agricultural ecosystems on which we depend.

**UG 408 Advanced Fisheries Science 2 cr.** Offered spring. Prereq., BIOL 308. Quantitative analysis and interpretation of fish population and community data for use in management. Selection, application and evaluation of management techniques.

**UG 410 Insect Biology 4 cr.** Offered spring. Prereq., BIOL 108N, 109N and 223. The classification, morphology, anatomy, development, life-history, behavior and ecology of insects. Labs include identification of major insect groups, internal and external anatomy and student collections.

**UG 415 Field Methods in Fisheries Biology and Management 1-4 cr.** Offered autumn. Prereq., BIOL 308; Consent of instr. Same as WBIO 441. Field instruction by practicing biologists in techniques for evaluating and managing aquatic habitats and fish populations.

**UG 418 Fungal Biology 3 cr.** Offered autumn even-numbered years. Prereq., BIOL 108N-109N and 221-223 or MICB 300 or consent of instr. Same as MICB 418. Reviews the definition, evolution, genetics, physiology, and ecology of fungi (including organisms in the Chromista), provides overview of all fungal phyla (Chytridiomycota, Zygomycota, Ascomycota, Basidiomycota, Hyphochytriomycota, Labyrinthulomycota, Oomycota), and highlights the importance of fungi to human affairs (food production, fungal pathogens).

**UG 430 Plant Biogeography 3 cr.** Prereq., consent of instr. Offered alternate years. Description of the distribution of plants and animals at global, continental and regional scales. Analysis of ecological and historical factors influencing distribution and association.

**UG 435 Comparative Animal Physiology 3 cr.** Offered autumn. Prereq., BIOL 221 or equivalent. Animal physiology with emphasis on diversity of functional processes, with strong links to broader ecological and evolutionary contexts.

**UG 440 Biological Electron Microscopy 2 cr.** Offered spring. Prereq., senior standing or consent of instr. Theory of electron microscopy, recent developments in transmission and scanning electron microscopy. Limited experience with the instruments.

**UG 442 Ecology of Infectious Diseases 3 cr.** Offered autumn (even-numbered years). Prereq., BIOL 223, 340. Introduction to the field of disease ecology, focusing on diversity of parasites, parasite population biology and causes and consequences of host-parasite interactions.

**UG 444 Plant Physiology 3 cr.** Offered spring. Prereq., BIOL 108N-109N, 120N or 316. The chemical and physical basis of water relations, photosynthesis, mineral nutrition, respiration, vegetative and reproductive growth of plants.

**UG 445 Plant Physiology Lab 1 cr.** Offered spring. Prereq or coreq., BIOL 444. Laboratory exercises designed to familiarize students with concepts and techniques in plant physiology.

**UG 446 Wildlife Physiological Ecology 3 cr.** Offered spring. Same as WBIO 446. Prereq., BIOL 221, 223 and 340. How physiological and biochemical processes in animals influence behavior and ecology. Application of physiological approaches to wildlife conservation such as assessment of animal health, nutritional condition, and physiological performance.

**UG 447 Terrestrial Ecosystem Ecology 3 cr.** Offered autumn odd-numbered years. Prereq., BIOL 110N and any ecology-themed course or consent of instr. Same as MICB 447. Introduction to systems thinking and the ecosystem concept, review of water and energy balance, carbon cycling and production processes, nutrient cycling, trophic dynamics, and species effects on ecosystem functioning.

**UG 448 Terrestrial Plant Ecology 4 cr.** Offered autumn. Prereq., an introductory college course in ecology. The interrelationships between plants and plant communities and their natural environment.

**UG 449 Plant-Animal Interactions 4 cr.** Offered summers only at Flathead Lake Biological Station. Prereq., a college course in ecology. Concepts and techniques for understanding the interdependent relationships between plants and animals. Emphasis given to ecological and behavioral studies.

**UG 451 Landscape Ecology 3 cr.** Offered summers only at Flathead Lake Biological Station. Prereq., BIOL 342 or 340/341. Biophysical processes that determine landscape and ecosystem structure and function using remote sensing tools, geographic information systems and dynamic models to demonstrate landscape change.

**UG 452 Conservation Ecology 3 cr.** Offered summers only at Flathead Lake Biological Station. Prereq., BIOL 342 or 340/341. Concepts and approaches for sustaining biodiversity and other natural goods and services provided by terrestrial and aquatic systems.

**UG 453 Lake Ecology 3 cr.** Offered summers only at Flathead Lake Biological Station. Prereq., BIOL 342 or 340/341, CHMY 121N (CHEM 151N) and CHMY 123N (CHEM 152N). The physical, chemical and biological characteristics of lake ecosystems with an emphasis on nutrient cycling, food web interactions and water quality.

**UG 454 Stream Ecology 3 cr.** Offered summers only at Flathead Lake Biological Station. Prereq., BIOL 342 or 340/341, CHMY 121N (CHEM 151N). The biota and biogeochemical processes of running waters with unifying principles and contemporary research approaches.

**UG 458 Ecology of Forests and Grasslands 3 cr.** Offered summers only at Flathead Lake Biological Station. Prereq., BIOL 342 or 340/341. Patterns and processes of the forests and grasslands of the northern Rocky Mountains in the context of principles of population community and ecosystem ecology.

**UG 459 Alpine Ecology 3 cr.** Offered summers only at Flathead Lake Biological Station. Prereq., BIOL 342 or 340/341. Distribution, abundance and life cycles of plants and animals and their unique ecophysiological adaptations to life in the rigorous environments of the high mountains above the timberline, with emphasis on the Crown of the Continent area.

**UG 460 Medical Physiology 3 cr.** Offered spring. Prereq., C (2.00) or better in BIOL 312, 313, one year college chemistry or consent of instr. An advanced course in human physiology for students preparing for careers in health care.

**UG 464 Advanced Cellular Biology 3 cr.** Offered spring. Prereq., BIOL 221 and BIOL 223; BIOC 380 strongly recommended. Cell structure and function, cell cycle, cellular signaling, molecular basis of cancer, regulated cell death, membrane transport, organelle dynamics, cytoskeleton, cell adhesion, and the molecular basis of learning and memory.

