ChemBio Courses of Interest

Below is a list of courses being offered this year that many of our students have taken in the past.

Online Course Catalog courses.my.harvard.edu
Nano and Quarter Courses https://curriculumfellows.hms.harvard.edu/nanocourses

All year

CHEMBIO 300HFA. Introduction to Chemical Biology Research – REQUIRED
Phil Cole and Emily Balskus
W 4:30–5:30.
Lectures introduce the research areas of current program faculty in Chemical Biology. Students must complete both parts of this course (parts A and B) within the same academic year in order to receive credit.

Fall Semester

CHEM 110. The Chemistry and Biology of Therapeutics - REQUIRED
Matt Shair
Half course (fall term). M, W 10:30-11:45
This course will cover the chemical and biological principles that govern small molecule therapeutics. We will discuss small molecule conformational analysis, chemical forces that drive small molecule-protein interactions, and small molecule binding to proteins to affect disease states. We will also discuss how protein targets are identified and the frontiers of modern small molecule therapeutics. Protein targets include, but are not limited to kinases, proteases, GTPases, scaffolding proteins, epigenetic modifiers, metabolic enzymes and transcription factors. This course will teach students how to use modern computer modeling applications to perform structure-based design of small molecule ligands.

BCMP 218. Molecular Medicine
Srinivas Viswanathan and Vidyasagar Koduri
Half course (fall term). T, 1:00-3:00
A seminar on various human diseases and their underlying genetic or biochemical bases. Primary scientific papers discussed. Lectures by faculty and seminars conducted by students, faculty supervision. Faculty mentors will guide student-led discussions of the papers.
Recommended prep: College-level mastery of principles of cellular and molecular biology and genetics.

MICROBI 202. Mechanisms of Bacterial Pathogenesis and Host Immune Response
Marcia Goldberg, Michael Starnbach, Sophie Helaine, Amy Barvzak, Lauren Essler, Jacob Lemieux, Alex Kostic, Deepali Ravel
Half course (fall term) T, Th 3:00-5:00
This course focuses on molecular mechanisms of bacterial pathogenesis and the host response to infection. The class consists of lectures and group discussions emphasizing themes of pathogenesis, methods, results, and interpretations of classic and contemporary literature.
Subjects including bacterial secretion systems, mechanisms of entry into host cells, biofilm formation, and motility are viewed primarily from the pathogen's perspective, whereas topics including

inflammasome activation, TLR signaling, and adaptive immune responses provide a host-centric view. Additional sessions are spent examining current methods of antibiotic discovery and vaccine development.
The course also introduces students to the wide diversity of pathogenic bacteria. Organisms discussed include pathogenic E. coli, Shigella species, Vibrio cholerae, Listeria monocytogenes, Chlamydia trachomatis, Pseudomonas aeruginosa and Staphylococcus aureus, as well as a discussion of the challenges presented by currently unculturable species. Where relevant, connections will also be made with pathogenesis and immune responses to viruses, parasites, and fungi.
Class note: Designed to complement Microbiology 201; however, students who have not taken Microbiology 201 previously are welcome. Designed for graduate students in their first year or beyond, however undergraduates with specific interest in the field may also enroll.

SCRB250QC. Cell and Gene Therapies – new class required for TGP students
Fernando Camargo
Quarter Course (fall term), Th 10:00-11:30 am
Cell and gene therapies are among the newest breakthroughs in health care that can address difficult-to-treat diseases with no other treatment options. This course covers the history, development, and implementation of cell and gene therapies. Class time will consist of guest lectures from Harvard faculty or industry experts, in addition to discussion on primary/secondary research articles, case studies, and/or popular press articles. Students will participate in a capstone group project that proposes a novel cell or gene therapy, based on an unmet clinical need with a clear gene/cell target. Evaluation for the capstone project will be based on oral presentations of the project and an individual written assignment.

CHEM 177. The Chemistry, Biology, and Societal Implications of Genome Editing
David Liu
F, 3:00-5:45 (not offered fall 2026)
The life sciences and medicine are undergoing a revolution stimulated by breakthrough advances in genome editing technologies. These technologies, including those enabled by CRISPR systems, enable researchers and physicians to modify target DNA sequences in the genomes of living cells, including those in plants, animals, and human patients. This class will overview the chemistry and biology underlying recent and current genome editing agents. We will also discuss their current limitations, how they are reshaping medicine and agriculture, and some social and ethical implications of their use. In addition to attending lectures that present the chemistry and biology of genome editing, students will analyze recent reports from the scientific literature, and will present their analyses and reasoned opinions during the semester. Participants will also develop and present final projects on an aspect of genome editing to the class at the end of the semester.
Recommended prep: For advanced undergraduates and graduate students with undergraduate-level understanding of molecular biology and either organic chemistry or biochemistry.
Class Note: Enrollment is limited and by petition only. For full consideration, submit an enrollment petition by following the directions posted on the course Canvas site.

