

BCHE-BIOCHEMISTRY

BCHE 140. Explorations in Chemistry and Biochemistry

1 Credit (1)

In introduction to the experience of chemistry and biochemistry degrees. In this course, students will prepare a degree plan and personal statement. Career opportunities in chemistry and biochemistry will be presented and discussed. Graded S/U.

Learning Outcomes

1. Demonstrate knowledge and understanding of the sub-disciplines of Chemistry and Biochemistry.
2. Demonstrate knowledge and understanding of the requirements for the Chemistry and Biochemistry majors and career opportunities available to these majors.
3. Adopt strategies to prepare for future success in a job search or graduate school application.
4. Learn about undergraduate research opportunities in chemistry and biochemistry.

BCHE 241. Introduction to Research in Biochemistry

1-3 Credits

Techniques and procedures of biochemical research. May be repeated for a maximum of 3 credits.

Prerequisites: 8 credits of chemistry and 3.0 GPA in chemistry.

BCHE 395. Biochemistry I

3 Credits (3)

Principles governing chemistry and physics of life processes with emphasis on the relationships between molecular structure and cell function. Basic principles of biochemical processes, enzymology, and the structure/function of the major classes of biomolecules with introductions to metabolism. Introduction to catabolic metabolism. May be repeated up to 3 credits.

Prerequisite: C- or better in CHEM 314.

Learning Outcomes

1. Understand the structure, reactivity, and metabolic function of the presented biological molecules and apply that knowledge to biomolecules encountered in future experiences. Examples include the 20 common amino acids, carbohydrate molecules of glycolysis, carboxylic acids of the citric acid cycle, lipid components of biological membranes, and many catalytic enzymes.
2. Understand the theory and application of many of the experimental techniques of Biochemistry.
3. Understand biochemical regulation and the interconnectedness of metabolic processes. A large fraction of contemporary biochemical research is devoted to delineating biochemical regulation. Details of biochemical regulation will be interwoven with material presented throughout the semester, stressing the principles of regulation that are common in many organisms.
4. Understand enzyme kinetics and enzyme mechanism.

BCHE 395H. Biochemistry I Honors

3 Credits (3)

Principles governing chemistry and physics of life processes with emphasis on the relationships between molecular structure and cell function. Basic principles of biochemical processes, enzymology, and the structure/function of the major classes of biomolecules with introductions to metabolism. Introduction to catabolic metabolism. Taught with BCHE 395 with additional experiential-focused work required.

Prerequisite: C- or better in CHEM 314.

Learning Outcomes

1. Understand the structure, reactivity, and metabolic function of the presented biological molecules and apply that knowledge to biomolecules encountered in future experiences: Examples include the 20 common amino acids, carbohydrate molecules of glycolysis, carboxylic acids of the citric acid cycle, lipid components of biological membranes, and many catalytic enzymes.
2. Understand the theory and application of many of the experimental techniques of Biochemistry.
3. Understand biochemical regulation and the interconnectedness of metabolic processes. A large fraction of contemporary biochemical research is devoted to delineating biochemical regulation. Details of biochemical regulation will be interwoven with material presented throughout the semester, stressing the principles of regulation that are common in many organisms.
4. Understand enzyme kinetics and enzyme mechanism.
5. Demonstrate proficiency in problem-based learning and scientific communication.

BCHE 396. Biochemistry II, Lecture and Laboratory

4 Credits (2.5+3P)

Introduction to anabolic metabolism and hormonal regulation. Biochemical principles of the mechanism and regulation of replication, transcription, recombination and translation in prokaryotes and eukaryotes. Introduction to DNA-based information technology. Taught with BCHE 396 H. May be repeated up to 4 credits.

Prerequisite: C- or better in BCHE 395.