**U 471 Teaching Anatomy and Physiology I 3 or 4 cr.** Offered autumn. Prereq., "A" or "B" in BIOL 312 and 313 or equiv. and consent of instr. This select group of students performs cadaver dissections; assists in preparation and grading of demonstrations and laboratory teaching materials; and provides laboratory anatomy and physiology instruction to undergraduate students enrolled in BIOL 312. Students enrolling for the 4 credit option will also provide occasional comparable assistance for BIOL 112.

**U 472 Teaching Anatomy and Physiology II 3 or 4 cr.** Offered spring. Prereq., "A" or "B" in BIOL 312 and 313 or equiv. and consent of instr. This select group of students performs cadaver dissections; assists in the preparation and grading of demonstrations and laboratory teaching materials; and provides laboratory anatomy and physiology instruction to undergraduate students enrolled in BIOL 313. Students enrolling for the 4 credit option will also provide occasional comparable assistance for BIOL 113.

**UG 480 Conservation Genetics 3 cr.** Offered autumn. Prereq., BIOL 223. Genetic basis for solving biological problems in conservation including the genetics of small populations, the application of molecular genetic techniques to conservation biology and case studies of the application of genetics to conservation problems.

**UG 482 Evolution and Development 3 cr.** Offered spring, alternate years. Prereq., BIOL 108N and 223. Lecture, reading and discussion of questions at the intersection of developmental and evolutionary biology. Questions include but are not restricted to: how novel traits arise; how diversity in animal form is generated; and how phenotypic plasticity (environment-sensitive expression of traits) is produced.

**UG 484 Plant Evolution 3 cr.** Offered fall, alternate years. Prereq., BIOL 223. Lecture, reading and discussion on the evolutionary processes that shape major patterns of plant diversity. Topics include but are not restricted to: local adaptation, floral and mating system evolution, polyploidy, genome evolution, and speciation.

**UG 486 Field Techniques in Mammalogy 2 cr.** Offered autumn. Prereq., BIOL 306 or equiv. and consent of instr. A "hands-on" approach to lab and field techniques employed for the study of mammals. Includes mark/recapture live trapping methods, remote cameras,

and tracking plates of non-invasive censusing.

**UG 492 Seminars in Ecology and Resource Management 1 cr.** Offered summers only at Flathead Lake Biological Station. Prereq., BIOL 342 or 340/341 or taken concurrently with BIOL 342. Seminar course that meets weekly for 2 hours in the evening. Includes seminar speaker and discussion.

**U 493 Omnibus 1-10 cr.** Offered intermittently. Prereq., consent of instr. Independent work under the University omnibus option. See index.

**UG 494 Seminar in Biology 1 cr.** (R-3) Offered intermittently. Prereq., consent of instr.

**UG 495 Special Topics Variable cr.** (R-10) Offered intermittently. Prereq., consent of instr. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.

**UG 497 Advanced Undergraduate Research 1-10 cr.** (R-10) Offered every term. Prereq., junior or senior standing and consent of instr. Independent research under the direction of a faculty member. Graded credit/no credit.

**U 498 Internship 1-6 cr.** Offered intermittently. Prereq., consent of the Division. Extended classroom experience that provides practical application of learning during placement 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 Undergraduate Thesis 3-6 cr.** (R-6) Offered every term. Prereq., senior standing and consent of instr. Preparation of a thesis or manuscript based on undergraduate research for presentation and/or publication. Student must give oral or poster presentation at the Biological Sciences Undergraduate Research Symposium or a scientific meeting. Graded credit/no credit

**G 501 Graduate Issues and Policies 1 cr.** Prereq., graduate standing in biological sciences. Discussion of issues of importance to new graduate students, including the philosophy of graduate education, the mentor-student relationship, the role of the teaching assistant, handling ethical quandaries, library resources and bibliographic searches, animal use policies and issues, proposal writing and the publication process. Review of ongoing research by faculty in the organismal biology and ecology program.

**G 510 Avian Ecology 3 cr.** (R-6) Offered intermittently. Prereq., graduate standing in EVST, BIOL, WBIO; upper-division course in ecology; or consent of instr. Review of recent developments in avian ecology with special emphasis on scientific methodology.

**G 513 Community Ecology 3 cr.** Offered alternate years. Prereq., BIOL 340 or equiv., consent of instr. Current concepts of species interactions, succession, food webs, temporal and spatial patterns and quantitative characterization of community structure.

**G 517 Advanced Plant Ecology 3 cr.** Prereq., upper-division course in ecology or consent of instr. Offered alternate years. Review and discussion of recent advances in plant ecology.

**G 518 Plant-Consumer Interactions 3 cr.** Offered alternate years. Prereq. BIOL 340 or equiv. Ecology and evolution of plant-consumer interactions. Review of classic and contemporary literature on plant-consumer interactions.

**G 519 Fire Ecology 3 cr.** Offered autumn even-numbered years. Prereq., graduate standing or consent of instr. Review of fundamental principles and recent advances in fire ecology with the primary focus on biological effects.

**G 522 Readings in Morphology, Physiology and Ecology 1 cr.** (R-8) Prereq., graduate standing and consent of instr. Review and discussion of current literature in the fields of morphology, physiology, and ecology.

**G 524 Physiological Plant Ecology 3 cr.** Offered alternate years. Prereq., BIOL 340 and 444. The physiological basis of plant adaptation and response to the environment.

**G 526 Current Trends in Plant Ecology 2 cr.** (R-16) Prereq., graduate standing. Current concepts, theory, and experiments in plant ecology.

**G 530 Advanced Topics in Physiology 1-4 cr.** (R-8) Prereq., consent of instr. Offered alternate years. Topics vary but emphasize aspects of comparative or environmental physiology of animals and/or plants.

**G 541 Electron Microscopy Laboratory Variable cr.** (R-6) Prereq. or coreq., BIOL 440 or equiv. Practical laboratory experience in the preparation of various biological materials, hands-on operation of the transmission electron microscope.

**G 551 Environmental Field Study 1-3 cr.** (R-3) Prereq. or coreq., BIOL 550 or EVST 540 or 560. Same as EVST 551. Designing, executing, and interpreting environmental studies. Project oriented.

