MOLECULAR BIOPHYSICS AND BIOCHEMISTRY (MB&B)

* MB&B 090b, Topics in Cancer Biology  Sandy Chang
Introduction to cancer as a genetic disease, with a focus on major discoveries in cancer biology that offer mechanistic insights into the disease process. A brief history of cancer; influence of the genomic revolution on cancer diagnostics; molecular defects underlying specific cancers; current and future cancer therapeutics. Patient case studies highlight specific molecular pathways and treatment strategies. Enrollment limited to first-year students with a strong background in biology and/or chemistry, typically demonstrated by a score of 5 on Advanced Placement examinations. Preregistration required; see under First-Year Seminar Program.  WR, SC

* MB&B 099b / MCDB 099b / MENG 099b / PHYS 099b, Introduction to Research Methods in Physics and Biology: Preparing for a First Research Experience  Simon Mochrie, Andrew Miranker, Corey O’Hern, and Megan King
Spanning both the classroom and laboratory, this seminar course provides an immersive introduction to scientific research. Students build practical laboratory skills, computational competency, and begin to build fluency in the structures and modes of communication that define modern research. The course also facilitates identification of a laboratory mentor and devising a research proposal (with mentorship) for competitive summer research fellowship applications. This class is open to first-year students, interested in any STEM major, who have no prior research experience. This course does not count toward major requirements. Enrollment limited to first-year students. Preregistration required; see under First-Year Seminar Program.

MB&B 105a or b / MCDB 105a or b, Biology, the World, and Us  Staff
Biological concepts taught in context of current societal issues, such as emerging diseases, genetically modified organisms, green energy, and the human brain and its disorders. Emphasis on biological literacy to enable students to evaluate scientific arguments.  SC

* MB&B 107b / EDST 107b / PHYS 107b, Being Human in STEM  Mark Hochstrasser
A collaboratively-designed, project-oriented course that seeks to examine, understand, and disseminate how diversity of gender, race, religion, sexuality, economic circumstances, etc. shape the STEM experience at Yale and nationally, and that seeks to formulate and implement solutions to issues that are identified. Study of relevant peer-reviewed literature and popular-press articles. Implementation of a questionnaire and interviews of STEM participants at Yale. Creation of role-play scenarios for provoking discussions and raising awareness. Design and implementation of group interventions.  SO

* MB&B 200a or b / MCDB 300a or b, Biochemistry  Ronald Breaker and Staff
An introduction to the biochemistry of animals, plants, and microorganisms, emphasizing the relations of chemical principles and structure to the evolution and regulation of living systems. Prerequisites: BIOL 101 or equivalent performance on the corresponding biological sciences placement examination; one term of organic chemistry; or with permission of instructor.  SC

* MB&B 251La or b / MCDB 301La or b, Laboratory for Biochemistry  Staff
An introduction to current experimental methods in molecular biology, biophysics, and biochemistry. Limited enrollment. Requires preregistration by e-mail to aruna.pawashe@yale.edu prior to the first week of classes. Please note: During the fall term, this course runs as two sections, Tuesday or Thursday from 1:15 p.m.-5:15 p.m., for the entire semester. During the spring term it meets once a week on Tuesdays. Prerequisite: BIOL 101.  SC ½ Course cr

MB&B 300a, Principles of Biochemistry I  Matthew Simon, Michael Koelle, and Candie Paulsen
Discussion of the physical, structural, and functional properties of proteins, lipids, and carbohydrates, three major classes of molecules in living organisms. Energy metabolism and hormone signaling as examples of complex biological processes whose underlying mechanisms can be understood by identifying and analyzing the molecules responsible for these phenomena. After BIOL 101; after or concurrently with CHEM 175 (or CHEM 125) or 220  SC

MB&B 301b, Principles of Biochemistry II  Christian Schlieker, Joan Steitz, and Franziska Bleichert
Building on the principles of MB&B 300 through study of the chemistry and metabolism of DNA, RNA, and proteins. Critical thinking emphasized by exploration of experimental methods and data interpretation, from classic experiments in biochemistry and molecular biology through current approaches. Prerequisite: MB&B 300 or permission of instructor.  SC

MB&B 302b, Principles of Biophysics  Enrique De La Cruz and Charles Sindlar
An introduction to the theoretical basis of biophysical concepts and approaches with selected examples and applications. Prerequisites: MB&B 300 and CHEM 328.  SC

