

BIOCHEMISTRY (AGLS)

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 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, 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 Major in the College of Agriculture and Life Sciences

For the undergraduate curriculum leading to the degree bachelor of science, see College of Agriculture and Life Sciences, Curricula. Biochemistry is recommended to students interested in the areas of agriculture requiring strong preparation in biochemistry, chemistry, physics, and mathematics, or in preparation for the study of veterinary medicine. Employment opportunities exist in agrochemical industries, and animal and plant biotechnology.

Biochemistry program of study

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 490	Independent Study (Elective) ^{max. 9 cr. can be applied}	arr t
BBMB 499	Undergraduate Research (Elective) ^{highly encouraged}	arr t
Take one of the following:		5-7
CHEM 201	Advanced General Chemistry	
CHEM 177	General Chemistry I	
& CHEM 178	and General Chemistry II	
Take one of the following:		1
CHEM 201L	Laboratory in Advanced General Chemistry	
or CHEM 177L	Laboratory in General Chemistry I	
or CHEM 177LL	Laboratory in General Chemistry I	
CHEM 211	Quantitative and Environmental Analysis	4
& 211L	and Quantitative and Environmental Analysis Laboratory	
Take one of the following:		3-4
CHEM 322L	Laboratory in Physical Chemistry	
or BBMB 461	Molecular Biophysics	
& BBMB 561	and Laboratory in Molecular Biophysics	
CHEM 324	Introductory Quantum Mechanics	3
CHEM 325	Chemical Thermodynamics	3
CHEM 331	Organic Chemistry I	6
& CHEM 332	and Organic Chemistry II	
CHEM 333L	Laboratory in Organic Chemistry I (for Chemistry and Biochemistry Majors)	1-2
or CHEM 331L	Laboratory in Organic Chemistry I	
MATH 165	Calculus I	4
MATH 166	Calculus II	4
MATH 265	Calculus III	3-4
or MATH 266	Elementary Differential Equations	

or MATH 267	Elementary Differential Equations and Laplace Transforms	
PHYS 221 & PHYS 222	Introduction to Classical Physics I and Introduction to Classical Physics II	10
BIOL 211 & BIOL 212	Principles of Biology I and Principles of Biology II	6
BIOL 211L or BIOL 212L or BIOL 313L	Principles of Biology Laboratory I Principles of Biology Laboratory II Genetics Laboratory	1
BIOL 313	Principles of Genetics	3
BIOL 314	Principles of Molecular Cell Biology	3
Agricultural Sciences from approved list		9
Total Credits		83-88
		†

† Arranged with instructor.

The College of Agriculture and Life Sciences requires the following:

University Requirements: Select approved courses to meet U.S. Diversity 3 cr. and International Perspectives 3 cr. Credits can dual assign with Humanities and Social Science choices.

Communications Proficiency

ENGL 150	Critical Thinking and Communication (C or better)	3
ENGL 250	Written, Oral, Visual, and Electronic Composition (C or better)	3
SP CM 212	Fundamentals of Public Speaking	3
LIB 160	Information Literacy	1
Total Credits		10

Ethics

Courses from an approved list. 3

Humanities and Social Sciences: select from approved lists

Humanities course		3
Social Science course		3
Total Credits		6

Agricultural Sciences

Courses from an approved list 9

Biochemistry, B.S. - option 1

Freshman

Fall	Credits	Spring	Credits
CHEM 177	3	CHEM 178	3
CHEM 177N	4	MATH 166	4
MATH 165	3	ENGL 250	3
ENGL 150	1	BBMB 102	3

BIOL 211	3	BIOL 212	3
BIOL 211L*	1	Student choice	3
BBMB 101	1		
LIB 160	1		
		18	17

Sophomore

Fall	Credits	Spring	Credits
PHYS 221	5	PHYS 222	5
CHEM 211	2	CHEM 332	3
CHEM 211L	2	BIOL 314	3
CHEM 331	3	BBMB 201	2
CHEM 331L	1	MATH 265 or 266	3-4
BIOL 313	3		
		16	16-17

Junior

Fall	Credits	Spring	Credits
BBMB 404	3	BBMB 405	3
SP CM 212	3	Student choice	3
Student choice	3	Student choice	3
Student choice	3	Student choice	3
Student choice	3	Student choice	3
		15	15

Senior

Fall	Credits	Spring	Credits
BBMB 411	4	CHEM 325	3
CHEM 324	3	BBMB 461	2
Student choice	3	and BBMB 561L	2
Student choice	3	or CHEM 322L	3
Student choice	3	Student choice	3
		Student choice	3
		Student choice	3
		16	19

* Students may elect to take either 211L, 212L or 313L.

'Student choice' are for courses in Humanities, Ethnicities, Social Sciences, Agriculture Sciences, and Electives.

