BIOMOLECULAR CHEMISTRY (BMOLCHEM)

BMOLCHEM/B M I/BIOCHEM/MATH 609 – MATHEMATICAL METHODS FOR SYSTEMS BIOLOGY
3 credits.

Provides a rigorous foundation for mathematical modeling of biological systems. Mathematical techniques include dynamical systems and differential equations. Applications to biological pathways, including understanding of bistability within chemical reaction systems, are emphasized.
Requisites: MATH 415 and (MATH 320, 340, 341, or 375) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2023
Learning Outcomes: 1. Recall and state the formal definitions of the mathematical objects and their properties in systems biology (e.g., reaction networks, reaction rate equations, mass-action kinetics models, detailed balanced and complex balanced systems, Lyapunov functions, etc.).
Audience: Both Grad & Undergrad

2. Use such definitions to argue that a mathematical object does or does not have the condition of being a particular type or having a particular property (e.g., reversible, weakly reversible, mass-action, detailed balanced, complex balanced, globally stable, oscillatory, persistent, permanent, etc.).
Audience: Both Grad & Undergrad

3. Recall and state the standard theorems of the field (e.g., the Horn-Jackson theorem, the deficiency zero theorem, theorems on characterization of mass-action systems, theorems on persistence and permanence, theorems on dynamical equivalence, etc.) and recall the arguments for these theorems and the underlying logic of their proofs.
Audience: Both Grad & Undergrad

4. Construct mathematical arguments related to the above definitions, properties, and theorems, including the construction of examples and counterexamples.
Audience: Both Grad & Undergrad

5. Convey arguments using English and appropriate mathematical terminology, notation and grammar.
Audience: Both Grad & Undergrad

6. Model real biological systems by means of systems of differential equations, and be able to use software (such as Matlab) for visualization of their dynamics. Example models could include: (i) Enzymes, substrates and saturating kinetics, (ii) Glycolytic oscillations, (iii) Cell cycle control, budding yeast cell cycle models, (iv) Activator-inhibitor and positive feedback systems.
Audience: Both Grad & Undergrad

7. Identify applications of course content in current areas of research.
Audience: Graduate

BMOLCHEM/MICROBIO 668 – MICROBIOLOGY AT ATOMIC RESOLUTION
3 credits.

Three-dimensional protein structures form the basis for discussions of high resolution microbiology; how particular problems are solved with given protein architectures and chemistries and how themes of protein structure are modified and recycled.
Requisites: (BIOCHEM 501 or 507) and (MICROBIO 470 or 612) or graduate/professional standing
Course Designation: Breadth - Biological Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Demonstrate proficient use of PyMol software for visualizing 3D structures.
Audience: Both Grad & Undergrad

2. Evaluate the quality of published structural models for biological macromolecules.
Audience: Both Grad & Undergrad

3. Identify common themes in structural biology which are used when addressing structural biology research questions.
Audience: Both Grad & Undergrad

4. Design and deliver a presentation to communicate scientific results to an audience of their peers.
Audience: Graduate

BMOLCHEM 675 – ADVANCED OR SPECIAL TOPICS IN BIOMOLECULAR CHEMISTRY
1-3 credits.

Examines special topics in biomolecular chemistry. Topics and content will vary each semester and by section of the course.
Requisites: None
Course Designation: Breadth - Biological Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2024
Learning Outcomes: 1. Apply, analyze, or evaluate advanced theories, concepts, or methods in biomolecular chemistry.
Audience: Both Grad & Undergrad

2. Explore a new phenomenon or modality in the biomolecular chemistry area and apply the knowledge gained to research in the field.
Audience: Graduate

BMOLCHEM 699 – SPECIAL RESEARCH PROBLEMS
1-5 credits.

Self-directed work under the supervision and guidance of an Instructor and often in conjunction with a day-to-day mentor that is a graduate student or postdoc researcher in the instructor's group. Students normally participate in aspects of ongoing research projects.
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2025
Learning Outcomes: 1. Apply concepts learned in coursework to real life situations
Audience: Undergraduate

2. Read and effectively search scientific literature
Audience: Undergraduate

3. Develop critical, analytical, and independent thinking skills
Audience: Undergraduate

BMOLCHEM 700 – PRACTICAL BIOPHYSICS
3 credits.