**G 561 Population Genetics Seminar 1-2 cr.** (R-12) Prereq., consent of instr. or graduate standing. Current topics in population genetics, evolutionary biology, molecular evolution and related topics.

**G 575 Frontiers in Conservation Research 2 cr.** (R-6) Same as WBIO 575. Exploration of current topics in conservation biology.



**G 594 Seminar in Biology 1 cr.** (R-6) Prereq., graduate standing or consent of instr. A review and discussion of current research in biology. Topics vary.

**G 595 Special Topics 1-8 cr.** (R-8) Prereq., graduate standing and consent of instr. Experimental offering of new courses by resident or visiting faculty.

**G 596 Independent Study 1-8 cr.** (R-8) Prereq., consent of instr. Credit for independent research project unrelated to thesis or dissertation.

**G 597 Research 1-8 cr.** (R-12) Prereq., consent of instr. Library work involved with preparation of a thesis or dissertation proposal.

**G 598 Internship 1-8 cr.** (R-8) Prereq., consent of the Division, graduate standing. Extended classroom experience that provides practical application of learning during placement off campus. Prior approval must be obtained from the faculty supervisor and the Internship Services office.

**G 599 Thesis 1-10 cr.** (R-10) Prereq., masters student in biology. Field and laboratory research on, and writing of, a student's master's thesis.

**G 699 Dissertation 1-10 cr.** (R-20) Prereq., doctoral student in biology. Credit for field and laboratory research on, and writing of, a student's doctoral dissertation.

## Biological Station

### Jack A. Stanford (Bierman Professor of Ecology), Director

The University of Montana-Missoula operates its Flathead Lake Biological Station as a year-round research facility and academic center in ecological sciences. The Station is located on 80 acres at Yellow Bay on Flathead Lake, some 85 miles north of Missoula near Kalispell and Glacier National Park. Up to 110 students can room in cabins and the G. W. Prescott dorm/apartment facility; board is provided by the station's commissary. Several large academic and office structures complement the state-of-the-art Freshwater Research Laboratory at this field campus.

During the annual 8-week summer session, formal courses are offered which emphasize field investigations of the rich flora and fauna of the diverse aquatic and terrestrial habitats found at or near the Station. Faculty from UM and other universities throughout the United States and Canada teach the field-oriented courses of the summer program. The formal courses each carry three to five semester credits for either advanced undergraduate or graduate academic programs.

A Bachelor of Science in Biology with Field Ecology Option is available through the Division of Biological Sciences which requires summer courses offered at the Flathead Lake Biological Station. This Field Ecology Option requires students to take advantage of at least one summer of courses at the Biological station, while allowing additional summers of coursework to apply to degree requirements as well. The required coursework includes Landscape Ecology, Conservation Ecology and either the Aquatic Emphasis (Stream ecology, Lake Ecology) or the terrestrial Emphasis (Ecology of Forests and Grasslands, Alpine Ecology). Students may complete BIOL 340/341 Ecology and Lab on the UM campus or take BIOL 342 Field Ecology at the Biological Station. Students who plan their academic years and summer programs carefully and who enroll for two or three summer sessions at the Biological Station may be able to complete degree requirements in three years.

Biological Station courses can also substitute for major program requirements in the Division of Biological Sciences and Wildlife Biology. Credits are transferable to most universities in the United States and Canada. Students must have completed introductory courses in biology, ecology and chemistry before enrolling in courses of the program.

Biological Station courses are offered for two or four-weeks during the eight-week session.

- 342 Field Ecology
- 343 Ecological Methods & Analysis
- 451 Landscape Ecology
- 452 Conservation Ecology
- 453 Lake Ecology
- 454 Stream Ecology
- 458 Ecology of Forests and Grasslands
- 459 Alpine Ecology
- 492 Seminar in Ecology and Resource Management
- 497 Undergraduate Research Experience
- 499 Undergraduate (Senior) Thesis in Field Ecology
- 596 Research in Ecology

In addition to these summer courses, the Biological Station offers opportunities for graduate studies in aquatic biology and ecology. After formal admission to a graduate degree-granting program, research programs leading to M.S. or Ph.D. degrees can be designed by the student, academic departments at the University and the faculty of the Station. Research assistantships are often available for students working on advanced degrees at FLBS. Numerous scholarships are also available annually for students enrolled at UM/FLBS.

## Enrollment Procedures

Students interested in participating in the annual summer academic program must apply by mid-May. Application forms are available from the Biological Station website ([www.umt.edu/flbs](http://www.umt.edu/flbs)) or may be obtained in the Division of Biological Sciences office at UM.

Students interested in pursuing graduate work at FLBS should apply in writing to Graduate Admissions, Division of Biological Sciences, The University of Montana-Missoula, 32 Campus Drive #4824, Missoula, MT 59812-4824, or contact the Director.

For detailed information about academic and research opportunities at the Flathead Lake Biological Station, please visit the station web page ([www.umt.edu/flbs](http://www.umt.edu/flbs)) or contact:

Flathead Lake Biological Station  
The University of Montana  
32125 Bio Station Lane  
Polson, MT 59860-6815  
Phone: (406) 982-3301  
Fax: (406) 982-3201  
E-Mail: [flbs@flbs.umt.edu](mailto:flbs@flbs.umt.edu)  
Web Page: [www.umt.edu/flbs/](http://www.umt.edu/flbs/)

## Division of Biological Sciences

### Charles H. Janson, Associate Dean for the Biological Sciences

The Division of Biological Sciences offers undergraduate and graduate programs representing the full range of the biological sciences. The Division offers bachelor degrees in biology (with a broad array of formal options including botanical sciences, cellular and molecular biology, ecology, field ecology, human biological sciences, natural history, zoological sciences, biological education and general sciences education), medical technology, microbiology including microbial ecology, and wildlife biology (a cooperative program administered by the College of Forestry and Conservation). The Division also advises students in pre-medical and other pre-health sciences, and offers a series of courses during the summer at the University's Flathead Lake Biological Station (see separate listing in this section). The Division is one of the leading research units in the University. Research programs in the Division provide abundant opportunities for students to enhance their educational experience by participating in research. Several sources of funding are available to support undergraduate student research, and the Division participates in the University undergraduate research symposium each spring.

