The department of Biochemistry, Biophysics & Molecular Biology 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.

<table>
<thead>
<tr>
<th>Biochemistry program of study</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BBMB 101 Introduction to Biochemistry</td>
<td>1</td>
</tr>
<tr>
<td>BBMB 102 Introduction to Biochemistry Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>BBMB 201 Chemical Principles in Biological Systems</td>
<td>2</td>
</tr>
<tr>
<td>BBMB 312 Experimental Research Skills in Biochemistry</td>
<td>2</td>
</tr>
<tr>
<td>or CHEM 211 &amp; 211L Quantitative and Environmental Analysis Laboratory</td>
<td></td>
</tr>
<tr>
<td>BBMB 404 Biochemistry I</td>
<td>3</td>
</tr>
<tr>
<td>or (4 credits) BBMB 504 Amino Acids and Proteins</td>
<td></td>
</tr>
<tr>
<td>BBMB 505 Bioenergetics and Metabolism</td>
<td></td>
</tr>
<tr>
<td>BBMB 405 Biochemistry II</td>
<td>3</td>
</tr>
<tr>
<td>or (4 credits) BBMB 506 Membrane Biochemistry</td>
<td></td>
</tr>
<tr>
<td>BBMB 507 Biochemistry of Nucleic Acids</td>
<td></td>
</tr>
<tr>
<td>BBMB 411 Techniques in Biochemical Research</td>
<td>4</td>
</tr>
<tr>
<td>BBMB 490 Independent Study (Elective) max. 9 cr. can be applied</td>
<td>arr</td>
</tr>
<tr>
<td>BBMB 499 Undergraduate Research (Elective) highly encouraged</td>
<td>arr</td>
</tr>
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</table>

Take one of the following:

| CHEM 201 Advanced General Chemistry | 5-7 |
| CHEM 177 General Chemistry I & CHEM 178 and General Chemistry II | |

Take one of the following:

| CHEM 201L Laboratory in Advanced General Chemistry | 1 |
| or CHEM 177:Laboratory in General Chemistry I | |
| or CHEM 177:Laboratory in General Chemistry I | |

Take one of the following:

| CHEM 322L Laboratory in Physical Chemistry | 3-4 |
| or BBMB 461Molecular Biophysics & BBMB 561 and Laboratory in Molecular Biophysics | |
| CHEM 324 Introductory Quantum Mechanics | 3 |
| CHEM 325 Chemical Thermodynamics | 3 |
| CHEM 331 Organic Chemistry I & CHEM 332 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 | |
| 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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>PHYS 221</td>
<td>Introduction to Classical Physics I</td>
<td>5</td>
</tr>
<tr>
<td>PHYS 232</td>
<td>Introduction to Classical Physics II</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 232L</td>
<td>Introduction to Classical Physics II Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 211</td>
<td>Principles of Biology I</td>
<td>6</td>
</tr>
<tr>
<td>&amp; BIOL 212</td>
<td>and Principles of Biology II</td>
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<tr>
<td>BIOL 211L</td>
<td>Principles of Biology Laboratory I</td>
<td>1</td>
</tr>
<tr>
<td>or BIOL 212L</td>
<td>Principles of Biology Laboratory II</td>
<td>3</td>
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<tr>
<td>or BIOL 313L</td>
<td>Genetics Laboratory</td>
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<tr>
<td>BIOL 313</td>
<td>Principles of Genetics</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 314</td>
<td>Principles of Molecular Cell Biology</td>
<td>3</td>
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</table>

Agricultural Sciences from approved list 9

Total Credits 81-86

† 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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>ENGL 150</td>
<td>Critical Thinking and Communication (C or better)</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 250</td>
<td>Written, Oral, Visual, and Electronic Composition (C or better)</td>
<td>3</td>
</tr>
<tr>
<td>SP CM 212</td>
<td>Fundamentals of Public Speaking</td>
<td>3</td>
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<tr>
<td>LIB 160</td>
<td>Information Literacy</td>
<td>1</td>
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Total Credits 10

Ethics

Courses from an approved list. 3

Humanities and Social Sciences: select from approved lists

<table>
<thead>
<tr>
<th>Humanities course</th>
<th>Social Science course</th>
<th>Credits</th>
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Total Credits 6