Introduction to methods used in biophysical measurements. Thermodynamics and kinetics are introduced along with the theory and instrumentation used for several complementary biophysical approaches. Hands-on experimentation using state-of-the-art instrumentation and data interpretation.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Describe the strengths and weaknesses of several biophysical methods and use that knowledge to design biophysical experiments for their research.
Audience: Graduate

2. Explain the fundamentals of thermodynamics, kinetics, and fluorescence and practically apply this knowledge to modern research problems.
Audience: Graduate

3. Use data interpretation skills to interpret results from several biophysical instruments.
Audience: Graduate

4. Integrate their knowledge of biophysical methods in the form of an experimental plan within a grant application.
Audience: Graduate

BMOLCHEM/BIOCHEM 701 – RESPONSIBLE CONDUCT IN BIOSCIENCE RESEARCH
2 credits.

Introductory training in the practical aspects of being a graduate-level scientist and the professional standards and expectations of ethical researchers. Covers a wide variety of professional development topics, including choosing a research laboratory and a thesis mentor, transitioning to self-education, managing stress in graduate school, and the importance of diversity in science. Ethics topics include conflicts of interest, the protection of human subjects, the welfare of laboratory animals and workers, safe laboratory spaces, mentor and mentee responsibilities, collaborative research, peer review, data acquisition and data management practices, research misconduct, responsible authorship and publication, contemporary ethical issues in biomedical research, and the roles of responsible scientists in society. Covers all NIH-recommended topics for Responsible Conduct of Research, thus meeting the requirements for trainees involved in NIH-sponsored research programs.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Evaluate and apply fundamental concepts and best practices in bioscience research conduct and research ethics
Audience: Graduate

2. Identify and meet individual and professional responsibilities and obligations to society
Audience: Graduate

3. Explore and implement activities for professional skills development and career management
Audience: Graduate

BMOLCHEM 720 – EXPERIMENTAL DESIGN AND PARADIGMS IN CELLULAR BIOCHEMISTRY AND MOLECULAR BIOLOGY
3 credits.

Covers following areas from historical to modern contexts: biochemistry of post-translational modification of proteins, model organisms, transcriptional switches, chromosome replication, and RNA in biological regulation.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Develop critical thinking skills required to design and interpret an experiment in molecular and/or cellular biology
Audience: Graduate

2. Develop the writing skills relevant to preparing a grant proposal
Audience: Graduate

3. Gain insight into how the scientific method is applied in molecular and cellular biology
Audience: Graduate

4. Develop an ability to critically evaluate research literature
Audience: Graduate

BMOLCHEM 901 – BIOMOLECULAR CHEMISTRY SEMINAR
1 credit.

Critical review of selected topics in biomolecular chemistry.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2024
Learning Outcomes: 1. Gain exposure to a variety of relevant research topics, potentially leading to cross-disciplinary, collaborative research opportunities
Audience: Graduate

2. Identify principles and best practice for preparing and presenting a seminar
Audience: Graduate

3. Gain experience in evaluating and critiquing research presentations in light of those principles and best practices
Audience: Graduate

BMOLCHEM/BIOCHEM 913 – SEMINAR-RIBOGROUP (ADVANCED)
1 credit.

Student-led discussions of RNA-related problems.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2025
Learning Outcomes: 1. Develop an understanding of current research questions in the field of RNA biology
Audience: Graduate

2. Become familiar with the approaches used to study RNA and its interactions with proteins
Audience: Graduate

3. Build a professional network with other RNA biologists on campus
Audience: Graduate

4. Develop techniques for presenting complex concepts to a diverse audience
Audience: Graduate

BMOLCHEM 990 – ADVANCED BIOMOLECULAR CHEMISTRY AND RESEARCH
1-12 credits.

Research supervised by individual faculty members.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2025
Learning Outcomes: 1. Exhibit a broad understanding of general biochemical principles.
Audience: Graduate

2. Conduct independent research using a variety of approaches.
Audience: Graduate

3. Think critically to address research challenges.
Audience: Graduate

4. Exhibit and foster professional and ethical conduct in their research.
Audience: Graduate

5. Collaborate with other investigators within or outside the thesis lab.
Audience: Graduate