

# BIOCHEMISTRY AND BIOPHYSICS

The Department of Biochemistry and Biophysics (BB) is part of the School of Life Sciences.

The Department has world-class faculty, a tradition of interdisciplinary research, teaching excellence and extraordinary laboratories to facilitate undergraduate and graduate learning. The department ranks high nationally and internationally in many research areas of biochemistry and molecular biophysics, including structural biology, genetic code expansion technology, metabolic regulation, signal transduction, protein chemistry, gene expression, epigenetics, cell cycle control and cell movement and adhesion.

## Undergraduate Degrees

Biochemists explore the chemical structure of living matter and the chemical reactions occurring in living cells. Biophysicists use the methods of physical science to study the structure and functions of macromolecules. The Department offers two BS degrees, both accredited by the American Society for Biochemistry and Molecular Biology (ASBMB):

- Biochemistry and Biophysics (BB)
- Biochemistry and Molecular Biology (BMB) with options in Advanced Molecular Biology, Computational Molecular Biology, and Pre-Medicine.

Both degrees provide students a foundation in the physical and biological sciences. They are designed to help students prepare for careers in the health sciences, for technical employment at the BS level, or for graduate study in the life sciences. Graduates of the department's programs have found rewarding careers in medicine, dentistry, clinical chemistry, biotechnology, genetics, cell biology, forensic science, pharmacology, physiology, toxicology, and nutrition, as well as in biochemistry or biophysics. Others have used the degree as a springboard to nontechnical careers that benefit from a broad scientific background, including business, intellectual property law, journalism, and health care administration. Both majors benefit from the wealth of departmental course offerings and faculty research programs. Because of the interdisciplinary nature of the program, students majoring Biochemistry and Biophysics and Biochemistry and Molecular Biology cannot seek a dual major or double degree in both majors or in the BioHealth Sciences, Biology, Zoology and Microbiology majors.

High school students interested in careers in biochemistry or biophysics should prepare for college by taking four years of mathematics and at least one year each of physics, chemistry, and biology. Students transferring from a community college should have completed one year each of the following by the end of the sophomore year, if they plan to graduate in four years' total time: general chemistry, organic chemistry, calculus-based physics, general biology and three semesters or four quarters of calculus, including vector calculus. An excellent advising program is available to undergraduates, and prospective students are encouraged to consult with a departmental advisor or with faculty members working in an area of interest to them. Undergraduate students are also encouraged to participate in research in the laboratory of a faculty member.

## Graduate Degrees

The Biochemistry and Biophysics department also oversees an internationally recognized graduate program that offers PhD and MS degrees, including a "4+1" Accelerated Masters Program degree. Faculty in the program include departmental faculty and also a group of affiliate faculty from other departments who have research programs in the molecular life sciences. Graduate program faculty have diverse research expertise including protein and DNA structural biology, redox biology, protein homeostasis, aging, single molecule studies, molecular motors, genetic code expansion, molecular neuroscience, bioinformatics and computational biophysics, metabolic regulation, signal transduction, vitamin D and innate immunity, gene expression, epigenetics, cell cycle control, membrane dynamics and repair, biomineralization, and cell movement and adhesion. Detailed information on the graduate faculty and program is available from the Department of Biochemistry and Biophysics website (<https://biochem.oregonstate.edu/>).

## Undergraduate Programs

### Majors

- Biochemistry and (<http://catalog.oregonstate.edu/college-departments/science/school-life-sciences/biochemistry-biophysics/biochemistry-molecular-biology-bs-hbs/>)Biophysics (<http://catalog.oregonstate.edu/college-departments/science/school-life-sciences/biochemistry-biophysics/biochemistry-biophysics-bs-hbs/>)

#### Options:

- Advanced B (<http://catalog.oregonstate.edu/college-departments/science/school-life-sciences/biochemistry-biophysics/biochemistry-biophysics-bs-hbs/advanced-biophysics-option/>)*iophysics*
  - N (<http://catalog.oregonstate.edu/college-departments/science/school-life-sciences/biochemistry-biophysics/biochemistry-biophysics-bs-hbs/neuroscience-option/>)*euroscience*
  - Pre-Medicine/Biochemistry and B (<http://catalog.oregonstate.edu/college-departments/science/school-life-sciences/biochemistry-biophysics/biochemistry-biophysics-bs-hbs/pre-medicinebiochemistry-biophysics-option/>)*iophysics*
  - Biochemistry and Molecular Biology (<http://catalog.oregonstate.edu/college-departments/science/school-life-sciences/biochemistry-biophysics/biochemistry-molecular-biology-bs-hbs/>)
- Options:**
- *Advanced Molecular Biology*
  - *Computational Molecular Biology*
  - *Pre-Medicine/Biochemistry and Molecular Biology*

