

2010-2011 Course Catalog

The University Of Montana

Biochemistry

Bruce E. Bowler, Program Director

The Biochemistry Program is a joint program between the Department of Chemistry and Biochemistry and the Division of Biological Sciences. Biochemistry is an interdisciplinary science that integrates chemistry and biology to understand the basis of life at the molecular level. The program offers a B.S. in Biochemistry and M.S. and Ph.D. degrees in Biochemistry & Biophysics.

Undergraduate majors receive a solid foundation in both chemistry and biology. Biochemistry courses are usually taken in the junior year allowing majors to become involved in research with faculty and to take electives in their senior year. The major also introduces students to computer science and bioinformatics, essential tools in modern biochemistry. The B.S. in Biochemistry prepares students for both advanced degrees in biochemistry and for careers in the pharmaceutical and biotechnology industries. A Health Professions option is also offered within the B.S. in Biochemistry for students whose career goals are in fields related to biochemistry.

The graduate degrees in Biochemistry & Biophysics prepare students to be independent researchers in academic laboratories or in the biotechnology and pharmaceutical industries. Through coursework and independent research, graduate students in this program will become adept at the physical and structural methods necessary to probe important problems in the life sciences at the molecular level. In collaboration with the Center for Biomolecular Structure & Dynamics, the Biochemistry Program provides state-of-the-art facilities for research in biochemistry, biophysics and structural biology.

Prospective students desiring further information on these degrees should contact the Program Director by visiting the Biochemistry Program web site: <http://www.cas.umt.edu/biomolecular/>.

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

Bachelor of Science in Biochemistry

- CHMY 141N-143N (CHEM 161N-162N); College Chemistry I & II + Lab - 10 cr.
- CHMY 221-224 (CHEM 221-224); Organic Chemistry I & II + Lab -10 cr.
- CHMY 225 (CHEM 264); Organic Majors Lab may be substituted for CHMY 224 (CHEM 224)
- CHMY 311-421 (CHEM 341-342); Quantitative Analysis and Instrumental Methods - 8 cr.
- CHMY 360 (CHEM 370); Applied Physical Chemistry - 3 cr.
- CHMY 373 (CHEM 371); Phys Chem-Kntcs & Thrmdynmcs may be substituted for CHMY 360 (CHEM 370)

- CHMY 401 (CHEM 452); Advanced Inorganic Chemistry - 3 cr.
- BCH 110-111 (BIOC 110-111); Biochemistry of Life + Lab - 4 cr.
- BCH 294 (BIOC 210); Introductory Biochemistry Seminar - 1 cr.
- BCH 480-482 (BIOC 481-482); Advanced Biochemistry I & II - 6 cr.
- BCH 486 (BIOC 486); Biochemistry Research Laboratory - 3 cr.
- BIOB 260/261 (BIOL 221); Cellular and Molecular Biology - 4 cr.
- BIOB 275 (BIOL 223); Genetics and Evolution - 4 cr.
- BIOB 425 (BIOL 464); Advanced Cellular Biology - 3 cr.
- M 171-172 (MATH 152-153); Calculus I & II - 8 cr.
- PHSX 215N/216N and 217N/218N (PHYS 211N/213N and 212N/214N); Fundamentals of Physics with Calculus I & II + Lab - 10 cr.
- CSCI 250 (CS 177); Computer Modeling for Science Majors - 3 cr.
- CSCI 451 (CS 458); Bioinformatics - 3 cr.

13 credits of electives from BCH 490¹ (BIOC 497); BIOB 301, 410, 411, 440, 490¹ (BIOL 301, MICB 410, 411, BIOL 440, 490); BIOH 360, 405 (BIOL 347, MICB 309); BIOL 312, 313, 345, 460; BIOM 360, 361, 400, 410, 411, 427, 428, 435 (MICB 300, 301, 302, 404, 405), BIOL 400, 401, MICB 420; BMED 347, 421, 422; CHMY 371, 397, 402, 403, 442, 465, 466, 485, 490,¹ 498¹ (CHEM 372, 380, 453, 455, 442, 465, 486, 485, 489, 498).

