

BIOCHEMISTRY AND BIOPHYSICS

The department of Biochemistry, Biophysics & Molecular Biology (<http://www.bbmb.iastate.edu>) offers majors in biochemistry or biophysics in the College of Liberal Arts and Sciences and a major in agricultural biochemistry in the College of Agriculture and Life Sciences.

Biochemists and biophysicists seek to understand life processes in terms of chemical and physical principles. They conduct research in the frontiers of biology such as metabolic networking; structure and function of enzymes, membranes, and hormones; computational approaches; genomic and proteomic technology; protein engineering; plant biotechnology; muscle structure and function; and the design and evaluation of drugs for the treatment of disease. Biochemistry, biophysics and molecular biology provide the basis for much of modern biotechnology. Graduates have opportunities in industry, especially the biotechnology sector, in universities, veterinary and medical schools, and government laboratories. Students who meet the necessary high scholastic standards have the opportunity to continue their education to pursue advanced degrees in graduate school, medicine, pharmacy or veterinary medicine.

Graduates of biochemistry, agricultural biochemistry and biophysics understand the chemical principles of biological systems including molecular biology. They have developed laboratory expertise in modern biochemical techniques, including the ability to analyze data and prepare scientific reports. Most have participated in undergraduate research and have developed the skills necessary for both written and oral presentations at a level that will serve the student both within the university and in postgraduate professional life. Graduates have the experience of interacting with persons of different disciplines and cultures. Students have the training in biological and physical science and mathematics to solve problems of broad scope in biological, biomedical and environmental sciences and to provide leadership in diverse scientific and technological arenas.

A program that combines a bachelor of science and masters of science in biochemistry or biophysics is offered.

Biochemistry or Biophysics Majors in the College of Liberal Arts and Sciences

For the undergraduate curriculum leading to the degree bachelor of science, see College of Agriculture, Agricultural biochemistry.

Biochemistry and biophysics are recommended to students whose career interests involve advanced graduate or medical study or employment in biochemistry or biophysics, or in related areas of the biological or medical sciences.

Biochemistry undergraduate major program of study

Total Degree Requirement: 120 cr.

BBMB 101	Introduction to Biochemistry	1
BBMB 102	Introduction to Biochemistry Laboratory	1
BBMB 201	Chemical Principles in Biological Systems	2
BBMB 404	Biochemistry I	3
or (4 credits)		
BBMB 504	Amino Acids and Proteins	
BBMB 505	Bioenergetics and Metabolism	
BBMB 405	Biochemistry II	3
or (4 credits)		
BBMB 506	Membrane Biochemistry	
BBMB 507	Biochemistry of Nucleic Acids	
BBMB 411	Techniques in Biochemical Research	4
BBMB 461	Molecular Biophysics	2
or BBMB 561 Molecular Biophysics		
BBMB 561L	Laboratory in Molecular Biophysics	2-3
or CHEM 322L Laboratory in Physical Chemistry		
BBMB 490	Independent Study (Not required)	1-3
BBMB 499	Undergraduate Research (Not required but strongly encouraged)	1-5
Take one of the following:		5-7
CHEM 201	Advanced General Chemistry	
or CHEM 177 General Chemistry I & CHEM 178 and General Chemistry II		
Take one of the following:		
CHEM 201L	Laboratory in Advanced General Chemistry	
or CHEM 177 Laboratory in General Chemistry I		
or CHEM 177 Laboratory in General Chemistry I		
CHEM 211 & 211L	Quantitative and Environmental Analysis and Quantitative and Environmental Analysis Laboratory	4
CHEM 324	Introductory Quantum Mechanics	3
CHEM 325	Chemical Thermodynamics	3
CHEM 331 & CHEM 332	Organic Chemistry I and Organic Chemistry II	6
CHEM 333L	Laboratory in Organic Chemistry I (for Chemistry and Biochemistry Majors)	1-2
or CHEM 331L Laboratory in Organic Chemistry I		
CHEM 334L	Laboratory in Organic Chemistry II (for Chemistry and Biochemistry Majors)	1-2
or CHEM 332L Laboratory in Organic Chemistry II		
MATH 165	Calculus I	4