## Graduate Programs

### Major

- Biochemistry and Biophysics (<http://catalog.oregonstate.edu/college-departments/science/school-life-sciences/biochemistry-biophysics/biochemistry-biophysics-ma-ms-phd/>)

### Minor

- Biochemistry and Biophysics (<http://catalog.oregonstate.edu/college-departments/science/school-life-sciences/biochemistry-biophysics/biochemistry-biophysics-graduate-minor/>)

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## Faculty

**Professors** Ahern, Barbar, Beckman, Freitag, Gombart, Hagen, Karplus, Mehl

**Associate Professors** Hendrix, Hsu, Johnson, McFadden, Perez

**Assistant Professors** Nyarko, Qiu

**Senior Instructors** van Zee

**Instructor** Dalton

**Assistant Professor, Senior Research** Cooley, Franco

**Associate Professor, Senior Research** Estevez

## BB 100, THE MOLECULES OF LIFE, 2 Credits

A brief introduction to molecular biology for nonspecialists. Subjects vary, but have included biochemical basis of the origin of life, biochemical genetics, biochemical aspects of memory and behavior, mutagenesis, bioenergetics and nutrition, and environmental biochemistry.

**Equivalent to:** BB 100H

## BB 111, INTRODUCTION TO BIOCHEMISTRY AND BIOPHYSICS RESEARCH, 1 Credit

Designed to introduce biochemistry and biophysics students to departmental research opportunities and advisors.

## BB 211, PROFESSIONAL DEVELOPMENT II: MOLECULAR, MICROBIAL, BIOHEALTH, 1 Credit

Develop awareness of the elements of professional development, identify strategic areas for growth, and design an exploration plan. Emphasis is placed on being able to analyze career opportunities to determine the best mix of technical and professional skills needed for success as a biological science professional. Graded P/N. CROSSLISTED as BB 211/ BHS 211.

**Equivalent to:** BHS 211

## BB 220, \*CANCER: SOCIETY'S MALIGNANT SHADOW, 3 Credits

Explores the social context of our modern understanding of the group of diseases called cancer. Stimulates critical thinking about how trends in prevention, diagnosis, treatment, and care are influenced by the way we view social categories such as race, gender, and socioeconomic class. Demonstrates that access to medical advances is informed by societal beliefs regarding the role of government and other authoritative institutions. (Bacc Core Course)

**Attributes:** CPDP – Core, Perspective, Difference/Power/Discrimination

## BB 314, CELL AND MOLECULAR BIOLOGY, 4 Credits

Fundamental concepts of prokaryotic and eukaryotic cell biology.

Emphasizes cell structure and function at the molecular level. Lec/rec.

**Prerequisite:** (( (BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-])) and (CH 331 (may be taken concurrently) [C-] or CH 334 (may be taken concurrently) [C-])

**Equivalent to:** BB 314H, BI 314, BI 314H

*Available via Ecampus*

## BB 314H, CELL AND MOLECULAR BIOLOGY, 4 Credits

Fundamental concepts of prokaryotic and eukaryotic cell biology.

Emphasizes cell structure and function at the molecular level. Lec/rec.

**Attributes:** HNRS – Honors Course Designator

**Prerequisite:** (( (BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) or (BI 204 [C-] and BI 205 [C-] and BI 206 [C-])) and (CH 331 (may be taken concurrently) [C-] or CH 334 (may be taken concurrently) [C-])

**Equivalent to:** BB 314, BI 314, BI 314H

## BB 315, MOLECULAR BIOLOGY LABORATORY, 3 Credits

Laboratory projects exploring the transmission of genetic information from storage to function will introduce students to fundamental molecular biology concepts and techniques, including isolation of DNA, construction of recombinant plasmids, quantification of gene expression in model organisms, polymerase chain reaction, and analysis of protein expression and subcellular localization. Lec/lab.