¹No more than 3 credits combined of BCH 490 (BIOC 497), CHMY 490, 498 (CHEM 489, 498) or BCH 490 (BIOC 497) may be counted toward the 13 credit elective requirement.

For Group I of the General Education requirements (English Writing Skills), all students must complete WRIT 101 (ENEX 101), a lower division writing course, an upper division writing course, and need to obtain a score of 3 or better on the WPA exam. The upper division requirement will be satisfied by BCH 482 (BIOC 482) (1/3 of requirement) and BCH 486 (BIOC 486) (2/3 of requirement).

Group II of the General Education requirement (Mathematics) is fulfilled by M 171-172 (MATH 152-153).

The Foreign Language/Symbolic Systems requirement (Group III of the General Education Requirement) is fulfilled by M 171 (MATH 152).

All students must complete 27 credit hours from groups IV to XI of the General Education requirement to graduate (CHMY 141N-143N (CHEM 161N- 162N) counts as the 6 credit group XI requirement). One of these courses should be an approved lower division writing course.

Credits to Graduate:

Required courses:	83
Elective courses:	13
General education: ¹	21
WRIT 101 (ENEX 101):	3
Total:	120

¹Groups IV to X account for 21 credit hours.

Bachelor of Science in Biochemistry: Health Professions Option

- CHMY 141N-143N; (CHEM 161N-162N) College Chemistry I & II + Lab - 10 cr.
- CHMY 221-224 (CHEM 221-224); Organic Chemistry I & II + Lab - 10 cr.
- CHMY 225 (CHEM 264); Organic Majors Lab may be substituted for CHMY 224 (CHEM 224)
- CHMY 302E (CHEM 334); Chem. Lit and Science Writing - 3 cr.
- CHMY 311-421; (CHEM 341-342) Quantitative Analysis and Instrumental Methods - 8 cr.
- CHMY 360 (CHEM 370); Applied Physical Chemistry - 3 cr.
- CHMY 373 (CHEM 371); Phys Chem-Kntcs & Thrmodynms may be substituted for CHMY 360 (CHEM 370)
- CHMY 401 (CHEM 452); Advanced Inorganic Chemistry - 3 cr.
- BCH 110-111 (BIOC 110-111); Biochemistry of Life + Lab - 4 cr.
- BCH 294 (BIOC 210); Introductory Biochemistry Seminar - 1 cr.
- BCH 481-482 (BIOC 481-482); Advanced Biochemistry I & II - 6 cr.
- BIOB 260/261 (BIOL 221); Cellular and Molecular Biology - 4 cr.
- BIOB 275 (BIOL 223); Genetics and Evolution - 4 cr.
- BIOM 360 (MICB 300); General Microbiology - 3 cr.
- BIOM 400 (MICB 302); Medical Microbiology may be substituted for BIOM 360 (MICB 300)
- M 162 (MATH 162); Applied Calculus - 4 cr.
- M 274 (MATH 158); Intro to Differential Equations - 3 cr.
- PHSX 205N/206N-207N/208N (PHYS 111N/113N-112N/114N); College Physics I&II + Lab - 10 cr.
- 23 credits of electives from BCH 486, 490¹ (BIOC 486, 497); BIOB 301, 410, 411, 425, 440, 490¹ (BIOL 301, MICB 410, 411, BIOL 464, 440, 490); BIOH 360, 405 (BIOL 347, MICB 309); BIOL 312, 313, 345, 460; BIOM 361, 410, 411, 427, 428, 435 (MICB 301, 404, 405, BIOL 400, 401, MICB 420); BMED 347, 421, 422; CHMY 371, 397, 402, 403, 442, 465, 466, 485, 490,¹ 498¹ (CHEM 372, 380, 453, 455, 442, 465, 486, 485, 489, 498).¹No more that 3 credits combined or BIOB 490 (BIOL 497), CHMY 490, 498 (CHEM 489, 498) or BCH490 (BIOC 497) may be counted toward the 23 credit elective requirement.