MATH 166	Calculus II	4	BBMB 411	Techniques in Biochemical Research	4
MATH 265	Calculus III	3-4	BBMB 461	Molecular Biophysics	2
or MATH 266	Elementary Differential Equations		or BBMB 561	Molecular Biophysics	
or MATH 267	Elementary Differential Equations and Laplace Transforms		BBMB 561L	Laboratory in Molecular Biophysics	2-3
			or CHEM 322L	Laboratory in Physical Chemistry	
PHYS 221	Introduction to Classical Physics I	10	Take one of the following:		5-7
& PHYS 222	and Introduction to Classical Physics II		CHEM 201	Advanced General Chemistry	
BIOL 211	Principles of Biology I	6	CHEM 177	General Chemistry I	
& BIOL 212	and Principles of Biology II		& CHEM 178	and General Chemistry II	
BIOL 211L	Principles of Biology Laboratory I	1	CHEM 201L	Laboratory in Advanced General Chemistry	1
or BIOL 212L	Principles of Biology Laboratory II		or CHEM 177N	Laboratory in General Chemistry I	
or BIOL 313L	Genetics Laboratory		or CHEM 177L	Laboratory in General Chemistry I	
BIOL 313	Principles of Genetics	3	CHEM 211	Quantitative and Environmental Analysis	4
BIOL 314	Principles of Molecular Cell Biology	3	& 211L	and Quantitative and Environmental Analysis Laboratory	
Biological Science electives	from Biochemistry, Biology, Chemistry, Genetics, Microbiology	4	CHEM 324	Introductory Quantum Mechanics	3
Total Credits		81-93	CHEM 325	Chemical Thermodynamics	3

Communication Proficiency: A grade of C or better is required in ENGL 250. For students fulfilling the upper-level requirement with BBMB 411, a grade of 80% or better must be earned on two journal-style written reports.

LIB 160	Information Literacy	1
ENGL 150	Critical Thinking and Communication	3
ENGL 250	Written, Oral, Visual, and Electronic Composition	3
One course from the following:		
BBMB 411	Techniques in Biochemical Research	4
ENGL 305	Creative Writing: Nonfiction	3
ENGL 309	Proposal and Report Writing	3
ENGL 314	Technical Communication	3

General Education Area

Arts and Humanities	12
Social Sciences	9
International Perspectives	3
U.S. Diversity	3

Biophysics undergraduate major program of study

Total Degree Requirement: 120 cr,

BBMB 101	Introduction to Biochemistry	1	PHYS 221	Introduction to Classical Physics I	10
BBMB 102	Introduction to Biochemistry Laboratory	1	& PHYS 222	and Introduction to Classical Physics II	
BBMB 201	Chemical Principles in Biological Systems	2	One course from the following:		
BBMB 404	Biochemistry I	3	MATH 481	Numerical Methods for Differential Equations	
or BBMB 420	Mammalian Biochemistry		STAT 407	Methods of Multivariate Analysis	
			STAT 430	Empirical Methods for the Computational Sciences	
			COM S 207	Fundamentals of Computer Programming	3
			STAT 305	Engineering Statistics	3-4
			or STAT 231	Probability and Statistical Inference for Engineers	
			BIOL 211	Principles of Biology I	6
			& BIOL 212	and Principles of Biology II	
			BIOL 211L	Principles of Biology Laboratory I	1
			or BIOL 212L	Principles of Biology Laboratory II	
			Additional 300+ or higher level courses in biochemistry, biophysics, biological sciences, chemistry or physics.		
Total Credits		85-89			

Communication Proficiency: A grade of C or better is required in ENGL 250. For students fulfilling the upper-level requirement with BBMB 411, a grade of 80% or better must be earned on two journal-style written reports.

LIB 160	Information Literacy	1
ENGL 150	Critical Thinking and Communication	3
ENGL 250	Written, Oral, Visual, and Electronic Composition	3
One course from the following:		
BBMB 411	Techniques in Biochemical Research	4
ENGL 305	Creative Writing: Nonfiction	3
ENGL 309	Proposal and Report Writing	3
ENGL 314	Technical Communication	3

General Education Area

Arts and Humanities	12
Social Sciences	9
U.S. Diversity	3
International Perspectives	3

Biochemistry minor is offered in both the College of Liberal Arts and Sciences and Agriculture and Life Sciences

BBMB 404	Biochemistry I	3
BBMB 405	Biochemistry II	3
BBMB 411	Techniques in Biochemical Research	4
One course from the following:		2-3
BBMB 461	Molecular Biophysics (2 crs)	
BBMB 561	Molecular Biophysics (2 crs)	
CHEM 325	Chemical Thermodynamics	
300+ level courses in BBMB or CHEM to 15 cr total		3-4
Total Credits		15-17

These lists of courses should not be regarded as statements of fixed requirements or as complete outlines of the work necessary for the major. They are given solely for the convenience of students or advisers who wish to estimate the amount of basic study that may be needed.

See also the B.S./M.S. program under Graduate Study.

Biochemistry, B.S.