Learning Outcomes

1. Recognize the essential biochemical reactions and enzymatic mechanisms required for nucleic acid, amino acid, and fatty acid synthesis.
2. Learn the biochemical reaction mechanisms associated with key elements of the central dogma of molecular biology.
3. Identify the reactions and enzymes required for DNA maintenance and replication, transcription and RNA polymerization, and the translation of mRNA to primary amino acid sequence and protein synthesis.
4. Conduct experiments safely.
5. Select and manipulate plasmids to achieve desired recombinant DNA for experimentation.
6. Obtain relevant DNA sequence information from public databases.
7. Transform and isolate plasmid DNA to be used for cloning procedures.
8. Design DNA specific primers for PCR reactions.
9. Perform restriction digest and ligation reactions. 1
10. Analyze DNA sequence to validate the outcome of recombinant DNA experimentation. 1
11. Demonstrate scientific dissemination skills by attending scientific seminars or review primary literature and provide summary via written or oral presentation.

BCHE 396 H. Biochemistry II Honors, Lecture and Laboratory

4 Credits (2.5+3P)

Introduction to anabolic metabolism and hormonal regulation. Biochemical principles of the mechanism and regulation of replication, transcription, recombination and translation in prokaryotes and eukaryotes. Introduction to DNA-based information technology. Taught with BCHE 396 with additional work required. May be repeated up to 3 credits.

Prerequisite: C- or better in BCHE 395.

Learning Outcomes

1. Recognize the essential biochemical reactions and enzymatic mechanisms required for nucleic acid, amino acid, and fatty acid synthesis.
2. Learn the biochemical reaction mechanisms associated with key elements of the central dogma of molecular biology.
3. Identify the reactions and enzymes required for DNA maintenance and replication, transcription and RNA polymerization, and the translation of mRNA to primary amino acid sequence and protein synthesis.
4. Conduct experiments safely.
5. Select and manipulate plasmids to achieve desired recombinant DNA for experimentation.
6. Obtain relevant DNA sequence information from public databases.
7. Transform and isolate plasmid DNA to be used for cloning procedures.
8. Design DNA specific primers for PCR reactions.
9. Perform restriction digest and ligation reactions. 1
10. Analyze DNA sequence to validate the outcome of recombinant DNA experimentation. 1
11. Demonstrate scientific dissemination skills by attending scientific seminars or review primary literature and provide summary via written or oral presentation.

BCHE 432. Physical Biochemistry**3 Credits (3)**

This course focuses on the theoretical principles of biophysical techniques and how they are applied to biological problems. Primary literature is used heavily to explain concepts and applications along with periodic demonstrations of biophysical techniques using department instruments. Students taking this course will be expected to present primary literature highlighting the applications of various techniques.

Prerequisite: CHEM 430 or CHEM 433.

Learning Outcomes

1. Understand the theoretical principles of spectroscopic and biophysical techniques.
2. Understand the appropriate applications for various instruments.
3. Be able to interpret spectroscopic and biophysical data.
4. Understand and describe biophysical literature.
5. Be able to describe biophysical studies to a diverse audience of scientists and non-scientists.

BCHE 440. Biochemistry Seminar**1 Credit (1)**

Introduction to current literature in biochemistry and molecular biology. Selected topics in the field will be presented by the faculty. Students will present written and oral reports from literature searches. Restricted to: BCHE majors.

Prerequisite: BCHE 396.

Learning Outcomes

1. Students are proficient in reading scientific literature.
2. Students are proficient in the oral communication of scientific literature.

BCHE 441. Advanced Research in Biochemistry**1-3 Credits**

Investigation of biochemical problems and the development of special techniques. May be repeated for a maximum of 3 credits.

Prerequisites: consent of instructor, 16 credits of chemistry and 3.0 GPA in chemistry for nonmajors.

BCHE 451. Special Topics**1-3 Credits**

Selected topics of current interest designated by title and credit. May be repeated up to 12 credits.

