

# BIOCHEMISTRY, BIOPHYSICS, AND MOLECULAR BIOLOGY (BBMB)

*Any experimental courses offered by BBMB can be found at:*

registrar.iastate.edu/faculty-staff/courses/explisting/ (<http://www.registrar.iastate.edu/faculty-staff/courses/explisting/>)

**Courses primarily for undergraduates:**

## **BBMB 101: Introduction to Biochemistry**

(1-0) Cr. 1. F.

Foundational principles of the molecules and chemistry of life, including structure and function of biological molecules: protein, lipids, nucleic acids, and carbohydrates. Survey of modern biotechnology frontiers. 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 concurrent enrollment in (CHEM 177; CHEM 177L) or (CHEM 201; 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.

Biochemistry & Biophysics Learning Community serving an overview of the program of study, academic planning, and university resources. Survey of careers and research in biotechnology and medicine. Introductions to ISU research and faculty. Concurrent enrollment with BBMB 101 highly recommended. Offered on a satisfactory-fail basis only.

## **BBMB 111: Biochemistry Learning Community**

Cr. 1. S.

Biochemistry & Biophysics Learning Community serving an overview of career-development and research resources, including research opportunities, internships, lab skills, and leadership roles. Introductions to ISU research and faculty. Concurrent enrollment with BBMB 102 highly recommended. 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 concurrent enrollment 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.

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. The differences between drugs and supplements. Intended for students of all majors.

## **BBMB 201: Chemical Principles in Biological Systems**

(2-0) Cr. 2. S.

*Prereq: Credit or concurrent enrollment in CHEM 332*

Survey of chemical principles as they apply to 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 or 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. Course offered online. Only one of BBMB 301, 303, or 316 may count toward graduation; Not acceptable for credit toward a major in biochemistry, biophysics, or agricultural biochemistry.

**BBMB 303: General Biochemistry**

Cr. 3. F.

*Prereq: CHEM 331*

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 311: Writing Scientific Reports in Biochemistry**

Cr. 1. F.S.

*Prereq: Credit or concurrent enrollment in BBMB 312*

Data analysis, presentation, and writing reports in biochemistry. This course accompanies BBMB 312.

**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, and research record keeping. Concurrent enrollment in BBMB 311 recommended.

**BBMB 316: Principles of Biochemistry**

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

*Prereq: BIOL 314; (CHEM 231 or CHEM 331)*

Biological systems at the molecular level; chemistry of biological macromolecules, enzyme function and regulation, basic 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. Only one of BBMB 301, 303, or 316 may count toward graduation; Not acceptable for credit toward a major in biochemistry, biophysics, or agricultural biochemistry.

**BBMB 404: Biochemistry I**

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

*Prereq: CHEM 331*

A general overview for graduate and advanced undergraduate students in agricultural, biological, chemical and nutritional sciences. First semester of a two-semester series with BBMB 405. Chemistry of amino acids, proteins, carbohydrates, and lipids, vitamins; protein structure and function; enzymology; carbohydrate metabolism. BIOL 314 strongly recommended. 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. F.S.SS.

*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 410: Analysis of Scientific Literature**

(2-0) Cr. 2. Repeatable, maximum of 2 times. F.S.

*Prereq: Credit or concurrent enrollment in BBMB 404 or BBMB 504*

Examination and discussion of current research reports in biochemistry, biophysics, genetics, molecular and cell biology. Critical evaluation and analysis of scientific data and experimental design in research literature.

**BBMB 411: Techniques in Biochemical Research**

(2-8) Cr. 4. F.

*Prereq: Credit or concurrent enrollment in CHEM 332*

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: BIOL 314; CHEM 332*

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 445: Molecular Signaling**

(Dual-listed with BBMB 545). (2-0) Cr. 2. Alt. S., offered even-numbered years.

*Prereq: 445: BBMB 405 or BBMB 420, 545: BBMB 506; BBMB 507*

Molecular mechanisms of cellular signaling including receptor activation, desensitization and cross talk, signal transduction pathways, nuclear receptors, growth factor and extracellular matrix activators, protein kinases, caspase and transcription factor downstream signals, and lipids, gases and cyclic nucleotides as regulators of cell signaling. Course content includes current literature, student and instructor presentations and, for BBMB 545 students only, research proposal writing and review.

**BBMB 461: Molecular Biophysics**

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

*Prereq: CHEM 178; PHYS 232*

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: 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: 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 Instructor*

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.S.

*Prereq: CHEM 332 or equivalent*

Protein structure and chemistry including protein folding, examples of enzyme functions and mechanisms, methods of protein expression, purification, and analysis, and elementary enzyme kinetics.

**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 512: Principles of Glycobiology**

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

*Prereq: 3 credits in Organic Chemistry*

Structure, synthesis, and functions of glycans, glycoproteins, glycolipids, and glycosylated secondary metabolites in prokaryotic and eukaryotic organisms. Fundamental role of glycans in living organisms along with the most advanced techniques used for their characterization. Biotechnological applications of glycans and glycoconjugates for human needs.

**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 531: Plant Biochemistry**

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

*Prereq:* BBMB 301 or equivalent

In-depth exploration of plant biochemistry with a focus on the unique aspects of plants versus heterotrophic organisms. Analysis of unique pathways, metabolic trafficking between unique organelles and tissues, and techniques for their characterization.

**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.

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 545: Molecular Signaling**

(Dual-listed with BBMB 445). (2-0) Cr. 2. Alt. S., offered even-numbered years.

*Prereq:* 445: BBMB 405 or BBMB 420, 545: BBMB 506; BBMB 507

Molecular mechanisms of cellular signaling including receptor activation, desensitization and cross talk, signal transduction pathways, nuclear receptors, growth factor and extracellular matrix activators, protein kinases, caspase and transcription factor downstream signals, and lipids, gases and cyclic nucleotides as regulators of cell signaling. Course content includes current literature, student and instructor presentations and, for BBMB 545 students only, research proposal writing and review.

**BBMB 549: Nuclear Magnetic Resonance Spectroscopy**

(Cross-listed with CHEM). (3-0) Cr. 3. S.

*Prereq:* any one of the following: CHEM 324, CHEM 325, BBMB 461, BBMB 561

Theoretical principles of NMR, practical aspects of experimental NMR, solution and solid state NMR, methodologies for molecule characterization, protein structure determination, NMR relaxation, and recent advances.

**BBMB 553: Current Research in Chemical and Physical Biology**

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

*Prereq: BBMB 404 or equivalent*

Principles and applications of chemical and physical methods to analyze biological structures and function ranging from cells to individual biomolecules.

**BBMB 561: Molecular Biophysics**

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

*Prereq: CHEM 178; PHYS 232*

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 661: Advanced Topics in Neuroscience**

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

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

Students will present three journal articles and two overview lectures on topics in neuroscience that are related but outside of their own research interest.

**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 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. S.

Student and faculty presentations.

**BBMB 699: Research**

Cr. arr. Repeatable. F.S.

*Prereq: Permission of instructor*