MB&B 330a / BENG 230a / MCDB 330a / NSCI 324a, Modeling Biological Systems I  Thierry Emonet and Kathryn Miller-Jensen
Biological systems make sophisticated decisions at many levels. This course explores the molecular and computational underpinnings of how these decisions are made, with a focus on modeling static and dynamic processes in example biological systems. This course is aimed at biology students and teaches the analytic and computational methods needed to model genetic networks and protein signaling pathways. Students present and discuss original papers in class. They learn to model using MatLab in a series of in-class hackathons that illustrate the biological examples discussed in the lectures. Biological systems and processes that are modeled include: (i) gene expression, including the kinetics of RNA and protein synthesis and degradation; (ii) activators and repressors; (iii) the lysogeny/lysis switch of lambda phage; (iv) network motifs and how they shape response dynamics; (v) cell signaling, MAP kinase networks and cell fate decisions; and (vi) noise in gene expression. Prerequisites: MATH 115 or 116, BIOL 101-104, or with permission of instructors. This course also benefits students who have taken more advanced biology courses (e.g. MCDB 200, MCDB 310, MB&B 300/301).  QR, SC
Advanced topics related to dynamical processes in biological systems. Processes by which cells compute, count, tell time, oscillate, and generate spatial patterns. Time-dependent dynamics in regulatory, signal-transduction, and neuronal networks; fluctuations, growth, and form. Comparisons between model and experimental data. Dynamical models applied to neurons, neural systems, and cellular biophysical processes. Use of MATLAB to create models. Prerequisite: MB&B 330 or equivalent, or a 200-level biology course, or with permission of instructor. QR

**MB&B 420a, Macromolecular Structure and Biophysical Analysis**  
Yong Xiong, Joe Howard, and Jack Zhang  
Analysis of macromolecular architecture and its elucidation using modern methods of structural biology and biochemistry. Topics include architectural arrangements of proteins, RNA, and DNA; practical methods in structural analysis; and an introduction to diffraction and NMR. Prerequisites: MB&B 301 and 302. SC

* MB&B 425a / MCDB 425a, Basic Concepts of Genetic Analysis  
Jun Lu  
The universal principles of genetic analysis in eukaryotes. Reading and analysis of primary papers that illustrate the best of genetic analysis in the study of various biological issues. Focus on the concepts and logic underlying modern genetic analysis. Prerequisite: MCDB 202 or pre-approval of instructor. SC

**MB&B 435a, Quantitative Approaches in Biophysics and Biochemistry**  
Yong Xiong  
An introduction to quantitative methods relevant to analysis and interpretation of biophysical and biochemical data. Topics include statistical testing, data presentation, and error analysis; introduction to mathematical modeling of biological dynamics; analysis of large datasets; and Fourier analysis in signal/image processing and macromolecular structural studies. Instruction in basic programming skills and data analysis using MATLAB; study of real data from MB&B research groups. Prerequisites: MATH 120 and MB&B 300 or equivalents, or with permission of instructors. QR, SC

**MB&B 443b, Advanced Eukaryotic Molecular Biology**  
Mark Hochstrasser, Matthew Simon, Franziska Bleichert, and Wendy Gilbert  
Selected topics in regulation of chromatin structure and remodeling, mRNA processing, mRNA stability, translation, protein degradation, DNA replication, DNA repair, site-specific DNA recombination, and somatic hypermutation. Prerequisites: MB&B 300 and 301, or permission of instructor. SC

* MB&B 445b, Methods and Logic in Molecular Biology  
Wendy Gilbert, Mark Hochstrasser, and Christian Schlieker  
An examination of fundamental concepts in molecular biology through analysis of landmark papers. Development of skills in reading the primary scientific literature and in critical thinking. Prerequisites: MB&B 300 and 301. SC

**MB&B 449a, Medical Impact of Basic Science**  
Joan Steitz, I. George Miller, Daniel DiMaio, Franziska Bleichert, Sandy Chang, Karla Neugebauer, and Seyedtaghi Takyar  
Examples of recent discoveries in basic science that have elucidated the molecular origins of disease or that have suggested new therapies for disease. Readings from the primary scientific and medical literature, with emphasis on developing the ability to read this literature critically. Prerequisites: MB&B 300 and 301 or equivalents, or permission of instructor. SC