Freshman

Fall	Credits	Spring	Credits
BBMB 101	1	BBMB 102	1
CHEM 201*	2	5 CHEM 211	2
CHEM 201L*	2	1 CHEM 211L	2
MATH 165**	4	4 MATH 166	4

ENGL 150	3	BIOL 211	3
LIB 160 ¹	1	BIOL 211L ³	1
		LAS General Education requirement ²	3
		15	16

Sophomore

Fall	Credits	Spring	Credits
CHEM 331	2	3 BBMB 201	2
CHEM 331L or 333L	3	1-2 CHEM 332	3
MATH 265 or 266	1-2	3-4 CHEM 332L or 334L	1-2
BIOL 212	5	3 PHYS 222	5
PHYS 221	3	5 ENGL 250 ¹	3
		15-17	14-15

Junior

Fall	Credits	Spring	Credits
BBMB 404 ⁴	3	BBMB 405 ⁴	3
BIOL 313	3	BIOL 314	3
LAS General Education Requirement ²	3	LAS General Education Requirement ²	3
LAS General Education Requirement ²	3	LAS General Education Requirement ²	3
LAS World Language Requirement ⁸	4	LAS World Language Requirement ⁸	4
		16	16

Senior

Fall	Credits	Spring	Credits
BBMB 411 ¹	2	4 BBMB 461	2
CHEM 324	4	3 Biological Science Elective ⁶	4
LAS General Education Requirement ²	3	CHEM 325	3
LAS General Education Requirement ²	3	BBMB 561L ⁷	2
BBMB 499 ⁵	var	BBMB 499 ⁵	var
		13	11

Total Credits: 116-119

* General Chemistry I and II (177, 177N or 177L and 178) are acceptable substitutes for CHEM 201 and 201L.

** ALEKS assessment determines math placement.

¹ Communication Proficiency: A grade of C or better is required in ENGL 250. For students fulfilling the upper-level requirement with BBMB 411, a grade of 80% or better must be earned on two journal-style written reports.

- ² Liberal Arts and Sciences (LAS) General Education requirements include:
12cr. Arts and Humanities, 9 cr. Social Sciences and 11 cr. Natural Sciences (8 cr.) and Math (3 cr.).
Students in all ISU majors must complete a 3 cr. course in U.S. Diversity and a 3 cr. course in International Perspectives. Discuss with your adviser how the two courses you select can be applied to address general education requirements. Check for a list of approved courses at: <http://www.registrar.iastate.edu/students/div-ip-guide>
- ³ One Biology laboratory course is required. Choose Biol 211L, 212L or 313L.
- ⁴ Students have the option of choosing the senior level biochemistry sequence for 6 credits (BBMB 404 and BBMB 405) or the graduate-level biochemistry sequence for 8 credits (BBMB 504, 505 and BBMB 506, 507).
- ⁵ Undergraduate study or research, BBMB 490 or 499, is recommended but not required. Credit value is variable.
- ⁶ Four credits of electives in Biological Sciences are required.
- ⁷ CHEM322L may be taken as a substitute for BBMB 561L.
- ⁸ World Language Requirement: (www.las.iastate.edu/academics/learning_goals.shtml)

Biophysics, B.S.

Freshman

Fall	Credits Spring	Credits
BBMB 101	1 BBMB 102	1
CHEM 201*	5 CHEM 211	2
or CHEM 177 and CHEM 178	CHEM 211L	2
CHEM 201L or 177L*	1 MATH 166	4
MATH 165**	4 BIOL 211	3
ENGL 150	3 BIOL 211L ³	1
LIB 160 ¹	1 COM S 207	3
	15	16

Sophomore

Fall	Credits Spring	Credits
CHEM 331	3 BBMB 201	2
MATH 265	4 CHEM 332	3
BIOL 212	3 MATH 266	3
PHYS 221	5 PHYS 222	5
	ENGL 250 ¹	3
	15	16

Junior		
Fall	Credits Spring	Credits
BBMB 404 ⁴	3 CHEM 325	3
CHEM 324	3 BBMB 461	2
LAS World Language Requirement ⁸	4 BBMB 561L ⁷	2
Science Elective ⁶	3 MATH 317	4
	LAS General Education Requirement ²	3
	LAS World Language Requirement ⁸	4
	13	18
Senior		
Fall	Credits Spring	Credits
BBMB 411 ¹	4 Science Elective ³	
Science Elective 300+ ⁵	3 LAS General Education Requirement ²	3
LAS General Education Requirement ²	3 LAS General Education Requirement ²	3
STAT 231 or 305	4 LAS General Education Requirement ²	3
LAS General Education Requirement ²	3 BBMB 499 ⁵	var
BBMB 499 or 490 ⁵	var	
	17	9