Graduate degrees offered by the Division of Biological Sciences include Master of Science degrees in biochemistry, microbiology, and organismal biology and ecology. Doctor of Philosophy degrees in integrative biochemistry and microbiology, organismal biology and ecology, and biomolecular structure and dynamics are offered. The Division participates in the graduate (M.S. and Ph.D.) program in wildlife biology, administered by the College of Forestry and Conservation. Information on graduate study and program requirements is available from the Graduate School or the Division of Biological Sciences.

The Division of Biological Sciences is committed to providing coursework and experiences for non-science majors. The world faces many problems and opportunities that include significant biological components. Courses for non-science majors have the goal of fostering understanding of the process of science and enhancing biological knowledge as it relates to environmental, medical, social, and other issues. A number of introductory courses are open both to majors and non-majors. In addition, the Division offers courses designed specifically for non-majors: elementary medical microbiology, introductory ecology, Montana wildlife, and others.

Degree requirements and courses are described below (see the College of Forestry and Conservation for information about wildlife biology).

## Faculty

### Professors

- Fred W. Allendorf, Ph.D., University of Washington, 1975
- Joel Berger, Ph.D., University of Colorado, Boulder, 1978 (John J. Craighead Endowed Chair)
- Carol A. Brewer, Ph.D., University of Wyoming, 1993
- Ragan M. Callaway, Ph.D. University of California at Santa Barbara, 1990
- Kenneth P. Dial, Ph.D., Northern Arizona University, 1984
- Douglas Emlen, Ph.D., Princeton University, 1994
- Kerry R. Foresman, Ph. D., University of Idaho, 1977
- James E. Gannon, Ph.D., University of Houston, 1981
- Willard O. Granath, Ph.D., Wake Forest University, 1982
- Erick P. Greene, Ph.D., Princeton University, 1989
- F. Richard Hauer, Ph.D., North Texas State University, 1980
- Walter E. Hill, Ph.D., University of Wisconsin, 1967
- William E. Holben, Ph.D., University of New York, Buffalo, 1985
- Richard L. Hutto, Ph.D., University of California at Los Angeles, 1977
- Charles H. Janson, Ph.D., University of Washington, 1985

- Ralph C. Judd, Ph.D., The University of Montana, 1979
- Michael F. Minnick, Ph.D., Washington State University, 1987
- Jack H. Nunberg, Ph.D., Stanford University, 1979 (Director for the Montana Biotechnology Center)
- Anna Sala, Ph.D., University of Barcelona, 1992
- D. Scott Samuels, Ph.D., University of Arizona, 1991
- Stephen Sprang, Ph.D., University of Wisconsin, Madison, 1977 (Director, Center for Biomolecular Structure and Dynamics)
- Jack A. Stanford, Ph.D., University of Utah, 1975 (Bierman Professor; Director of the Biological Station)

#### **Associate Professors**

- Mark L. Grimes, Ph.D., University of Oregon, 1986
- Jesse C. Hay, Ph.D., University of Wisconsin, Madison, 1994
- J. Stephen Lodmell, Ph.D., Brown University, 1996
- John L. Maron, Ph.D., University of California-Davis, 1996
- Michele A. McGuirl, Ph.D., Montana State University, 1999
- Scott Miller, Ph.D., University of Oregon, 1999
- Frank Rosenzweig, Ph.D., University of Pennsylvania, 1991
- Bret W. Tobalske, Ph.D., The University of Montana, 1994 (Director of the Field Station at Fort Missoula)

#### **Assistant Professors**

- Creagh W. Breuner, Ph.D., University of Washington, 1998
- Sarah J. Certel, Ph.D., The University of Iowa, 1999
- Vanessa O. Ezenwa, Ph.D., Princeton University, 2002
- Lila Fishman, Ph.D., Princeton University, 1998
- Jeffrey Good, Ph.D., University of Arizona, 2007
- Winsor H. Lowe, Ph.D., Dartmouth College, 2002
- John P. McCutcheon, Ph.D., Washington University, 2006
- Brent J. Ryckman, Ph.D., The University of Iowa, 2003
- Scott A. Wetzel, Ph.D., Oregon Health and Science University, 2001
- H. Arthur Woods, Ph.D., University of Washington, 1998

#### **Lecturers**

- Heather Davis, M.S., The University of Montana, 2005
- Kevin J. Murray, Ph.D., University of Nevada-Reno, 1994

#### **Research Faculty**

- Jim Battisti, Ph.D., The University of Montana, 1998
- Jerry J. Bromenshenk, Ph.D., Montana State University, 1973
- Dan Drecktrah, Ph.D., Cornell University, 1999
- Bonnie Ellis, Ph.D., The University of Montana, 2006
- Ric Hauer, Ph.D., University of North Texas, 1980
- John Kimball, Ph.D., Oregon State University, 1995
- Evgueny Kroll, Ph.D., Hopkins School of Medicine, USA
- Penny Kukuk, Ph.D., University of Kansas, 1980
- Jean-Marc Lanchy, Ph.D., University; Louis Pasteur, Stransbourg, France
- Gordon Luikart, Ph.D., The University of Montana, 1997
- Megan McPhee, Ph.D., University of New Mexico, 2003
- Dan Mummey, Ph.D., University of Wyoming, 2003
- Philip Ramsey, Ph.D., The University of Montana, 2006

#### **Associated Faculty**

- Thomas E. Martin, Ph.D., University of Illinois, 1982
- L. Scott Mills, Ph.D., University of California, Santa Cruz, 1993

## **Medical Technology**

### **Michael Minnick (Professor of Microbiology), Advisor**

Medical Technology or clinical laboratory sciences, is a combined study of chemistry, physiology and microbiology. A medical technologist performs chemical, microscopic, and microbiological procedures used in the diagnosis, study and treatment of disease, under the supervision of a qualified physician or lab director. Medical technologists are in high demand in hospital labs, clinical labs, research institutions and government health departments. Although certification is required for clinical practice, individuals with a B.S. degree in Medical Technology are qualified microbiologists and can obtain positions in research many labs as technicians. The degree is also an

excellent foundation for students planning to attend professional schools in the health sciences or graduate school in the molecular biosciences.