Learning Outcomes

1. Increase depth of knowledge in a specific area of biochemistry.
2. Learn how to read and critically review primary research papers in a specific area of biochemistry.
3. Gain experience in presenting primary research papers in a specific area of biochemistry.

BCHE 452. Chemical Carcinogenesis**3 Credits (3)**

Chemical-dependent DNA mutagenesis, cancer development, and progression, with an emphasis on current research.

Prerequisite: CHEM 314 or CHEM 2120.

Learning Outcomes

1. Students can describe the fundamental principles of multistage carcinogenesis, including initiation, promotion, and progression.
2. Students can explain the role of DNA mutagenesis and repair mechanisms in the development and prevention of cancer.
3. Students can summarize the basic principles of toxicokinetics and explain how carcinogens are metabolized and interact with biological systems.
4. Analyze and critically evaluate primary scientific literature related to chemical carcinogenesis.
5. Assess the significance and implications of recent advancements in carcinogenesis research.

BCHE 455. Independent Studies**1-3 Credits**

Independent studies directed by consulting faculty.

Prerequisite: consent of instructor.

BCHE 542. Biochemistry I**3 Credits (3)**

Principles governing chemistry and physics of life processes with emphasis on the relationships between molecular structure and cell function. In depth principles of biochemical processes, enzymology, and the structure/function of the major classes of biomolecules. Enzyme reaction and regulatory mechanisms in central metabolism and principles of bioenergetics are covered.

Prerequisite: CHEM 314 and CHEM 430 or CHEM 433; or BCHE 395 or equivalent.

Learning Outcomes

1. Understand the structure, reactivity, and metabolic function of the presented biological molecules and apply that knowledge to biomolecules encountered in future experiences: examples include the 20 common amino acids, carbohydrate molecules of glycolysis, carboxylic acids of the citric acid cycle, lipid components of biological membranes, and many catalytic enzymes.
2. Understand the theory and application of many of the experimental techniques of Biochemistry.
3. Understand biochemical regulation and the interconnectedness of metabolic processes: a large fraction of contemporary biochemical research is devoted to delineating biochemical regulation.
4. Apply the principles of enzyme kinetics as a technique to determine enzyme mechanism and regulation.

- Propose novel enzyme reaction mechanisms based on the understanding of various classes of enzyme mechanisms and the known function of cofactors.
- Details of biochemical regulation will be interwoven with material presented throughout the semester, stressing the principles of regulation that are common in many organisms.

BCHE 545. Molecular and Biochemical Genetics

3 Credits (3)

An accelerated treatment of the molecular basis of gene expression. Discussion of chemical, enzymological, and genetic techniques of molecular biology.

Prerequisite/Corequisite: BCHE 542.

Learning Outcomes

- Understand and explain fundamental concepts in biochemical genetics: describe the molecular structure and function of DNA, RNA, and proteins.
- Analyze genetic mechanisms and their applications: Evaluate the processes of DNA repair, recombination, and site-specific recombination.
- Develop and apply scientific inquiry and problem-solving skills: Formulate and articulate relevant research questions based on course material by demonstrate the ability to apply biochemical and genetic concepts to experimental design and interpretation and engaging in critical thinking through weekly question submissions and article discussions and communicating scientific concepts effectively and construct clear, well-reasoned written and verbal explanations of biochemical genetics concepts.
- Demonstrate the ability to communicate complex genetic mechanisms to peers: Properly cite and reference academic sources, including AI-generated content when applicable: Understand and adhere to ethical guidelines regarding plagiarism, academic integrity, and responsible scientific conduct by completing a plagiarism tutorial and apply best practices in scientific writing and Engaging in respectful, collaborative discussions and maintain a professional attitude in all course interactions.
- Apply knowledge to broader scientific and biomedical contexts: Relate biochemical genetic principles to real-world applications, including genetic engineering, biotechnology, and medical research.
- Compare and contrast the mechanisms of DNA replication, transcription, and translation in prokaryotic and eukaryotic systems.
- Explain the biochemical principles underlying gene expression and its regulation.
- Recognize the importance of biochemical genetics in understanding diseases and developing therapeutic strategies.
- Appreciate the evolutionary and functional implications of genetic mechanisms across biological systems. 1
- Discuss epigenetic modifications and chromatin remodeling in gene regulation. 1
- Analyze the role of non-coding RNAs and other regulatory elements in gene expression. 1
- Interpret and critically assess primary scientific literature related to biochemical genetics and Synthesize experimental evidence to support or refute scientific hypotheses. 1
- Identify key methodologies used in genetic and biochemical research.