Total Credits: 119

- * General Chemistry I and II (177, 177n or 177l and 178) are acceptable substitutes for CHEM 201 and 201L.
- ** ALEKS assessment determines math placement.
- ¹ Communication Proficiency: A grade of C or better is required in ENGL 250. For students fulfilling the upper-level requirement with BBMB 411, a grade of 80% or better must be earned on two journal-style written reports.
- ² Liberal Arts and Sciences (LAS) General Education Requirements include a minimum of: 12 cr. Arts and Humanities, 9 cr. Social Sciences and 11 cr Natural Sciences (8 cr.) and Math (3 cr.)
Students in all ISU majors must complete a 3-cr. course in U.S. Diversity and a 3-cr. course in International Perspectives. Discuss with your adviser how the two courses you select can be applied to address general education requirements. Check for a list of approved courses at: <http://www.registrar.iastate.edu/courses/div-ip-guide.html>
- ³ One Biology laboratory course is required. Choose BIOL 211L or 212L.

- ⁴ Students have the option of choosing BBMB 405 or BBMB 420.
- ⁵ Undergraduate study or research, BBMB 490 or 499, is recommended but not required. Credit value is variable.
- ⁶ Seven additional science elective credits 300+; biochemistry, biophysics, biological sciences, chemistry or physics.
- ⁷ CHEM 322L can substitute for BBMB 561L.
- ⁸ World Language Requirement: (www.las.iastate.edu/academics/learning_goals.shtml)

Graduate Study

The department offers work for the degrees master of science and doctor of philosophy with majors in biochemistry and biophysics and with interdepartmental majors in bioinformatics and computational biology, genetics and genomics, immunobiology, molecular, cellular, and developmental biology, neuroscience, plant biology, and toxicology. Minor work is offered to students taking major work in other departments.

Prerequisite to graduate work is a sound undergraduate background in biology, chemistry, mathematics, and physics.

All graduate students are required by the department to teach as part of their training for an advanced degree.

The department offers a B.S./M.S. program in biochemistry and biophysics that allows students to obtain both the B.S. and M.S. degrees in five years. The program is open to students in the College of Liberal Arts and Sciences and in the College of Agriculture and Life Sciences. Students interested in this program should contact the department office for details. Application for admission to the Graduate College should be made near the end of the junior undergraduate (third) year. Students would begin research for the M.S. thesis during the summer semester after their junior year and are eligible for research assistantships.

Courses primarily for undergraduates:

BBMB 101: Introduction to Biochemistry

(1-0) Cr. 1. F.

Research activities, career opportunities in biochemistry and biophysics, and an introduction to the structure of biologically important compounds. For students majoring in biochemistry, agricultural biochemistry or biophysics or considering one of these majors.

BBMB 102: Introduction to Biochemistry Laboratory

(0-2) Cr. 1. S.

Prereq: Credit or enrollment in CHEM 177 and CHEM 177L or CHEM 201 and CHEM 201L

Topics in the scientific background of biochemistry, such as macromolecules, metabolism, and catalysis. Laboratory experimentation covers biochemical concepts and the study of bio-molecules including proteins, lipids and nucleic acids. A significant component is practice in scientific communication. For students majoring in biochemistry, agricultural biochemistry or biophysics or considering one of these majors.

BBMB 120: The Biochemistry of Beer

(Cross-listed with FS HN). (2-0) Cr. 2. F.

An introduction to the major classes of biomolecules, basic biochemical concepts, enzymology, metabolism and genetic engineering as they apply to the production and flavor of beer. All aspects of the biochemistry of beer will be covered, including the malting of barley, starch conversion, yeast fermentation and the chemical changes that occur during the aging of beer. Intended for non-majors. Natural science majors are limited to elective credit only.

BBMB 201: Chemical Principles in Biological Systems

(2-0) Cr. 2. S.

Prereq: Credit or enrollment in CHEM 332

Survey of chemical principles as they apply in biological systems including: water, organic chemistry of functional groups in biomolecules and biochemical cofactors, weak bonds and their contribution to biomolecular structure, oxidation-reduction reactions and redox potential, thermodynamic laws and bioenergetics, chemical equilibria and kinetics, inorganic chemistry in biological systems, data presentation. The subjects will be taught using molecules from biological systems as examples. Intended for majors in biochemistry, biophysics or agricultural biochemistry.

BBMB 221: Structure and Reactions in Biochemical Processes

(3-0) Cr. 3. F.S.

Prereq: CHEM 163, CHEM 167, or CHEM 177

Fundamentals necessary for an understanding of biochemical processes. Primarily for students in agriculture. Not acceptable for credit toward a major in biochemistry, biophysics, or agricultural biochemistry. Credit for both BBMB 221 and Chem 231 may not be applied toward graduation.

BBMB 301: Survey of Biochemistry

(3-0) Cr. 3. F.S.SS.