Four years are required to earn a B. S. degree in Medical Technology. The curriculum is devoted to development of a sound foundation in chemistry, biology, and microbiology and clinical methods. The student is encouraged to obtain an understanding of social science and cultural subjects.

To be certified by the Board of Registry, a student, after satisfying the minimum course requirements, serves a clinical internship of at least 12 consecutive months in an approved school of medical technology endorsed by the National Accrediting Agency for Clinical Laboratory Sciences (NAACLS) or American Society of Clinical Pathology (ASCP) of the American Medical Association. After completing a clinical internship and passing the Registry exam, the student receives a diploma from the Board of Registry with the professional designation of Medical Technologist M.T. (ASCP).

The University of Montana has two coursework options for the medical technology degree:

**Option A** is a 4+1 curriculum in which the student completes the B.S. degree and subsequently does a one-year clinical internship if desired. Students who choose the 4+1 curriculum do a clinical internship by applying in the fall of their senior year. Details and application forms can be obtained online at the following: <http://www.umt.edu/Medtech/>. Internship applications are typically due in October for enrollment the following May.

**Option B** is a 3+1 curriculum designed to fast-track students who definitely want to become a medical technologists. The first three years are completed at UM. The fourth year is applied and incorporates both classroom learning and a clinical internship at one of our affiliates (University of North Dakota or at the Montana Medical Laboratory Science Training Program) in cooperation with several clinical sites located in Montana and the Midwest. Internship information is available online at <http://www.umt.edu/medtech/>. The B.S. degree and certification are granted after successful completion of the fourth year.

**High School Preparation:** In addition to the general University requirements for admission, it is recommended that high school preparation include algebra, geometry, trigonometry, chemistry, and a foreign language.

### Special Degree Requirements

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

In addition to the General Education requirements, the following courses are required for either option leading to a Bachelor of Science in Medical Technology: Thirty or more credits (300-level or above) in biology, biochemistry and microbiology including MICB 300-301, 309, 410, 412-413, 420, BIOC 380; BIOL 221, 223, 312, 400-401; CHMY 141N,143N (CHEM 161N-162N), 221-223 and M 162 or 171 (MATH 150) and STAT 216 (MATH 241). The 4+1 option also requires CHMY 222-224, 311 (CHEM 222-224,341); MICB 309, 406-407,433; and PHYS 111N/113N, 112N/114N . The 3+1 option also requires 37 credits of MICB 490 (Clinical Laboratory Internship).

**Upper-Division Writing Expectation:** To meet the Upper-Division Writing Expectation for the major, medical technology 4+1 students take MICB 410 and MICB 411; 3+1 students take MICB 410, 412, and one class chosen from: BIOC 482, MICB 411, or MICB 499.

### Suggested Course of Study

#### Option A (4+1)

<b>First Year</b>	<b>A</b>	<b>S</b>
CHMY 141N,143N (CHEM 161N-162N) College Chemistry and Laboratory	5	5
+M 162 (MATH 150) Applied Calculus	4	-
+WRIT 101 (ENEX 101) College Writing I	3	-
General Education	3	9
Electives	-	1
	15	15
+Depends on placement test.		
<b>Second Year</b>	<b>A</b>	<b>S</b>
BIOL 221 Cell and Molecular Biology	4	-
BIOL 223 Genetics and Evolution	-	4
CHMY (CHEM) 221-222, 223-224 Organic Chemistry and Laboratory	5	5
MICB 300-301 General Microbiology and Laboratory	-	5
Lower-Division Writing Course	3	-
General Education	3	-
Elective	-	1
	15	15

<b>Third Year</b>		<b>A</b>	<b>S</b>
BIOL 312 Anatomy and Physiology I	4	-	
BIOC 380 Biochemistry	4	-	
MICB 410-411 Immunology and Laboratory	5	-	
MICB 412-413 Medical Bacteriology and Laboratory	-	5	
Elective	3	2	
General Education	-	3	
STAT 216 Intro to Statistics		4	
	16	14	

<b>Fourth Year</b>		<b>A</b>	<b>S</b>
CHMY 311 (CHEM 341) Quantitative Analysis and Instrumental Methods	4	-	
BIOL 400/401 Parasitology and Lab (add 4 credits to fall)	3		
MICB 309 Hematology	3	-	
MICB 406 Clinical Diagnosis	-	2	
MICB 407 Clinical Diagnosis Laboratory	-	1	
MICB 420 Virology	-	3	
PHYS 111N-112N (121N-122N) or 221N-222N General Physics	5	5	
Elective	-	4	
	16	14	

### Option B (3+1)

<b>First Year</b>		<b>A</b>	<b>S</b>
CHMY 141N,143N (CHEM 161N-162N)College Chemistry and Laboratory	5	5	
+WRIT 101 (ENEX 101) College Writing I	3	-	
+ M 162 (MATH 150) Applied Calculus	4	-	
General Education	3	9	
Electives	1	1	
	16	15	

+Depends on placement test.

<b>Second Year</b>		<b>A</b>	<b>S</b>
BIOL 221 Cell and Molecular Biology	4	-	
BIOL 223 Genetics and Evolution	-	4	
BIOL 312 Anatomy and Physiology	4	-	
CHMY (CHEM) 221, 222 Organic Chemistry and Laboratory	5	-	
MICB 300-301 General Microbiology and Laboratory	-	5	
Lower-division writing course	-	3	
General Education	-	3	
Elective	3	-	
	16	15	

<b>Third Year</b>		<b>A</b>	<b>S</b>
BIOC 380 Biochemistry	4	-	
BIOL 400/401 Parasitology	4	-	
MICB 309 Hematology (3 credits in Fall)	3	-	
MICB 410-411 Immunology and Laboratory	5	-	
MICB 412-413 Medical Bacteriology and Laboratory	-	5	
MICB 420 Virology	-	3	
General Education	-	3	
STAT 216 Introduction to Statistics	-	4	
	16	15	