For Group I of the General Education requirements (English Writing Skills), all students must complete WRIT 101 (ENEX 101), a lower division writing course, an upper division writing course, and need to obtain a score of 3 or better on the WPA exam. CHMY 302E (CHEM 334) is the formal requirement to satisfy the upper division requirement in this option. It can also be satisfied by taking the following combinations of required and elective courses: BCH 482 (BIOC 482) (1/3 of requirement), and BCH 486 (BIOC 486) (2/3 of requirement); BCH 482 (BIOC 482) or BIOB 410 (MICB 410) (1/3 of requirement) and BIOM 410 or BIOB 411 (MICB 404 or MICB 411) (2/3 of requirement).

Group II of the General Education requirement (Mathematics) is fulfilled by M 162 (MATH 150).

The Foreign Language/Symbolic Systems requirement (Group III of the General Education Requirement) is fulfilled by M 162-274 (MATH 150-158).

All students must complete 27 credit hours from groups IV to XI of the General Education requirement to graduate (CHMY 141N-143N (CHEM 161N-162N) counts as the 6 credit group XI requirement; If CHMY 302E (CHEM 334) is taken to satisfy the upper division writing requirement it also satisfies the group VIII requirement). One of these courses should be an approved lower division writing course.

Credits to Graduate:

Required courses:	76
Elective courses:	23
General education: ¹	18
WRIT 101 (ENEX 101):	3
Total:	120

¹Groups IV to VII, IX and X account for 18 credit hours, assuming CHMY 302E is used for group VIII.

Suggested Course of Study for B.S. Degree in Biochemistry

First Year	A	S
CHMY 141N 5 (CHEM 161N) College Chemistry I	-	
CHMY 143N - (CHEM 162N) College Chemistry II	5	
M 171 (MATH 152) 4 Calculus I	-	
M 172 (MATH 153) - Calculus II	4	
WRIT 101 (ENEX 3 101) College Writing I	-	
BCH 110 (BIOC - 110) Biochemistry of Life Lecture	3	
BCH 111 (BIOC - 111) Biochemistry of Life Laboratory	1	
CSCI 250 (CS 177) - Computer Modeling for Science Majors	3	
General Education 3	-	
Total 15	16	
Second Year		

CHMY 221-222 (CHEM 221-222) Organic Chemistry I and Lab	5	-
CHMY 223-224 (CHEM 223-224) Organic Chemistry II and Lab	-	5
PHSX 215N/216N (PHYS 211N/213N) Fundamentals of Physics I with Calculus and Lab	5	-
PHSX 217N/218N (PHYS 212N/214N) Fundamentals of Physics II with Calculus and Lab	-	5
BIOB 260/261 (BIOL 221) Cellular and Molecular Biology	4	-
BIOB 275 (BIOL 223) Genetics and Evolution	-	4
BCH 294 (BIOC 210) Seminar/Workshop	-	1
Total	14	15
Third Year		
CHMY 311 (CHEM 341) Analytical Chem-Quant Analysis	4	-
CHMY 360 (CHEM 370) Applied Physical Chemistry (or CHMY 373 (CHEM 371) offered autumn)	-	3
CHMY 421 (CHEM 342) Advanced Instrument Analysis	-	4
BCH 480 (BIOC 481) Advanced Biochemistry I	3	-

BCH 482 (BIOC 482) Advanced Biochemistry II	-	3
BCH 486 (BIOC 486) Biochemistry Research Laboratory	-	3
General Education	9	-
Total	16	13

Fourth Year

CHMY 401 (CHEM 452) Advanced Inorganic Chemistry	3	-
CSCI 451 (CS 458) Computational Biology	3	-
BIOB 425 (BIOL 464) Advanced Cellular & Molecular Biology	-	3
Advanced Electives *	6	7
General Education	3	6
Total	15	16

*Advanced Biochemistry Electives: BCH 490 (BIOC 497), BIOB 301 (BIOL 301), BIOB 410 (MICB 410), BIOB 411 (MICB 411), BIOB 440 (BIOL 440), BIOB 490 (BIOL 490), BIOH 360 (BIOL 347), BIOH 405 (MICB 309), BIOL 312, BIOL 313, BIOL 345, BIOL 460, BIOM 360 (MICB 300), BIOM 361 (MICB 301), BIOM 400 (MICB 302), BIOM 410 (MICB 404), BIOM 411 (MICB 405), BIOM 427