Prereq: CHEM 231 or CHEM 331

A survey of biochemistry: structure and function of amino acids, proteins, carbohydrates, lipids, and nucleic acids; enzymology; metabolism; biosynthesis; and selected topics. Not acceptable for credit toward a major in biochemistry, biophysics, or agricultural biochemistry.

BBMB 316: Principles of Biochemistry

(3-0) Cr. 3. F.

Prereq: CHEM 231 or CHEM 331; BIOL 212; BIOL 313 and BIOL 314 strongly recommended.

Understanding biological systems at the molecular level; chemistry of biological macromolecules, enzyme function and regulation, metabolic pathways; integration of metabolism in diverse living systems. For students in biology and related majors who do not require the more rigorous treatment of biochemistry found in BBMB 404/405. Not acceptable for credit toward a major in biochemistry, biophysics, or agricultural biochemistry.

BBMB 404: Biochemistry I

(3-0) Cr. 3. F.

Prereq: CHEM 332

A general overview for graduate and advanced undergraduate students in agricultural, biological, chemical and nutritional sciences. Chemistry of amino acids, proteins, carbohydrates, and lipids, vitamins; protein structure; enzymology; carbohydrate metabolism. Credit for both BBMB 420 and the BBMB 404 - 405 sequence may not be applied toward graduation.

BBMB 405: Biochemistry II

(3-0) Cr. 3. S.

Prereq: BBMB 404

A general overview for graduate and advanced undergraduate students in agricultural, biological, chemical, and nutritional sciences. Metabolism of carbohydrates, amino acids, nucleotides and lipids; formation, turnover, and molecular relationships among DNA, RNA, and proteins; genetic code; regulation of gene expression; selected topics in the molecular physiology of plants and animals. Credit for both BBMB 420 and the BBMB 404 - BBMB 405 sequence may not be applied toward graduation.

BBMB 411: Techniques in Biochemical Research

(2-8) Cr. 4. F.

Prereq: Credit or enrollment in BBMB 404 or BBMB 504 and BBMB 505; CHEM 211

Laboratory experimentation and techniques for studying biochemistry, including: chromatographic methods; electrophoresis; spectrophotometry; enzyme purification; enzyme kinetics; and characterization of carbohydrates, proteins, lipids, and nucleic acids. Scientific communication and technical writing are emphasized.

BBMB 420: Mammalian Biochemistry

(3-0) Cr. 3. F.

Prereq: CHEM 332, BIOL 314

Structure and function of proteins; enzymology; biological oxidation; chemistry and metabolism of carbohydrates, lipids, amino acids and nucleic acids; protein synthesis and the genetic code; relationship of biochemistry to selected animal diseases. Biochemistry of higher animals emphasized. Not acceptable for credit toward a major in agricultural biochemistry or biochemistry. Acceptable for credit toward a major in biophysics. Credit for both BBMB 420 and the BBMB 404 - 405 sequence may not be applied toward graduation.

BBMB 430: Prokaryotic Diversity and Ecology

(Dual-listed with BBMB 530). (Cross-listed with MICRO). (3-0) Cr. 3. Alt. S., offered odd-numbered years.

Prereq: MICRO 302, MICRO 302L

Survey of the diverse groups of prokaryotes emphasizing important and distinguishing metabolic, phylogenetic, morphological, and ecological features of members of those groups.

BBMB 440: Laboratory in Microbial Physiology, Diversity, and Genetics

(Cross-listed with MICRO). (2-6) Cr. 4. F.

Prereq: MICRO 302, MICRO 302L, CHEM 332, BIOL 313L

Fundamental techniques and theory for studying the cellular mechanisms, genetic processes and diversity of microbial life. Experimental techniques will include isolation and physiological characterization of bacteria that inhabit different environments as well as an emphasis on genetic and molecular techniques to understand antibiotic resistance processes and mechanisms. Also included are techniques for phylogenetic characterization, measuring gene expression, and genetic manipulation of bacteria. Essential components for the effective communication of scientific results are also emphasized.

BBMB 461: Molecular Biophysics

(Dual-listed with BBMB 561). (2-0) Cr. 2. S.

Prereq: Credit or enrollment in MATH 166 and CHEM 178 and PHYS 222 or PHYS 112.

Physical methods for the study of molecular structure and organization of biological materials. X-ray diffraction, nuclear magnetic resonance, hydrodynamics and fluorescence spectroscopy. Registration for the graduate credit commits the student to graduate-level examinations, which differ from undergraduate-level examinations in the number and/or difficulty of questions.

BBMB 490: Independent Study

Cr. 1-3. Repeatable. F.S.SS.

Prereq: College of Agriculture: junior or senior classification and permission of instructor; College of Liberal Arts and Sciences: permission of instructor.