### 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.

### Clinical Laboratory Science (CLS)

- **U 460 Clinical Immunohematology I 1 cr.** Offered summer. Prereq., consent of medical technology advisor. Practical application of modern transfusion techniques, component therapy, and quality assurance.
- **U 461 Clinical Chemistry Theory 2 cr.** Offered summer. Prereq., consent of medical technology advisor. Overview of clinical chemistry theory, principles, procedures, and correlations. Topics include instrumentation, carbohydrates, proteins, lipids, enzymes, liver function, blood gases, electrolytes, renal function, endocrinology, therapeutic drug monitoring and toxicity.
- **U 462 Clinical Laboratory I 1 cr.** Offered summer. Prereq., consent of medical technology advisor. Theory and practice of phlebotomy in the clinical setting, specimen processing, review of state and federal regulations, safety and biohazard compliance, interpersonal relationship skills.
- **U 463 Clinical Hemostasis 2 cr.** Offered summer. Prereq., consent of medical technology advisor. Physiological mechanisms of normal human hemostasis as well as hereditary and acquired bleeding and thrombotic defects are discussed. Laboratory techniques for obtaining blood, screening procedures, specific assays and procedures to monitor anticoagulant therapy.
- **U 464 Clinical Microscopy and Urinalysis 2 cr.** Offered summer. Prereq., consent of medical technology advisor. Theory, techniques and practice of routine urinalysis.
- **U 465 Clinical Body Fluids 1 cr.** Offered summer. Prereq., consent of medical technology advisor. Body fluid physiology, pathology, laboratory measurement and case study analysis. Focus on laboratory technologies, principles of operation of various laboratory instruments and quality management in the clinical setting.
- **U 467 Clinical Immunohematology Theory 1 cr.** Offered summer. Prereq., consent of medical technology advisor. Theory of modern transfusion techniques, component therapy, and quality assurance.
- **U 468 Clinical Microbiology Theory and Laboratory 2 cr.** Offered summer. Prereq., consent of medical technology advisor. Study of groups of medically important bacteria correlated to laboratory practice in identification. Includes antibiotic susceptibility testing, quality control, and methods of identification; rapid, automated and traditional methods.
- **U 470 Clinical Immunohematology II 2 cr.** Offered autumn. Prereq., consent of medical technology advisor. Techniques and modern transfusion practices at the clinical affiliate. Review of the basic and advanced information in blood banking with correlation between laboratory testing and patient care.
- **U 471 Clinical Chemistry I 3 cr.** Offered autumn. Prereq., consent of medical technology advisor. Applied theory and practice in clinical chemistry at the clinical affiliate. Review of the basic and advanced information in clinical chemistry with correlation between laboratory testing and patient care.
- **U 472 Clinical Hematology I 2 cr.** Offered autumn. Prereq., consent of medical technology advisor. Morphologic evaluation of blood smears, interpretive correlation of hematology finds and the pathophysiology of disorders of the hematopoietic system.
- **U 473 Clinical Laboratory II 1 cr.** Offered autumn. Prereq., consent of medical technology advisor. Focus on performing phlebotomy techniques, hemostasis procedures and laboratory safety. Communication skills, attitude and work performance will be evaluated.
- **U 474 Clinical Microbiology I 2 cr.** Offered autumn. Prereq., consent of medical technology advisor. Techniques and practices in clinical microbiology at the clinical affiliate. Psychomotor skills, performance and understanding of the procedure methodologies, along with the relationship of test results to the patient disease/care.
- **U 475 Clinical Laboratory III 1 cr.** Offered autumn. Prereq., consent of medical technology advisor. Observation, practice or research in specialized areas or settings at the clinical affiliate.
- **U 476 Clinical Immunology 1 cr.** Offered autumn. Prereq., consent of medical technology advisor. Applied theory and practice in clinical immunology and serology at the clinical affiliate.
- **U 477 Medical Mycology 1 cr.** Offered autumn. Prereq., consent of medical technology advisor. Comparative morphology, physiology and pathogenicity of medically important fungi. Laboratory methods for identification emphasize interpretation and evaluation of results including the recognition of contaminating organisms.
- **U 480 Financial and Quality Management of the Clinical Laboratory 3 cr.** Offered spring. Prereq., consent of medical technology advisor. A capstone course designed to provide senior CLS students with the skills to manage a clinical laboratory. Brings together previous content with a focus on laboratory profitability, quality management and quality improvement.
- **U 481 Clinical Chemistry II 2 cr.** Offered spring. Prereq., consent of medical technology advisor.
- **U 482 Clinical Immunohematology III 2 cr.** Offered spring. Prereq., consent of medical technology advisor. Techniques and modern transfusion practices at the clinical affiliate. Psychomotor skills, performance and understanding of the procedure methodologies, along with the relationship of test results to the patient disease/care.
- **U 483 Clinical Hematology II 3 cr.** Offered spring. Prereq., consent of medical technology advisor. Techniques and practices in clinical hematology at the clinical affiliate. Psychomotor skills, performance and understanding of the procedure methodologies, along with the relationship of test results to the patient disease/care.
- **U 485 Clinical Microbiology II 2 cr.** Offered spring. Prereq., consent of medical technology advisor. Techniques and practices in clinical microbiology at the clinical affiliate. Psychomotor skills, performance and understanding of the procedure methodologies, along with the relationship of test results to the patient disease/care.

## Microbiology

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

Microbiology is the study of microorganisms, including the bacteria, yeasts, molds, viruses, protozoa and other microscopic parasites. Two options are available. The microbiology degree emphasizes microbial structure, function, and interactions and relationships with humans. The microbial ecology option emphasizes microbial structure, function, and interactions and relationships with the environment and other organisms including plants and animals.

A B.S. in Microbiology is offered as a general degree or with an option in microbial ecology. Initial work provides the student with a working knowledge of the basic principles of the physical and biological sciences and mathematics. The remaining study is devoted to a more intense and broadened training in microbiology and allied fields, and may include independent study which offers the student an opportunity to prepare for graduate work.

## Special Degree Requirements

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

In accordance with American Society for Microbiology recommendations, the following courses must be completed in addition to the General Education requirements for the Bachelor of Science in Microbiology: Thirty-two upper-division credits (300-level or above) in biology, biochemistry and microbiology including BIOL 340; BIOC 380 or 481-482; MICB 300-301, 404-405, 422, 450-451; and at least 7-9 credits chosen from the following courses (with lab if available):

MICB 309, 400-401, 406-407, 410-411, 412-413, 418, 420, 423, 497. BIOL 108N-109N, 110N, 221, 223; M 162 (MATH 150) STAT 216 (MATH 241); CHMY 141N-143N, 221-222, 223-224, 311 (CHEM 161N-162N, 221-223, 222-224, 341); PHYS 111N-113N, 112N-114N also are required.