(BIOL 400), BIOM
 428 (BIOL 402),
 BIOM 435 (MICB
 420), BMED 421,
 BMED 422, CHMY
 371 (CHEM 372),
 CHMY 397 (CHEM
 380), CHMY 402
 (CHEM 455),
 CHMY 403 (CHEM
 453), CHMY 442
 (CHEM 442),
 CHMY 465 (CHEM
 465), CHMY 466
 (CHEM 466),
 CHMY 485 (CHEM
 485), CHMY 490
 (CHEM 489),
 CHMY 498 (CHEM
 498)

**Suggested Course of Study for B.S. Degree in Biochemistry: Health Professions
 Option**

First Year		A		S
CHMY 141N (CHEM 161N) College Chemistry I	5		-	
CHMY 143N (CHEM 162N) College Chemistry II	-		5	
M 162 (MATH 150) Applied Calculus	4		-	
M 274 (MATH 158) Intro to Differential Equations	-		3	
WRIT 101 (ENEX 101) College Writing I	3		-	
BCH 110 (BIOC 110) Biochemistry of Life Lecture	-		3	
BCH 111 (BIOC 111) Biochemistry of Life Laboratory	-		1	
General Education	3		3	
Total	15		15	

Second Year		
CHMY 221-222 (CHEM 221-222) Organic Chemistry I and Lab	5	-
CHMY 223-224 (CHEM 223-224) Organic Chemistry II and Lab	-	5
PHSX 205N/206N (PHYS 111N/113N) College Physics I and Lab	5	-
PHSX 207M/208N (PHYS 112N/114N) College Physics II and Lab	-	5
BIOB 260/261 (BIOL 221) Cellular and Molecular Biology	4	-
BIOB 275 (BIOL 223) Genetics and Evolution	-	4
BCH 294 (BIOC 210) Introductory Biochemistry Seminar	-	1
Total	14	15

Third Year		
CHMY 311 (CHEM 341) Analytical Chem-Quant Analysis	4	-
CHMY 302E (CHEM 334) Chemistry Lit and Science Writing	3	-
CHMY 360 (CHEM 370) Applied Physical Chemistry (or CHMY 373 (CHEM 371) offered autumn)	-	3
CHMY 421 (CHEM 342) Advanced Instrument Analysis	-	4

BIOM 360 (MICB 300) General Microbiology (or BIOM 400 (MICB 302) offered autumn)	-	3
Advanced Electives*	3	5
General Education	6	-
Total	16	15

Fourth Year

CHMY 401 (CHEM 452) Advanced Inorganic Chemistry	3	-
BCH 480 (BIOC 481) Advanced Biochemistry I	3	-
BCH 482 (BIOC 482) Advanced Biochemistry II	-	3
Advanced Electives*	3	9
General Education	6	3
Total	15	15

*Advanced Biochemistry Electives: BCH 486 (BIOC 486), BCH 490 (BIOC 497), BIOB 301 (BIOL 301), BIOB 410 (MICB 410), BIOB 411 (MICB 411), BIOB 425 (BIOL 464), BIOB 440 (BIOL 440), BIOB 490 (BIOL 490), BIOH 360 (BIOL 347), BIOH 405 (MICB 309), BIOL 312, BIOL 313, BIOL 345, BIOL 460, BIOM 361 (MICB 301), BIOM 410 (MICB 404), BIOM 411 (MICB 405), BIOM

427 (BIOL 400),
BIOM 428 (BIOL
402), BIOM 435
(MICB 420), BMED
347, BMED 421,
BMED 422, CHMY
371 (CHEM 372),
CHMY 397 (CHEM
380), CHMY 402
(CHEM 455),
CHMY 403 (CHEM
453), CHMY 442
(CHEM 442),
CHMY 465 (CHEM
465), CHMY 466
(CHEM 466),
CHMY 485 (CHEM
485), CHMY
490 (CHEM 489),
CHMY 498 (CHEM
498).