Independent study with a faculty mentor. No more than 9 credits of BBMB 490 may count toward graduation.

BBMB 490H: Independent Study, Honors

Cr. 1-3. Repeatable. F.S.SS.

Prereq: College of Agriculture: junior or senior classification and permission of instructor; College of Liberal Arts and Sciences: permission of instructor

Independent study with a faculty mentor. No more than 9 credits of BBMB 490 may count toward graduation.

BBMB 499: Undergraduate Research

Cr. 1-5. Repeatable. F.S.SS.

Prereq: Permission of faculty member with whom student proposes to work.

Independent research under faculty guidance.

Courses primarily for graduate students, open to qualified undergraduates:**BBMB 504: Amino Acids and Proteins**

(2-0) Cr. 2. F.

Prereq: CHEM 332 or equivalent

Review of amino acids and proteins, including atomic interactions, thermodynamics, structure and properties of amino acids, post-translational modifications, protein expression, purification and analysis, protein secondary, tertiary and quaternary structure, protein folding, oxygen transport and hemoglobin, models for equilibrium binding, elementary reactions and enzyme kinetics, biosynthesis of amino acids: pathways and mechanisms.

BBMB 505: Bioenergetics and Metabolism

(2-0) Cr. 2. F.

Prereq: CHEM 211, CHEM 332; a previous course in biochemistry is strongly recommended

Examination of catabolic pathways involved in the oxidation of organic and inorganic molecules, and energy metabolism involving inputs from light or other non-light sources. Central metabolism and glycolysis, fermentation, aerobic and anaerobic respiration, photosynthesis.

BBMB 506: Membrane Biochemistry

(2-0) Cr. 2.

Prereq: CHEM 332 or equivalent

Analysis of the structure, function, and synthesis of membranes. Bacterial and eukaryotic membrane characteristics. Membrane transport and signaling mechanisms. Analysis of the structure and function of lipids and membrane proteins.

BBMB 507: Biochemistry of Nucleic Acids

(2-0) Cr. 2. S.

Prereq: CHEM 332 or equivalent

Analysis of the chemical structure, function, synthesis, and metabolism of nucleic acids. Chemical characterization of nucleotides, polynucleotides, DNA, and RNA. Analysis of transcription, translation, and the genetic code.

BBMB 510: Molecular Biology and Biochemistry of RNA

(2-0) Cr. 2. F.

Prereq: BIOL 313, BBMB 405, BBMB 502, BBMB 506 and 507 or Gen 409, or equivalent

Biochemical processes that define structure and function of nucleic acids. Emphasis on the molecular processes that take place during synthesis, processing, and function of different RNA species; review of recent advances in RNA research.

BBMB 530: Prokaryotic Diversity and Ecology

(Dual-listed with BBMB 430). (Cross-listed with MICRO). (3-0) Cr. 3. Alt. S., offered odd-numbered years.

Prereq: MICRO 302, MICRO 302L

Survey of the diverse groups of prokaryotes emphasizing important and distinguishing metabolic, phylogenetic, morphological, and ecological features of members of those groups.

BBMB 542A: Introduction to Molecular Biology Techniques: DNA Techniques

(Cross-listed with B M S, EEOB, FS HN, GDCB, HORT, NREM, NUTRS, V MPM, VDPAM). Cr. 1. Repeatable. F.S.

Includes genetic engineering procedures, sequencing, PCR, and genotyping. Offered on a satisfactory-fail basis only.

BBMB 542B: Introduction to Molecular Biology Techniques: Protein

(Cross-listed with B M S, EEOB, FS HN, GDCB, HORT, NREM, NUTRS, VDPAM). Cr. 1. Repeatable. S.SS.

Prereq: Graduate classification

Techniques. Includes: fermentation, protein isolation, protein purification, SDS-PAGE, Western blotting, NMR, confocal microscopy and laser microdissection, Immunophenotyping, and monoclonal antibody production. Sessions in basic molecular biology techniques and related procedures. Offered on a satisfactory-fail basis only.

BBMB 542C: Introduction to Molecular Biology Techniques: Cell Techniques

(Cross-listed with B M S, EEOB, FS HN, GDCB, HORT, NREM, NUTRS, V MPM, VDPAM). Cr. 1. Repeatable. F.S.

Includes: immunophenotyping, ELISA, flow cytometry, microscopic techniques, image analysis, confocal, multiphoton and laser capture microdissection. Offered on a satisfactory-fail basis only.

BBMB 542D: Introduction to Molecular Biology Techniques: Plant Transformation

(Cross-listed with B M S, EEOB, FS HN, GDCB, HORT, NREM, NUTRS, V MPM, VDPAM). Cr. 1. Repeatable. S.