BCHE 546. Biochemistry II: Central and Intermediary Metabolism

3 Credits (3)

Intermediary metabolism: catabolic and anabolic pathways of carbohydrates, lipids, amino acids, and nucleic acids, including their regulation.

Prerequisite: BCHE 542, or BCHE 395 with consent of instructor.

Learning Outcomes

- Apply knowledge of the structure, reactivity, and metabolic function of scores of biological molecules: examples include the 20 amino acids, carbohydrate molecules of glycolysis, carboxylic acids of the citric acid cycle, lipid components of biological membranes, and many catalytic enzymes.
- Apply the function of enzymes, enzymatic cofactors to the design and regulation of both catabolic and anabolic pathways.
- Master an understanding of biochemical regulation and the interconnectedness of metabolic processes and a large fraction of contemporary biochemical research is devoted to delineating biochemical regulation.
- Identify resources and communicate the connection between metabolism and disease or mutational analysis for basic research.
- Develop an appreciation of the unity of life processes at the molecular level, the field of Biochemistry offers a unique perspective on human existence, you will begin to understand that we are not as different, nor as separate, from the animals, plants, and microbes of this world as is commonly assumed.

BCHE 598. Special Research Programs

1-3 Credits

May be repeated for a maximum of 6 credits. Same as CHEM 598. Graded S/U.

BCHE 599. Master's Thesis

15 Credits

May be repeated for a maximum of 6 credits. Same as CHEM 599.

BCHE 600. Research

1-15 Credits

May be repeated for a maximum of 20 credits. PR/U grading. Same as CHEM 600.

BCHE 647. Physical Biochemistry

3 Credits (3)

Fundamental applications of physical chemistry to the investigation of biological metabolites and biological macromolecules, including proteins, oligo-nucleotides, and molecular arrays with an emphasis on understanding biological functions based on chemical structures. Taught with BCHE 432. May be repeated up to 3 credits.

Prerequisite: C- or better in CHEM 430 or CHEM 433 or BCHE 542.

Learning Outcomes

- Understand the theoretical principles of spectroscopic and biophysical techniques.
- Understand the appropriate applications for various instruments.
- Be able to interpret spectroscopic and biophysical data.
- Understand and describe biophysical literature.
- Be able to describe biophysical studies to a diverse audience of scientists and non-scientists.

BCHE 649. Topics in Biochemistry

1-3 Credits

Selected topics of current interest designated by title and credit. May be repeated for a maximum of 3 credits.

BCHE 652. Chemical Carcinogenesis

3 Credits (3)

Chemical-dependent DNA mutagenesis, cancer development, and progression, with an emphasis on current research.

Learning Outcomes

1. Students can describe the fundamental principles of multistage carcinogenesis, including initiation, promotion, and progression.
2. Students can explain the role of DNA mutagenesis and repair mechanisms in the development and prevention of cancer.
3. Students can summarize the basic principles of toxicokinetics and explain how carcinogens are metabolized and interact with biological systems.
4. Analyze and critically evaluate primary scientific literature related to chemical carcinogenesis.
5. Assess the significance and implications of recent advancements in carcinogenesis research.

BCHE 700. Doctoral Dissertation

20 Credits

May be repeated for a maximum of 20 credits. Graded PR/U. Same as CHEM 700.