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.

Biochemistry (BCH)

U 110 (BIOC 110) The Biochemistry of Life 3 cr. Offered spring. Prereq. CHMY 141N (CHEM 161N) or equivalent. Coreq., CHMY 143N (CHEM 162N) and BCH 111 (BIOC 111). An introductory course that explores bio-molecules and their roles in life processes. Provides a foundation for Cell and Molecular Biology (BIOB 260/261 (BIOL 221)), Genetics and Evolution (BIOL 223), Introductory Biochemistry Seminar (BCH 294 (BIOC 210)), and many other advanced science courses.

U 111 (BIOC 111) The Biochemistry of Life Laboratory 1 cr. Offered spring. Prereq., CHMY 141N (CHEM 161N) or equivalent. Coreq., CHMY 143N (CHEM 162N) and BCH 110 (BIOC 110). Introduction to the experimental techniques used to study bio-molecules and their roles in life processes. Provides a foundation for other advanced level laboratory courses in chemistry and biochemistry.

U 294 (BIOC 210) Introductory Biochemistry Seminar 1 cr. Offered spring. prereq., BCH 110/111 (BIOC 110/111) or equivalent. An introduction to important advances in biochemistry through readings from the primary literature and discussion of this literature. Faculty members will also make presentations on their research.

UG 380 (BIOC 380) Biochemistry 4 cr. Offered autumn and spring. Prereq., CHMY 223 (CHEM 223). Fundamental biochemistry; chemistry and metabolism of biomolecules, energy relationships in metabolism; storage, transmission, and expression of genetic information. Credit not allowed for both BCH 380 and 480-482 (BIOC 380 and BIOC 481-482).

UG 480 (BIOC 481) Advanced Biochemistry I 3 cr. Offered autumn. Prereq., CHMY 223 (CHEM 223), CHMY 360 (CHEM 370) or CHMY 373 (CHEM 371) or equiv. Primarily for science majors. The chemistry and metabolism of biomolecules, with emphasis on the structure and function of proteins, carbohydrates, lipids and nucleic acids and the associated bioenergetics. Credit not allowed for both BCH 380 and 480-482 (BIOC 380 and BIOC 481-482).

UG 482 (BIOC 482) Advanced Biochemistry II 3 cr. Offered spring. Prereq., BCH 480 (BIOC 481) or equiv. Continuation of BCH 480 (BIOC 481). Metabolism, especially macromolecule biosyntheses, the chemistry and regulation of the transfer and expression of genetic information, protein synthesis and molecular physiology. Credit not allowed for both BCH 380 and BCH 480-482 (BIOC 380 and BIOC 481-482).

UG 486 (BIOC 486) Biochemistry Research Laboratory 3 cr. Offered spring. Prereq., BCH 380 or 480 (BIOC 380 or 481). Applications of biochemical principles to modern molecular biology and biochemical techniques. Includes cloning a gene, making site-directed mutants; then will express, purify, and characterize the protein product.

U 490 (BIOC 497) 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 pass/not pass.

UG 491 (BIOC 495) Special Topics 1-10 cr. (R-10) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.

U 499 (BIOC 499) Senior Thesis/Capstone 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 an oral or poster presentation at the Undergraduate Research Symposium or a scientific meeting. Graded pass/not pass.

G 561 (BIOC 561) RNA Structure and Function 1 cr. (R-8) Offered every semester. Prereq., BCH 482, BIOB 260/261 (BIOC 482, BIOL 221), and consent of instr. Exploration of current scientific literature and new data that focuses on RNA biochemistry. Emphasis on literature relevant to research on RNA viruses and ribosomes and protein synthesis.

G 562 (BIOC 562) The Structural Basis of Amyloid Disease 1 cr. (R-8) CR/NCR only, offered every semester. Prereq., BCH 480 (BIOC 481) or equivalent and consent of instructor. Weekly exploration of current literature and new research that focuses on the biophysical aspects of amyloid diseases, including protein structure and therapeutic treatments.