**Microbial Ecology Option:** In addition to the General Education requirements and the Upper-Division Writing Expectation described below, the following must be completed for the Bachelor of Science in Microbiology with an option in microbial ecology: Thirty-two or more credits (300-level or above) in biology, biochemistry, microbiology including BIOL 340; BIOC 380 or 481-482; MICB 300-301, 404-405, 422, 450-451, and at least 7-9 credits chosen from the following courses (with lab if available): MICB 400-401, 410-411, 418, 420, 423, 497; BIOL 341, 366, 413, 440, 444/445, 453, 454,.

BIOL 108N/109N, 110N, 221, 223; M 162 or 171, STAT 216 (MATH 150 or 152, 241); CHMY 141N-143N, 221-222, 223-224 or CHMY 121N, 123N, 124N, (CHEM 161N-162N, 221-223, 222-224 or CHEM 151N, 152N,154N); PHYS 111N-113N also are required. In addition, choose at least 6 credits from: CHMY 311 (CHEM 341); CS 131; FOR 210N; GEO 301, 382, 420 (GEOS 301, 382, 480); M 172, 273 (MATH 153, 251) and STAT 451, 452, 457, 458 (MATH 444, 445, 447, 448); PHYS 112N/114N.

**Upper-Division Writing Expectation:** To meet the Upper-Division Writing Expectations for the major, Microbiology students must take MICB 404 (required), plus one more course chosen from: BIOL 482, BIOC 486, BIOL 366, BIOL 445, MICB 410, MICB 411, MICB 412 or MICB 499.

## Suggested Course of Study

### Microbiology

	<b>First Year</b>	<b>A</b>	<b>S</b>
BIOL 108N-109N Diversity of Life and Laboratory	5	-	
BIOL 110N Principles of Biology	-	4	
CHMY 141N-143N (CHEM 161N-162N) College Chemistry and Laboratory	5	5	
+M 162 (MATH 150) Applied Calculus	4	-	
+WRIT 101 (ENEX 101) College Writing I	-	3	
STAT 216 (MATH 241) Introduction to Statistics	-	4	
Total	14	16	
+Depends on placement exam.			
	<b>Second Year</b>	<b>A</b>	<b>S</b>
BIOL 221 Cell and Molecular Biology	4	-	
BIOL 223 Genetics & Evolution	-	4	
CHMY 221-222, 223-224 (CHEM 221-222, 223-224) Organic Chemistry and Laboratory	5	5	
MICB 300-301 General Microbiology and Laboratory	-	5	
Lower-Division Writing Course	3	-	
General Education	3	-	
Elective	-	1	
Total	15	15	
	<b>Third Year</b>	<b>A</b>	<b>S</b>
BIOC 481-482 (or 380 and two upper-division BIOL or MICB*)	3	3	
MICB 410-411 Immunology and Laboratory*	5	-	
MICB 422 Microbial Diversity and Ecology	-	3	
PHYS 111N-113N, 112N-114N General Physics	5	5	
Upper-division General Education	-	3	
Electives	2	1	

Total	15 15
<b>Fourth Year</b>	
BIOL 340 Ecology	- 3
CHMY 311 (CHEM 341) Quantitative Analysis and Instrumental Methods	4 -
MICB 404-405 Microbial Genetics and Laboratory	- 4
MICB 420 Virology*	- 3
MICB 450-451 Microbial Physiology and Laboratory	4 -
General Education	6 6
Total	14 16

\*Choose 7-9 credits from MICB 309, 400-401, 406-407, 410-411, 412-413, 418, 420, 423, 497.

### Microbiology with Microbial Ecology Option

<b>First Year</b>		<b>A S</b>
BIOL 108N-109N Diversity of Life and Laboratory	5 -	
BIOL 110N Principles of Biology	- 4	
CHMY 141N-143N (CHEM 161N-162N) College Chemistry and Laboratory	5 5	
+M 162 (MATH 150) Applied Calculus	4 -	
+WRIT 101 (ENEX 101) College Writing I	- 3	
STAT 216 (MATH 241) Introduction to Statistics	- 4	
Total	14 16	

+Depends on placement exam.

<b>Second Year</b>		<b>A S</b>
BIOL 221 Cell and Molecular Biology	4 -	
BIOL 223 Genetics & Evolution	- 4	
CHMY 221-222, 223-224 (CHEM 221-222, 223-224) Organic Chemistry and Laboratory	5 5	
MICB 300-301 General Microbiology and Laboratory	- 5	
Lower-Division Writing Course	3 -	
General Education	3 -	
Elective	- 1	
Total	15 15	

<b>Third Year</b>		<b>A S</b>
BIOC 481-482 (or 380 and two upper-division BIOL or MICB*)	3 3	
BIOL 340 Ecology	3 -	
FOR 210N Introductory Soils+	- 3	
MICB 400-401 General Parasitology and Laboratory	4 -	
MICB 422 Microbial Diversity and Ecology	- 3	
General Education	3 3	
Upper-division elective	- 4	
Electives	1 -	
Total	14 16	

<b>Fourth Year</b>		<b>A S</b>
GEO 382 Global Change	- 3	
MICB 404-405 Molecular Genetics and Laboratory	- 4	
MICB 423 Applied and Environmental Microbiology*	- 3	
MICB 450-451 Microbial Physiology and Laboratory	4 -	
PHYS 111N/113N, 112N/114N General Physics I	5 -	
General Education	3 6	
Elective	2 -	
Total	14 16	

\*Choose 7 credits from BIOL 341, 366, 440, 444; MICB 400-401, 410-411, 418, 420, 423, 497.

+Choose 6 credits from CHMY 311 (CHEM 341); CS 131; FOR 210N; GEO 301, 382, 420 (GEOS 301; 382 or 480); M 172, 273 (MATH 153, 251) Stat 451, 452, 457, 458 (MATH 444-447, 445-448); PHYS 112N/114N.