Includes: Agrobacterium and particle gun-mediated transformation of tobacco, Arabidopsis, and maize, and analysis of transformants. Offered on a satisfactory-fail basis only.

BBMB 542E: Introduction to Molecular Biology Techniques: Proteomics

(Cross-listed with B M S, EEOB, FS HN, GDCB, HORT, NREM, NUTRS, V MPM, VDPAM). Cr. 1. Repeatable. F.

Includes: two-dimensional electrophoresis, laser scanning, mass spectrometry, and database searching. Offered on a satisfactory-fail basis only.

BBMB 542F: Introduction to Molecular Biology Techniques: Metabolomics

(Cross-listed with B M S, EEOB, FS HN, GDCB, HORT, NREM, NUTRS, V MPM, VDPAM). Cr. 1. Repeatable. F.

Includes: metabolomics and the techniques involved in metabolite profiling. For non-chemistry majoring students who are seeking analytical aspects into their biological research projects. Offered on a satisfactory-fail basis only.

BBMB 542G: Introduction to Molecular Biology Techniques: Genomic

(Cross-listed with B M S, EEOB, FS HN, GDCB, HORT, NREM, NUTRS, V MPM, VDPAM). Cr. 1. Repeatable. S.

Offered on a satisfactory-fail basis only.

BBMB 552: Biomolecular NMR Spectroscopy

(2-0) Cr. 2. Alt. F., offered even-numbered years.

Prereq: CHEM 325 or permission of instructor

Advanced solution state Nuclear Magnetic Resonance spectroscopy as applied to biological systems. Topics include theoretical principles of NMR, practical aspects of experimental NMR, methodologies for protein structure determination, NMR relaxation, recent advances in NMR spectroscopy.

BBMB 561: Molecular Biophysics

(Dual-listed with BBMB 461). (2-0) Cr. 2. S.

Prereq: Credit or enrollment in MATH 166 and CHEM 178 and PHYS 222 or PHYS 112.

Physical methods for the study of molecular structure and organization of biological materials. X-ray diffraction, nuclear magnetic resonance, hydrodynamics and fluorescence spectroscopy. Registration for the graduate credit commits the student to graduate-level examinations, which differ from undergraduate-level examinations in the number and/or difficulty of questions.

BBMB 561L: Laboratory in Molecular Biophysics

(1-3) Cr. 2. S.

Prereq: Credit or enrollment in BBMB 461/BBMB 561

Practice in methods of X-ray diffraction, nuclear magnetic resonance, hydrodynamics and fluorescence spectroscopy as applied to macromolecules.

BBMB 569: Bioinformatics III (Structural Bioinformatics)

(Cross-listed with BCB, COM S, CPR E, GDCB). (3-0) Cr. 3. F.

Prereq: BCB 567, BBMB 316, GEN 409, STAT 430

Molecular structures including genes and gene products: protein, DNA and RNA structure. Structure determination methods, structural refinement, structure representation, comparison of structures, visualization, and modeling. Molecular and cellular structure from imaging. Analysis and prediction of protein secondary, tertiary, and higher order structure, disorder, protein-protein and protein-nucleic acid interactions, protein localization and function, bridging between molecular and cellular structures. Molecular evolution.

BBMB 590: Special Topics

Cr. arr.

By arrangement.

BBMB 593: Workshop in Biochemistry and Biophysics

Cr. 1. Repeatable. F.S.

Prereq: Permission and signature of course administrator required.

Workshops in selected topics in biochemistry and biophysics. Credit in this course does not meet the requirement for advanced graduate electives in Biochemistry. Spring only: BBMB Undergraduate Research Symposium participation. Scheduled class meetings are required in addition to attending the symposium.

Courses for graduate students:**BBMB 607: Plant Biochemistry**

(2-0) Cr. 2. Alt. F., offered even-numbered years.

Prereq: BBMB 405 or BBMB 506 and BBMB 507

Description of unique aspects of plant biochemistry including lipid metabolism, cell wall structure, secondary metabolism, phytoalexin biosynthesis, and plant defenses.

BBMB 615: Molecular Immunology

(Cross-listed with MICRO, V MPM). (3-0) Cr. 3. Alt. F., offered odd-numbered years.

Prereq: BBMB 405 or BBMB 506 and BBMB 507

Current topics in molecular aspects of immunology: T and B cell receptors; major histocompatibility complex; antibody structure; immunosuppressive drugs and viruses; and intracellular signaling pathways leading to expression of genes that control and activate immune function.

BBMB 622: Carbohydrate Chemistry

(2-0) Cr. 2. Alt. S., offered even-numbered years.

Prereq: BBMB 404 or BBMB 504 and BBMB 505

Structure, occurrence, properties, function, and chemical and enzymatic modifications of monosaccharides, oligosaccharides, polysaccharides, and glycoproteins.