**Prerequisite:** BB 314 with C- or better or BB 314H with C- or better

**Equivalent to:** BI 315

## BB 317, ^SCIENTIFIC THEORY AND PRACTICE, 3 Credits

Teaches students the practice of biological science. Topics cover scientific theory, communications, ethics and critical evaluation. (Writing Intensive Course)

**Attributes:** CWIC – Core, Skills, WIC

**Prerequisite:** (( (BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) )

**Equivalent to:** BI 317

## BB 331, \*INTRODUCTION TO MOLECULAR BIOLOGY, 3 Credits

Course dealing with the molecular basis of cellular function, with emphasis upon modern developments, and the foundation for practical applications of this knowledge. The course will involve the conceptual background necessary to appreciate the applications of molecular biology. Throughout the course opportunities will be given to discuss public policy issues and questions: What are the moral and practical problems that flow from identification of an individual as being at risk for a late-appearing genetic disorder, such as Huntington's disease or certain cancers? Does the scientific or public value of knowing the entire DNA sequence of the human genome justify a situation in which individual or small-scale research cannot be supported? What issues arise when the fruits of biological research, mostly publicly funded, are commercialized? Should a novel organism be patented? How can biotechnology be applied to environmental problems? (Bacc Core Course)

**Attributes:** CSST – Core, Synthesis, Science/Technology/Society

**Prerequisite:** CH 122 with D- or better or CH 202 with D- or better or CH 222 with D- or better or CH 225H with D- or better or ((CH 232 with D- or better or CH 232H with D- or better) or (CH 262 with D- or better or CH 262H with D- or better or CH 272 with D- or better))

Available via Ecampus

## BB 332, \*MOLECULAR MEDICINE, 3 Credits

Provides students an understanding of medical advances from a rapidly evolving molecular point of view. Advances in knowledge of the human genome arising from DNA sequencing efforts and major leaps in understanding of the regulating cellular growth and division are presented in an easy-to-understand fashion appropriate for students in all majors. Course discussions and assignments will cover implications of advances in molecular medicine from ethical, economic, technical and societal standpoints. The aim of the course is to present technical material in a way that non-scientists will understand and conversely to summarize ethical, economic, and philosophical considerations in a way that the scientists understand the implications of these technologies. (Bacc Core Course)

**Attributes:** CSST – Core, Synthesis, Science/Technology/Society

**Recommended:** Any biology course.

## BB 345, INTRODUCTION TO BIOLOGICAL SEQUENCE ANALYSIS, 2 Credits

Introduction to computer-based analyses of biomolecular data, particularly nucleic acid and protein sequences, with the Python programming language. Topics include reading and writing of sequence files, subsequences, reverse complement, finding sequence patterns, subroutines, control structures, and parsing complex data files.

## BB 350, ELEMENTARY BIOCHEMISTRY, 4 Credits

Service course for students desiring a short introduction to biochemistry. Four lectures weekly.

**Prerequisite:** CH 331 with D- or better and CH 332 (may be taken concurrently) [D-]

Available via Ecampus

## BB 360, INTRODUCTION TO NEUROSCIENCE, 3 Credits

An introduction to the field of neuroscience. Topics include structure of neurons, outline of signaling in the central nervous system, Nernst equation, action potentials, synaptic transmission, chemical signaling in vision, disease and drugs.

**Prerequisite:** (( (BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-])) ) and (CH 233 [C-] or CH 233H [C-]) and (CH 263 [C-] or CH 263H [C-])

Available via Ecampus

## BB 361, NEUROSCIENCE OF SENSORY AND MOTOR SYSTEMS, 3 Credits

Provides advanced knowledge and understanding of the structure and function of the sensory and motor systems and the interactions between them. These systems will be considered in the context of human physiology.

**Prerequisite:** BB 360 with C- or better

## BB 399, SPECIAL TOPICS, 1-16 Credits

**Equivalent to:** BB 399H

This course is repeatable for 16 credits.

## BB 399H, SPECIAL TOPICS, 1-16 Credits

**Attributes:** HNRS – Honors Course Designator

**Equivalent to:** BB 399

This course is repeatable for 16 credits.

## BB 401, UNDERGRADUATE RESEARCH, 1-16 Credits

**Equivalent to:** BB 401H

This course is repeatable for 16 credits.

## BB 403, THESIS, 1-16 Credits

This course is repeatable for 16 credits.