### Requirements for a Minor



To earn a minor in microbiology, the student must complete MICB 300-301, 404-405, 422, and 450-451, as well as at least three additional credits at the 300 or 400-level in Microbiology.

## 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.

### Microbiology (MICB)

- **U 107 Elementary Microbiology Laboratory 1 cr.** Offered spring. Same as BIOL 107. Observation of live microorganisms, their characteristics and activities. Experience with microbiological techniques. Credit not allowed toward a major in microbiology.
- **U 300 General Microbiology 3 cr.** Offered autumn and spring. Prereq., CHMY 141N, 143N (CHEM 161N, 162N); Prereq. or coreq., CHMY 221 (CHEM 221), BIOL 221. Microbial structure and function, growth and reproduction, physiology, ecology, genetics, environmental factors, control of microorganisms and sterility, antimicrobial agents, microbial diversity.
- **U 301 General Microbiology Laboratory 2 cr.** Offered autumn and spring. Prereq. or coreq., MICB 300. Basic microbiology procedures and techniques.
- **UG 302 Medical Microbiology 3 cr.** Offered autumn. Microbial structure and functions, pathogenic microorganisms, virology, immunology. Credit not allowed toward a major in microbiology.
- **U 309 Hematology 3 cr.** Offered autumn. Prereq., junior level or consent of instr., MICB 300. Study of blood and diseases of the circulatory system. Blood banking and serology.
- **UG 400 General Parasitology 2 cr.** Offered autumn. Prereq., BIOL 223. Same as BIOL 400. Parasitism as a biological phenomenon, origin of parasitism, adaptations and life cycles, parasite morphology, fine structure, physiology, parasites and their environment.
- **UG 401 General Parasitology Laboratory 2 cr.** Offered autumn. Coreq., MICB 400. Same as BIOL 401. Taxonomy, morphology and identification of parasitic protozoa, helminths and arthropods.
- **UG 404 Microbial Genetics 3 cr.** Offered spring. Prereq., MICB 300 and 301. The molecular genetics of prokaryotic organisms including: structure and replication of the prokaryotic chromosome; gene expression; mutagenesis and DNA repair; plasmids and other tools of genetic engineering; transmission of genetic material and recombination in prokaryotes; regulation of gene expression in prokaryotes; recombinant DNA and biotechnology.
- **UG 405 Experimental Microbial Genetics Laboratory 1 cr.** Offered spring. Prereq. or coreq., MICB 404. Experiments in microbial genetics: Analysis of genes and genomes.
- **UG 406 Clinical Diagnosis 2 cr.** Offered spring. Prereq., MICB 412-413. Principles of blood chemistry, urinalysis, hematology and other clinical parameters of disease and health.
- **UG 407 Clinical Diagnosis Laboratory 1 cr.** Offered spring. Prereq., MICB 406, 412-413. Clinical diagnostic methods.
- **U 408 Seminar 1 cr.** (R-3) Offered autumn and spring. Prereq., senior standing in natural sciences. Recent topics in microbiology and related subjects.
- **UG 410 Immunology 3 cr.** Offered autumn. Prereq., MICB 300-301. Modern concepts and methods in immunology.
- **UG 411 Immunology Laboratory 2 cr.** Offered autumn. Coreq., MICB 410. Modern techniques for analysis of immune responses.
- **UG 412 Medical Bacteriology and Mycology 3 cr.** Offered spring. Prereq., MICB 300, 301. A study of the pathogenic bacteria and fungi and the diseases they produce.
- **UG 413 Medical Bacteriology and Mycology Laboratory 2 cr.** Offered spring. Prereq. or coreq., MICB 412. Laboratory study of pathogenic bacteria and fungi.
- **UG 418 Fungal Biology 3 cr.** Offered autumn even-numbered years. Prereq., BIOL 108N-109N and 221-223 or MICB 300 or consent of instr. Same as BIOL 418. Reviews the definition, evolution, genetics, physiology, and ecology of fungi (including organisms in the Chromista), provides overview of all fungal phyla (Chytridiomycota, Zygomycota, Ascomycota, Basidiomycota, Hyphochytriomycota, Labyrinthulomycota, Oomycota), and highlights the importance of fungi to human affairs (food production, fungal pathogens).
- **UG 420 Virology 3 cr.** Offered spring. Prereq., MICB 410. The general nature of viruses, with emphasis on the molecular biology of animal and human viruses.
- **UG 422 Microbial Diversity and Ecology 3 cr.** Offered spring. Prereq., BIOL 221-223, MICB 300-301 or consent of instr. A broad overview of the physiological, phylogenetic and genomic diversity and ecology of microorganisms within a framework of general ecological principles. Focuses on microbial interactions with their environment at the level of the individual, population and community, including intimate associations with plants and animals. Surveys current methods for studying microbial ecology and diversity in the environment.
- **UG 423 Applied and Environmental Microbiology 3 cr.** Offered spring odd-numbered years. Prereq., MICB 300 or consent of instr. Study of microorganisms and their relation to environment including foods, water and wastewater treatment, bioremediation and industrial processes. Includes field trips and specialized laboratory exercises.
- **UG 447 Terrestrial Ecosystem Ecology 3 cr.** Offered autumn odd-numbered years. Prereq., BIOL 110N and any ecology-themed course or consent of instr. Same as BIOL 447. Introduction to systems thinking and the ecosystem concept, review of water and energy balance, carbon cycling and production processes, nutrient cycling, trophic dynamics, and species effects on ecosystem functioning.
- **UG 450 Microbial Physiology 3 cr.** Offered autumn. Prereq., MICB 300-301. Microbial structure and function, physiological diversity, microbial metabolism, role of microbial activity in the environment.
- **UG 451 Microbial Physiology Laboratory 1 cr.** Offered autumn. Coreq., MICB 450. Experimental approaches to analysis of microbial structure, composition and metabolism.
- **UG 490 Medical Technology Internship 1-16 cr.** Offered every term. Prereq., consent of instr.
- **UG 495 Special Topics 1-10 cr.** (R-10) Offered intermittently. Experimental offerings of new courses, experimental offerings of