Biochemistry, B.S. - option 2

Freshman

Fall	Credits	Spring	Credits
CHEM 201	5	MATH 166	4
CHEM 201L	1	ENGL 250	3
MATH 165	4	BBMB 102	1

BIOL 211	3 BIOL 212	3
BIOL 211L*	1 LIB 160	1
BBMB 101	1 CHEM 211	2
	CHEM 211L	2
15		16

Sophomore

Fall	Credits Spring	Credits
PHYS 221	5 PHYS 222	5
CHEM 331	3 CHEM 332	3
CHEM 331L	1 BIOL 314	3
BIOL 313	3 BBMB 201	2
Student choice	3 MATH 265 or 266	3-4
Student choice	3	
18		16-17

Junior

Fall	Credits Spring	Credits
BBMB 404	3 BBMB 405	3
SP CM 212	3 Student choice	3
Student choice	3 Student choice	3
Student choice	3 Student choice	3
Student choice	3 Student choice	3
15		15

Senior

Fall	Credits Spring	Credits
BBMB 411	4 CHEM 325	3
CHEM 324	3 BBMB 461	2
Student choice	3 and	
Student choice	3 BBMB 561L	2
Student choice	3 or CHEM 322L	3
	Student choice	3
	Student choice	3
	Student choice	3
16		19

* Students may elect to take either 211L, 212L or 313L.

'Student choice' are for courses in Humanities, Ethnicity, Social Sciences, Agriculture Sciences, and Electives.

Courses primarily for undergraduates:
BBMB 101: Introduction to Biochemistry

(1-0) Cr. 1. F.

Basic structure and function of biological molecules: protein, lipids, nucleic acids, and carbohydrates. Introduction to frontier technologies in the biosciences, and a survey of careers and research in biotechnology. For students majoring in 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 110: Biochemistry Learning Community Orientation

Cr. 1. F.

Prereq: Co-enrollment with BBMB 101 highly recommended.

Overview of the program of study, academic planning, resources on campus for the successful transition to Iowa State, team#building, leadership, and community#focused activities. For members of the Biochemistry & Biophysics Learning Community. Offered on a satisfactory-fail basis only.

BBMB 111: Biochemistry Learning Community

Cr. 1. S.

Prereq: Enrollment in BBMB102 is highly recommended.

Overview of career-building and research resources within BBMB and across ISU, including internships, lab skills, independent research, and leadership opportunities. For members of the Biochemistry & Biophysics Learning Community. Offered on a satisfactory-fail basis only.

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 120L: Biochemistry of Beer Laboratory

(Cross-listed with FS HN). Cr. 1.

Prereq: Credit or enrollment for credit in BBMB 120

An introduction to biochemical methods related to the production of beer. Laboratory exercises related to water chemistry, mash enzymology, hop compound extraction and analysis, and yeast biology will be performed. Closely follows the material being taught in BBMB 120. Natural science majors are limited to elective credit only.

BBMB 121: Medicines, Drugs and You

Cr. 2. S.

Prereq: One year of high school chemistry or CHEM 50 and biology.

An introduction to how medicines treat disease, what drug molecules look like, how they function, how they can be toxic, modern therapeutics ranging from over-the-counter pain relievers, antibiotics and anti-depressants, to anti-cancer chemotherapies, a discussion of illegal drugs from toxicity to mechanism of action and potential therapeutic benefits. Intended for students of all majors.

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. 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. Course offered online. Not acceptable for credit toward a major in biochemistry, biophysics, or agricultural biochemistry.

BBMB 303: General Biochemistry

Cr. 3. F.

Prereq: CHEM 331 or equivalent

Survey of biochemistry: structure and function of amino acids, proteins, carbohydrates, lipids and nucleic acids; enzyme activity; metabolism; DNA replication; RNA transcription; protein translation; with case studies examining industrial uses. Not acceptable for a credit towards a major in biochemistry, biophysics or agricultural biochemistry. Only one of 301, 303(X), or 316 may count toward graduation.

BBMB 312: Experimental Research Skills in Biochemistry

Cr. 2. F.S.

Prereq: BBMB 102; credit or concurrent enrollment in CHEM 178 or CHEM 201

Inquiry-based introduction to biochemical techniques such as protein purification, enzymatic assays, solution preparation, hypothesis formation and testing, data analysis, high-throughput methodology, research record keeping, technical writing and scientific communication.

BBMB 316: Principles of Biochemistry

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

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. Course offered online. Not acceptable for credit toward a major in biochemistry, biophysics, or agricultural biochemistry.

BBMB 404: Biochemistry I

(3-0) Cr. 3. F.

Prereq: CHEM 331

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. Course available online. 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.S.

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 532: Enzyme Kinetics and Mechanisms

Cr. 2. Alt. S., offered odd-numbered years.

Prereq: BBMB 504

Advanced concepts of enzyme kinetics and catalysis. Experimental methods for determining kinetic and chemical reaction mechanisms. Enzyme structure/function relationships and the role of dynamics in catalysis.

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 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: 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 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 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 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