Agricultural Sciences

Courses from an approved list 9

Biochemistry, B.S. - option 1

Freshman

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CHEM 177</td>
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<td>CHEM 178</td>
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<tr>
<td>CHEM 177N</td>
<td>1</td>
<td>MATH 166</td>
<td>4</td>
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<tr>
<td>MATH 165</td>
<td>4</td>
<td>ENGL 250</td>
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ENGL 150 3
BIOL 211 3 BIOL 212 3
BIOL 211L* 1 Student choice 3
BBMB 101 1
LIB 160 1

18 17

Sophomore

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<tr>
<th>Fall</th>
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<th>Spring</th>
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<tbody>
<tr>
<td>BBMB 312</td>
<td>2</td>
<td>BBMB 201</td>
<td>2</td>
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<tr>
<td>BIOL 313</td>
<td>3</td>
<td>MATH 265 or 266</td>
<td>3-4</td>
</tr>
<tr>
<td>PHYS 221</td>
<td>5</td>
<td>CHEM 332</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 331</td>
<td>3</td>
<td>PHYS 232</td>
<td>4</td>
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<tr>
<td>CHEM 331L</td>
<td>1</td>
<td>PHYS 232L</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 314</td>
<td></td>
<td></td>
<td>3</td>
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</table>

14 16-17

Junior

<table>
<thead>
<tr>
<th>Fall</th>
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<th>Spring</th>
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<tbody>
<tr>
<td>BBMB 404</td>
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<td>BBMB 405</td>
<td>3</td>
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<tr>
<td>SP CM 212</td>
<td>3</td>
<td>Student choice</td>
<td>3</td>
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<tr>
<td>Student choice</td>
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<tr>
<td>Student choice</td>
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<td>Student choice</td>
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15 15

Senior

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
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<tbody>
<tr>
<td>BBMB 411</td>
<td>4</td>
<td>CHEM 325</td>
<td>3</td>
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<tr>
<td>CHEM 324</td>
<td>3</td>
<td>BBMB 461</td>
<td>2</td>
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<tr>
<td>Student choice</td>
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<tr>
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<td>Student choice</td>
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<tr>
<td>Student choice</td>
<td>3</td>
<td>Student choice</td>
<td>3</td>
</tr>
</tbody>
</table>

16 19

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

‘Student choice ’are for courses in Humanities, Ethnics, Social Sciences, Agriculture Sciences, and Electives.

Biochemistry, B.S. - option 2

Freshman

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 201</td>
<td>5</td>
<td>MATH 166</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 201L</td>
<td>1</td>
<td>ENGL 250</td>
<td>3</td>
</tr>
<tr>
<td>Course Code</td>
<td>Credits</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>---------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>BBMB 101</td>
<td>(1-0) Cr. 1. F.</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>BBMB 102</td>
<td>(0-2) Cr. 1. S.</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>BBMB 411</td>
<td>3</td>
<td>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 &amp; Biophysics Learning Community. Offered on a satisfactory-fail basis only.</td>
<td></td>
</tr>
</tbody>
</table>

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

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

Courses primarily for undergraduates:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBMB 101</td>
<td>(1-0) Cr. 1. F.</td>
<td>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.</td>
</tr>
<tr>
<td>BBMB 102</td>
<td>(0-2) Cr. 1. S.</td>
<td>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.</td>
</tr>
</tbody>
</table>
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 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, 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.S.

*Prereq: CHEM 231 or CHEM 331*

A 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 toward a major in biochemistry, biophysics or agricultural biochemistry. Only one of 301, 303(X), or 316 may count toward graduation.

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 credit toward 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: Procaryotic 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 procaryotes emphasizing important and distinguishing metabolic, phylogenetic, morphological, and ecological features of members of those groups.

BBMB 440: Laboratory in Microbial Physiology, Diversity, and Genetics  
(Dual-listed with MICRO). (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, CHEM 178, PHYS 232 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.S.S.  
**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.S.S.  
**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.S.S.  
**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: Procaryotic 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 procaryotes 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, EE OB, FS HN, GDCB, HORT, NREM, NUTRS, VMPM, 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, EE OB, 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, VMPM, 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, VMPM, 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, CHEM 178, PHYS 232 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

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: Advanced Topics in Neuroscience
(Cross-listed with GDCB, 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 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.
S.
Student and faculty presentations.

BBMB 699: Research
Cr. arr. Repeatable. F.S.
Prereq: Permission of instructor