G 570 (BIOC 570) Introduction to Research 2 cr. Offered autumn. Prereq., graduate standing. Required course for biochemistry and biophysics graduate students. Students are acquainted with faculty research projects. Instruction in basic research techniques, research equipment. Introduction to relevant scientific research literature.

G 580 (BIOC 580) Training Seminar 1 cr. (R-2) Offered autumn and spring. Prereq., graduate standing or consent of instr. Same as BIOM 580 (MICB 580). A one-semester offering required of all new students.

G 581 (BIOC 581) Physical Biochemistry 3 cr. Offered spring odd-numbered years. Prereq., CHMY 360 or CHMY 373 (CHEM 371) or (CHEM 372); BCH 480 (BIOC 482). Techniques of physical chemistry used in studying biological structure and function of

macromolecules. Emphasis is on spectroscopic methods, hydrodynamic methods and x-ray and other scattering and diffraction techniques.

G 582 (BIOC 582) Proteins and Enzymes 3 cr. Offered autumn even-numbered years. Prereq., BCH 482 (BIOC 482) or equivalent. An investigation into the structure/function relationship in proteins and a detailed exploration of enzyme kinetics, using examples from current literature.

G 584 (BIOC 584) Nucleic Acids 3 cr. Offered autumn odd-numbered years. Prereq., BCH 482 (BIOC 482) or equivalent. Emphasis on critical reading of current literature that investigates structure, chemistry, and function of nucleic acids.

G 594 (BIOC 594) Professional Seminar 1 cr. (R-4) Offered autumn and spring. Prereq., graduate standing or consent of instr. Same as BIOM 594 (MICB 594). Presentation of current research in biochemistry and molecular biology by senior graduate students, faculty, and invited outside speakers.

G 595 (BIOC 595) Special Topics 1-3 cr. (R-6) Offered intermittently. Prereq., graduate standing and consent of instr. Experimental offering of new courses by resident or visiting faculty.

G 597 (BIOC 597) Research Variable cr. (R-18) Offered intermittently.

G 599 (BIOC 599) Thesis 1-10 cr. (R-10) Offered intermittently. Prereq., master's student in biochemistry and biophysics. Laboratory research for and preparation of a master's thesis.

G 600 (BIOC 600) Advanced Cellular Biochemistry 4 cr. Offered every spring. Prereq., BCH 380 or 482 (BIOC 380 or 482), or consent of instr. Same as BMED 600. Exploration on a molecular level the regulation of structure, function, and dynamics of eukaryotic cells. Topics include membranes, cytoskeleton, transcription, translation, signal transduction, cell motility, cell proliferation, and programmed cell death.

G 685 (BIOC 685) Advanced Biochemistry and Molecular Biology Laboratory 1-3 cr. (R-9) Offered autumn and spring. Prereq., BCH 482 (BIOC 482) or equiv. and consent of instr. Introduction to research techniques in biochemistry and molecular biology.

G 699 (BIOC 699) Dissertation 1-10 cr. (R-20) Offered intermittently. Prereq., doctoral student in biochemistry. Laboratory research for and preparation of a doctoral dissertation.

Faculty

Professors:

Bruce E. Bowler (Director), Chemistry & Biochemistry, Ph.D., Massachusetts Institute of Technology, 1986

J.B.A. (Sandy) Ross, Chemistry & Biochemistry, Ph.D., University of Washington, 1976

D. Scott Samuels, Division of Biological Sciences, Ph.D., University of Arizona, 1991

Stephen R. Sprang, Division of Biological Sciences, Ph.D., University of Wisconsin, Madison, 1977

Kent D. Sugden, Chemistry & Biochemistry, Ph.D, Montana State University, 1992

Associate Professors:

J. Stephen Lodmell, Division of Biological Sciences, Ph.D., Brown University, 1996

Michele A. McGuirl, Division of Biological Sciences, Ph.D., Montana State University, 1999

Assistant Professors:

Klara Briknarova, Chemistry & Biochemistry, Ph.D., Carnegie Mellon University, 1999

Valeriy Smirnov, Chemistry & Biochemistry, Ph.D., University of Nebraska, 2004