## BB 405, READING AND CONFERENCE, 1-16 Credits

**Equivalent to:** BB 405H

This course is repeatable for 16 credits.

## BB 405H, READING AND CONFERENCE, 1-16 Credits

**Attributes:** HNRS – Honors Course Designator

**Equivalent to:** BB 405

This course is repeatable for 16 credits.

## BB 407, BIOCHEMISTRY/BIOPHYSICS SEMINAR, 1-16 Credits

Informal seminars presenting information about research problems and careers and research programs on campus in biochemistry or biophysics. Graded P/N.

**Equivalent to:** BB 407H

This course is repeatable for 99 credits.

## BB 407H, BIOCHEMISTRY/BIOPHYSICS SEMINAR, 1-16 Credits

Informal seminars presenting information about research problems and careers and research programs on campus in biochemistry or biophysics.

**Attributes:** HNRS – Honors Course Designator

**Equivalent to:** BB 407

*This course is repeatable for 99 credits.*

## BB 410, INTERNSHIP, 1-16 Credits

*This course is repeatable for 16 credits.*

## BB 450, GENERAL BIOCHEMISTRY, 4 Credits

Sequence course for students with a limited background in physical chemistry. BB 450/BB 550, three lectures and one recitation. BB 451/BB 551, three lectures.

**Prerequisite:** CH 332 with D- or better or CH 336 with D- or better

**Equivalent to:** BB 450H

*Available via Ecampus*

## BB 451, GENERAL BIOCHEMISTRY, 3 Credits

Sequence course for students with a limited background in physical chemistry. BB 450/BB 550, three lectures and one recitation. BB 451/BB 551, three lectures.

**Prerequisite:** BB 450 with D- or better or BB 450H with D- or better

**Equivalent to:** BB 451H

*Available via Ecampus*

## BB 453, BIOCHEMISTRY AND MOLECULAR BIOLOGY LABORATORY TECHNIQUES, 4 Credits

Laboratory course for non-majors that introduces students to biochemistry and molecular biology techniques used to investigate the functional relationship between nucleic acid sequence, gene expression, and protein function.

**Prerequisite:** BB 451 with C- or better

## BB 460, ADVANCED CELL BIOLOGY, 3 Credits

History and theory of cell biology; microscopy and other techniques to study cells and organelles; membranes; organelles; protein import; cell signaling; cytoskeleton; polarity; cell cycle; stem cells; pattern formation; cancer biology. Offered every other fall in odd years.

**Prerequisite:** BB 314 with C- or better or BI 314 with C- or better or BI 314H with C- or better or BB 451 with C- or better or BB 492 with C- or better

## BB 481, MACROMOLECULAR STRUCTURE, 3 Credits

An introduction to structural biology, the discipline focused on understanding the structural properties of biological macromolecules—especially proteins and nucleic acids—and relating them to their function. Introduces students to the vocabulary and tools of this discipline, covering both the fundamental physico-chemical principles governing the structure and function of biological macromolecules and a selected set of widely used experimental and theoretical approaches to their characterization. This is done through lectures, and textbook and literature readings. Graduate students receive additional experience in scientific reading, writing and presentation through a literature-based term project.

**Prerequisite:** BB 450 with D- or better or BB 490 with D- or better

*Available via Ecampus*

## BB 482, BIOPHYSICS, 3 Credits

Examines quantitative properties of biological systems and biological phenomena using concepts derived from mathematics and physics.

**Prerequisite:** BB 481 with D- or better and CH 440 [D-]

## BB 483, ADVANCED BIOCHEMISTRY AND BIOPHYSICS: CAPSTONE, 3 Credits

Covers applications of advanced biophysical techniques, and how these fit within the larger context of biochemistry, biology and society. Explores techniques and their applications to macromolecules as well as the scientific process. Techniques discussed include in vitro, in vivo, and in silico methods, with an emphasis on biomolecular interactions.

**Prerequisite:** BB 482 with D- or better or BB 582 with D- or better

## BB 484, CHROMATIN AND EPIGENETICS, 3 Credits

An in-depth look at "chromatin" (the complex generated by DNA, RNA and complex protein) and how it behaves during gene activation and silencing. Specific examples of long-lasting gene regulation (across cell cycles) will be used to describe the concept of "epigenetic" gene regulation by modification of DNA or proteins. The class will combine more traditional lectures with discussion periods where primary research papers will be analyzed. The target audience is third- and fourth-year students as well as graduate students.