**MB&B 452b / MCDB 452b / S&DS 352b, Biomedical Data Science, Mining and Modeling**  
Mark Gerstein and Matthew Simon  
Techniques in data mining and simulation applied to bioinformatics, the computational analysis of gene sequences, macromolecular structures, and functional genomics data on a large scale. Sequence alignment, comparative genomics and phylogenetics, biological databases, geometric analysis of protein structure, molecular-dynamics simulation, biological networks, microarray normalization, and machine-learning approaches to data integration. Prerequisites: MB&B 301 and MATH 115, or permission of instructor. SC

* MB&B 459b / ENGL 459b / EVST 215b, Writing about Science, Medicine, and the Environment  
Carl Zimmer  
Advanced non-fiction workshop in which students write about science, medicine, and the environment for a broad public audience. Students read exemplary work, ranging from newspaper articles to book excerpts, to learn how to translate complex subjects into compelling prose. Admission by permission of the instructor only. Applicants should email the instructor at carl@carlzimmer.com with the following information: 1. One or two samples of nonacademic, nonfiction writing. (No fiction or scientific papers, please.) Indicate the course or publication, if any, for which you wrote each sample. 2. A note in which you briefly describe your background (including writing experience and courses) and explain why you’d like to take the course. WR, RP

* MB&B 460Lb, Advanced Laboratory for Biochemistry  
Andrew Miranker and Aruna Pawashe  
This is a project-oriented course in which each student tackles a unique research problem of their own design. Students learn cutting-edge molecular evolution techniques to create a new DNA structure that can specifically recognize and bind whatever target material they choose. Useful and transferable skills include biomolecular engineering and next generation DNA sequencing. Students learn from each other as they each report on their progress. The course is open to students interested in augmenting the research they are already doing or to students who simply prefer hands-on learning. Prerequisite: MB&B 351L or permission of the instructor. Some students may take this course concurrently with MB&B 351L if they have sufficient prior knowledge of organic chemistry, biochemistry, and basic biochemical lab techniques. SC

* MB&B 470a and MB&B 471b, Research in Biochemistry and Biophysics for the Major  
Jack Zhang  
Individual laboratory projects under the supervision of a faculty member. Students must submit an enrollment form that specifies the research supervisor by the date that course schedules are due. Students are expected to commit at least ten hours per week to working in a laboratory. Written assignments include a research proposal, due near the beginning of the term, and a research report that summarizes experimental results, due before the beginning of the final examination period. Students receive a letter grade. Up to 2 credits of MB&B
470/471 may be counted toward the MB&B major requirements. Enrollment limited to MB&B majors. Prerequisite: MB&B 251L or permission of the instructor. SC

* **MB&B 472a and MB&B 473b, Research in Biochemistry and Biophysics**  
  Jack Zhang  
  Individual laboratory projects under the supervision of a faculty member. Students must submit an enrollment form that specifies the research supervisor by the date that course schedules are due. Students are expected to commit at least ten hours per week to working in a laboratory. Written assignments include a research proposal, due near the beginning of the term, and a research report that summarizes experimental results, due before the beginning of the final examination period. Students are graded pass/fail. Taken after students have completed two credits of MB&B 470 and 471. These courses do not count toward the major requirements. Prerequisites: MB&B 470, 471 and 251L or permission of the instructor. SC

* **MB&B 478a and MB&B 479b, Intensive Research in Biochemistry and Biophysics**  
  Jack Zhang  
  Individual laboratory projects under the supervision of a faculty member. Students must submit an enrollment form that specifies the research supervisor by the day that course schedules are due. Students are expected to commit at least twenty hours per week to working in a laboratory. Written assignments include a research proposal, due near the beginning of the term, and a research report that summarizes experimental results, due before the beginning of the final examination period. No more than two course credits count as electives toward the B.S. degree. Enrollment limited to senior MB&B majors. Prerequisite: MB&B 251L or 360L. 2 Course cr per term

* **MB&B 490b, The Senior Project**  
  Dieter Soll and Nikhil Malvankar  
  Colloquium for fulfillment of the senior requirement. The course involves a written and an oral presentation of a senior paper in an area of biochemistry or biophysics. The topic is selected in consultation with the faculty members in charge of the course.