BBMB 632: Kinetics of Enzyme Action

(2-0) Cr. 2. Alt. F., offered even-numbered years.

Prereq: BBMB 504 and BBMB 505

Fundamental and advanced enzyme kinetics. Topics include integrated rate equations, methods for deriving initial-rate equations, inhibition, product effects, methods for verifying kinetic mechanisms, allostery, hysteresis, isotope effects, and complex kinetic mechanisms.

BBMB 642: Mechanisms of Enzymatic Catalysis

(2-0) Cr. 2. Alt. S., offered odd-numbered years.

Prereq: BBMB 404 or BBMB 420; or BBMB 504 and BBMB 505

The chemical basis of enzymatic catalysis with emphasis on mechanisms of substrate recognition, general acid-base catalysis and stereo-electronic factors.

BBMB 645: Molecular Signaling

(2-0) Cr. 2. Alt. S., offered odd-numbered years.

Prereq: BBMB 405 or BBMB 420; or BBMB 506 and BBMB 507

Molecular mechanisms of cellular signaling including receptor activation, desensitization and cross talk, signal transduction pathways, and nuclear receptors. Discussion includes a variety of cell surface receptors and their hormone; growth factor and extracellular matrix activators; protein kinases; caspase and transcription factor downstream signals; lipids, gases and cyclic nucleotides as regulators of cell signaling. Course content includes current literature, student and instructor presentations and research proposal writing.

BBMB 652: Protein Chemistry - Chemical Methods

(2-0) Cr. 1. Alt. F., offered odd-numbered years.

Prereq: BBMB 404 or BBMB 504 and BBMB 505

First 8 weeks. Chemical reactions as a means of determining protein structure and biological function.

BBMB 653: Protein Chemistry - Physical Methods

(2-0) Cr. 1. Alt. F., offered odd-numbered years.

Prereq: BBMB 404 or BBMB 504 and BBMB 505

Second 8 weeks. Protein structure determination as a means of understanding biological function.

BBMB 660: Membrane Biochemistry

(2-0) Cr. 2. Alt. F., offered even-numbered years.

Prereq: BBMB 405 or BBMB 506 and BBMB 507

Protein and lipid constituents of biological membranes. Structure and topography of membrane proteins. Selected topics concerning the membrane proteins involved in diverse biochemical processes, such as energy transduction transport across membranes, neurotransmission and signal transduction.

BBMB 661: Current Topics in Neuroscience

(Cross-listed with GDCB, NEURO). (2-0) Cr. 2-3. Repeatable. Alt. S., offered even-numbered years.

Prereq: NEURO 556 (or comparable course) or permission of instructor

Topics may include molecular and cellular neuroscience, neurodevelopment, neuroplasticity, neurodegenerative diseases, cognitive neuroscience, sensory biology, neural integration, membrane biophysics, neuroethology, techniques in neurobiology and behavior.

BBMB 675: Nucleic Acid Structure and Function

(2-0) Cr. 2. Alt. F., offered even-numbered years.

Prereq: BBMB 405 or BBMB 506 and BBMB 507

In-depth discussion of nucleic acid properties, structures and structure/function relationships. Interactions between nucleic acids and proteins will be emphasized.

BBMB 676: Biochemistry of Gene Expression in Eucaryotes

(Cross-listed with MCDB). (2-0) Cr. 2. Alt. S., offered even-numbered years.

Prereq: BBMB 404 and BBMB 504; and BBMB 506 and BBMB 507; or BBMB 405 or BBMB 505 and or GDCB 511

Analysis of the biochemical processes involved in expression of eucaryotic genes and the regulation thereof, including RNA polymerase, transcriptional regulatory proteins, enhancers and silencers, chromosome structure, termination, RNA processing, RNA transport, RNA turnover, small RNAs, translational regulation, protein turnover.

BBMB 681: Advanced Seminar

Cr. 1. Repeatable. F.S.

Prereq: Permission of instructor

Student presentations.

BBMB 682: Departmental Seminar

Cr. R. F.S.

Prereq: Permission of instructor

Faculty, staff and invited guest research seminar.

BBMB 696: Research Seminar

(Cross-listed with AGRON, FOR, GDCB, HORT, PLBIO). Cr. 1. Repeatable.

Research seminars by faculty and graduate students. Offered on a satisfactory-fail basis only.

BBMB 698: Seminar in Molecular, Cellular, and Developmental Biology

(Cross-listed with GDCB, MCDB, MICRO, V MPM). (2-0) Cr. 1-2. Repeatable. F.S.

Student and faculty presentations.

BBMB 699: Research

Cr. arr. Repeatable. F.S.

Prereq: Permission of instructor