**Prerequisite:** ((BI 314 with C- or better or BI 314H with C- or better or BB 314 with C- or better or BB 314H with C- or better) and (BI 315 [C-] or BB 315 [C-] or BB 493 [C-] or BB 493H [C-]))

## BB 485, APPLIED BIOINFORMATICS, 3 Credits

Fundamental concepts needed to understand the software and methods used in bioinformatics. Includes contemporary techniques such as databases, gene and genome annotations, functional annotations, sequence alignment, motif finding, secondary structure prediction, phylogenetic tree construction, high-throughput sequence data, ChIP-Seq peak identification, transcriptome profiling by RNA-Seq, microRNA discovery and target prediction.

**Prerequisite:** BB 314 with C- or better or BB 314H with C- or better

## BB 486, ADVANCED MOLECULAR GENETICS, 3 Credits

Covers aspects of transmission genetics (Mendel's laws, mapping strategies) informed by the machineries required for genetic information storage, transcription, translation, and protein processing. Analyses of state-of-the-art primary literature and lectures give a perspective on important "model" organisms, including examples from among bacteria, plants, fungi, and animals.

**Prerequisite:** (BB 314 with C- or better or BB 314H with C- or better) and (BB 492 [C-] or BB 451 [C-])

## BB 490, BIOCHEMISTRY 1: STRUCTURE AND FUNCTION, 3 Credits

Examines how the structure and function of biological macromolecules arises from the organic chemistry of their fundamental building blocks. The organic chemistry of biochemistry will be a focus, including the mechanisms by which enzymes catalyze biological reactions.

**Prerequisite:** (CH 332 with C- or better or CH 336 with C- or better) and ((BI 211 with C- or better or BI 211H with C- or better) and (BI 212 [C-] or BI 212H [C-]) and (BI 213 [C-] or BI 213H [C-])) or ((BI 221 [C-] or BI 221H [C-]) and (BI 222 [C-] or BI 222H [C-]) and (BI 223 [C-] or BI 223H [C-]))

## BB 491, BIOCHEMISTRY 2: METABOLISM, 3 Credits

Sequence professional course to meet the requirements of majors in biochemistry and biophysics. The second course in a series, BB 491/BB 591 covers the mechanisms and regulation of the pathways by which cells break down fuel molecules, conserve some of the released energy in the form of reactive nucleotides, and use this energy to create biological building blocks from simpler metabolites.

**Prerequisite:** BB 490 with D- or better or BB 590 with D- or better

## BB 492, BIOCHEMISTRY 3: GENETIC BIOCHEMISTRY, 3 Credits

Sequence professional course to meet the requirements of majors in biochemistry and biophysics. The third course in the series, BB 492/BB 592 focuses on genetic biochemistry, including the synthesis of nucleotides, DNA synthesis and repair, RNA synthesis and processing, and protein synthesis and modification.

**Prerequisite:** (BB 490 with D- or better or BB 590 with D- or better) and (BB 491 [D-] or BB 591 [D-])

## BB 493, BIOCHEMISTRY LABORATORY MOLECULAR TECHNIQUES 1, 3 Credits

Laboratory course to accompany BB 450, BB 451 or BB 490, BB 491, BB 492. Lec/lab.

**Prerequisite:** (BB 451 with D- or better or BB 451H with D- or better) or BB 492 with D- or better

**Equivalent to:** BB 493H

## BB 494, BIOCHEMISTRY LABORATORY MOLECULAR TECHNIQUES 2, 3 Credits

Laboratory to accompany BB 450, BB 451 or BB 490, BB 491, BB 492. Lec/lab.

**Prerequisite:** BB 493 with D- or better or BB 593 with D- or better or BB 315 with D- or better or BI 315 with D- or better

**Equivalent to:** BB 494H

## BB 498, ASBMB CERTIFICATION EXAM, 0 Credits

A comprehensive, standardized test administered by the American Society of Biochemistry and Molecular Biology and used as a direct assessment of the discipline specific knowledge of seniors in the majors administered by the Biochemistry and Biophysics department. A pass will be given to all students who complete the exam. Contact the Biochemistry and Biophysics Program for more information.

## BB 499, SPECIAL TOPICS, 0-16 Credits

Topics and credits vary.

*This course is repeatable for 16 credits.*

## BB 501, RESEARCH, 1-16 Credits

*This course is repeatable for 16 credits.*

## BB 503, THESIS, 1-16 Credits

*This course is repeatable for 999 credits.*

## BB 505, READING AND CONFERENCE, 1-16 Credits

*This course is repeatable for 16 credits.*

## BB 507, SEMINAR, 1-2 Credits

Section 1: Descriptions of campus research programs in biochemistry and biophysics, 1 credit fall. Graded P/N. Student presentations of current research literature, 1 credit winter and spring. Should be taken by all entering departmental graduate students. Section 2: Presentation of departmental research seminar, 2 credits any term. PhD candidates in biochemistry and biophysics present a departmental research seminar in the third or fourth year. One registers in the term the seminar is presented.

*This course is repeatable for 16 credits.*

## BB 550, GENERAL BIOCHEMISTRY, 4 Credits

Sequence course for students with a limited background in physical chemistry. BB 450/BB 550, three lectures and one recitation. BB 451/BB 551 and BB 452, three lectures.

**Recommended:** CH 332

*Available via Ecampus*

## BB 551, GENERAL BIOCHEMISTRY, 3 Credits

Sequence course for students with a limited background in physical chemistry. BB 450/BB 550, three lectures and one recitation. BB 451/BB 551 and BB 452, three lectures.

**Recommended:** BB 550

*Available via Ecampus*

## BB 560, ADVANCED CELL BIOLOGY, 3 Credits

History and theory of cell biology; microscopy and other techniques to study cells and organelles; membranes; organelles; protein import; cell signaling; cytoskeleton; polarity; cell cycle; stem cells; pattern formation; cancer biology

**Recommended:** BB 314 or BI 314 or BI 314H or BB 492 or BB 451

## BB 581, MACROMOLECULAR STRUCTURE, 3 Credits

An introduction to structural biology, the discipline focused on understanding the structural properties of biological macromolecules—especially proteins and nucleic acids—and relating them to their function. Introduces students to the vocabulary and tools of this discipline, covering both the fundamental physico-chemical principles governing the structure and function of biological macromolecules and a selected set of widely used experimental and theoretical approaches to their characterization. This is done through lectures, and textbook and literature readings. Graduate students receive additional experience in scientific reading, writing and presentation through a literature-based term project.

**Recommended:** BB 450 or BB 490

*Available via Ecampus*

## BB 582, BIOPHYSICS, 3 Credits

Examines quantitative properties of biological systems and biological phenomena using concepts derived from mathematics and physics.

**Prerequisite:** BB 581 with D- or better

## BB 583, ADVANCED BIOCHEMISTRY AND BIOPHYSICS: CAPSTONE, 3 Credits

Covers applications of advanced biophysical techniques, and how these fit within the larger context of biochemistry, biology and society. Explores techniques and their applications to macromolecules as well as the scientific process. Techniques discussed include in vitro, in vivo, and in silico methods, with an emphasis on biomolecular interactions.

**Prerequisite:** BB 582 with C or better

## BB 584, CHROMATIN AND EPIGENETICS, 3 Credits

An in-depth look at "chromatin" (the complex generated by DNA, RNA and complex protein) and how it behaves during gene activation and silencing. Specific examples of long-lasting gene regulation (across cell cycles) will be used to describe the concept of "epigenetic" gene regulation by modification of DNA or proteins. The class will combine more traditional lectures with discussion periods where primary research papers will be analyzed. The target audience is third- and fourth-year students as well as graduate students.

**Recommended:** (BI 314 or BI 314H) and BI 315

## BB 585, APPLIED BIOINFORMATICS, 3 Credits

Fundamental concepts needed to understand the software and methods used in bioinformatics. Includes contemporary techniques such as databases, gene and genome annotations, functional annotations, sequence alignment, motif finding, secondary structure prediction, phylogenetic tree construction, high-throughput sequence data, ChIP-Seq peak identification, transcriptome profiling by RNA-Seq, microRNA discovery and target prediction.

**Recommended:** BB 314 or BB 314H

## BB 586, ADVANCED MOLECULAR GENETICS, 3 Credits

Covers aspects of transmission genetics (Mendel's laws, mapping strategies) informed by the machineries required for genetic information storage, transcription, translation, and protein processing. Analyses of state-of-the-art primary literature and lectures give a perspective on important "model" organisms, including examples from among bacteria, plants, fungi, and animals.

**Recommended:** (BI 314 or BI 314H) and BI 315 and BB 492

## BB 590, BIOCHEMISTRY 1: STRUCTURE AND FUNCTION, 3 Credits

Examines how the structure and function of biological macromolecules arises from the organic chemistry of their fundamental building blocks. The organic chemistry of biochemistry will be a focus, including the mechanisms by which enzymes catalyze biological reactions.

## BB 591, BIOCHEMISTRY 2: METABOLISM, 3 Credits

Sequence professional course to meet the requirements of majors in biochemistry and biophysics. The second course in a series, BB 491/BB 591 covers the mechanisms and regulation of the pathways by which cells break down fuel molecules, conserve some of the released energy in the form of reactive nucleotides, and use this energy to create biological building blocks from simpler metabolites.

**Prerequisite:** BB 590 with C or better

## BB 592, BIOCHEMISTRY 3: GENETIC BIOCHEMISTRY, 3 Credits

Sequence professional course to meet the requirements of majors in biochemistry and biophysics. The third course in the series, BB 492/BB 592 focuses on genetic biochemistry, including the synthesis of nucleotides, DNA synthesis and repair, RNA synthesis and processing, and protein synthesis and modification.

**Prerequisite:** BB 590 with C or better and BB 591 [C]

## BB 593, BIOCHEMISTRY LABORATORY MOLECULAR TECHNIQUES 1, 3 Credits

Laboratory course to accompany BB 450, BB 451 or BB 490, BB 491, BB 492. Lec/lab.

**Recommended:** (BB 451 or BB 451H) or BB 492

## BB 594, BIOCHEMISTRY LABORATORY MOLECULAR TECHNIQUES 2, 3 Credits

Laboratory to accompany BB 450, BB 451 or BB 490, BB 491, BB 492. Lec/lab.

**Recommended:** BB 493 or BB 593 or BB 315 or BI 315

## BB 599, SPECIAL TOPICS, 0-16 Credits

Topics and credits vary.

*This course is repeatable for 16 credits.*

## BB 601, RESEARCH, 1-16 Credits

*This course is repeatable for 16 credits.*

## BB 603, THESIS, 1-16 Credits

*This course is repeatable for 999 credits.*

## **BB 605, READING & CONFERENCE, 1-16 Credits**

*This course is repeatable for 16 credits.*

## **BB 607, SEMINAR, 1-2 Credits**

Section 1: Descriptions of campus research programs in biochemistry and biophysics, 1 credit fall. Graded P/N. Student presentations of current research literature, 1 credit winter and spring. Should be taken by all entering departmental graduate students. Section 2: Presentation of departmental research seminar, 2 credits any term. PhD candidates in biochemistry and biophysics present a departmental research seminar in the third or fourth year. One registers in the term the seminar is presented.

*This course is repeatable for 16 credits.*

## **BB 650, SELECTED TOPICS IN BIOCHEMISTRY AND BIOPHYSICS, 3 Credits**

Nonsequence courses designed to acquaint student with current research in biochemistry and biophysics. Courses include enzyme kinetics, cell cycle and cancer, neurochemistry, oxidative stress, cell adhesion and motility. Most courses offered alternate years.

*This course is repeatable for 18 credits.*

## **BB 651, SELECTED TOPICS IN BIOCHEMISTRY AND BIOPHYSICS, 3 Credits**

Nonsequence courses designed to acquaint student with current research in biochemistry and biophysics. Courses include cell surfaces, enzyme kinetics, metabolism, neurochemistry, trace element metabolism, biological oxidations, and bioenergetics. Most courses offered alternate years.

*This course is repeatable for 18 credits.*

## **BB 652, SELECTED TOPICS IN BIOCHEMISTRY AND BIOPHYSICS, 3 Credits**

Nonsequence courses designed to acquaint student with current research in biochemistry and biophysics. Courses include enzyme kinetics, metabolism, neurochemistry, trace element metabolism, biological oxidations, and bioenergetics. Most courses offered alternate years.

*This course is repeatable for 18 credits.*

## **BB 699, SPECIAL TOPICS, 0-16 Credits**

*This course is repeatable for 16 credits.*