MCB 169. Molecular and Cellular Immunology
Shiv S. Pillai
T, Th 10:30-11:45
The immune system is the frontier at which molecular biology, cell biology, and genetics intersect with the pathogenesis of disease. There is no area of modern biology that is as intimately linked to disease as

Immunology. This field has given us the first rational therapies in medicine, actual cures for many cancers, and new innovative therapies harnessing immunology are being created at breakneck speed! In this course we examining the underlying scientific bases of how the immune system works and its contributions to disease pathogenesis, protection, treatment and prevention. We will discuss the biology of the host response to infections, autoimmunity, allergic disorders, primary immunodeficiency syndromes, transplantation, and cancer.
Prerequisite: Life and Physical Sciences A or Life Sciences 1a or equivalent. Genetics and cell biology strongly recommended.

MCB128 AI in Molecular Biology
Elena Rivas
M, W 10:30-11:45 (offered in fall and spring)
What are convolutional neural networks (CNNs) and how are they used to predict sequence motifs in biological sequences? What is a transformer and how it is used by AlphaFold to predict protein structures? This course will explore the major advances in deep learning, with a special emphasis on their applications to molecular biology and genomics. Starting from single neurons (perceptrons), we will progress to more complex architectures such as convolutional and recurrent neural networks, transformers, and generative neural networks. The course will cover both the general principles of these methods as well as specific applications in genomics. This is a computationally rigorous course for students interested in computational biology.

BST 219 Core Principles of Data Science
Heather Mattie
T, Th 9:45-11:15
Modern technology has led to the generation of unprecedented amounts of data, prompting the need to train researchers to leverage data for decision-making in public health and medicine. This course assumes no prior R or programming knowledge and serves as a gentle, practical introduction to wrangling, visualizing, and modeling data using the R statistical programming language. We also emphasize the importance of reproducible research and effective data science communication.

COMPSCI 50 Introduction to Computer Science
Henry Leitner
M, W 9-10:15
This is CS50, Harvard University's introduction to the intellectual enterprises of computer science and the art of programming, for concentrators and non-concentrators alike, with or without prior programming experience. (More than half of CS50 students have never taken CS before!) This course teaches you how to solve problems, both with and without code, with an emphasis on correctness, design, and style. Topics include computational thinking, abstraction, algorithms, data structures, and computer science more generally. Problem sets inspired by the arts, humanities, social sciences, and sciences. More than teach you how to program in one language, this course teaches you how to program fundamentally and how to teach yourself new languages ultimately. The course starts with a traditional but omnipresent language called C that underlies today's newer languages, via which you'll learn not only about functions, variables, conditionals, loops, and more, but also about how computers themselves work underneath the hood, memory and all. The course then transitions to Python, a higher-level language that you'll understand all the more because of C. Toward term's end, the course introduces SQL, via which you can store data in databases, along with HTML, CSS, and JavaScript, via which you

can create web and mobile apps alike. Course culminates in a final project.
See https://cs50.harvard.edu/college for advice, FAQs, syllabus, and what's new. Email the course's heads at heads@cs50.harvard.edu with questions.

January Term

***CHEMBIO 2200. Tools and Methods in Chemical Biology - REQUIRED**
Randy King and Melissa Leger-Abraham
M through F, 8am - 5pm (two weeks in mid January).
This course will provide a survey of major topics, technologies, and themes in Chemical Biology, with hands-on exposure to a variety of experimental approaches.
Note: Intended for first-year graduate students in the Chemical Biology Program; permission of the instructor required for all others.

Spring Semester

BCMP 236. Principles of Drug Action in People – BCMP236 or BCMP250 is REQUIRED
Sara Buhrlage, Xin Zhou, and Catherine Dubreuil
T, Th 3:30 – 5:00pm
This course will discuss principles of drug discovery drug modalities and drug pharmacology. In the first part of the course, fundamental aspects of receptor and enzyme targeting agents, drug mechanism, drug metabolism, pharmacokinetics and pharmacodynamics, small molecules, proteins, and nucleic acid drugs will be described. In the second part of the course, pharmacology of therapeutics that act on the cardiovascular, immunologic, and central nervous systems will be covered. The course will include frontier lectures delivered by experts at Harvard and in the Biopharmaceutics industry. A range of speakers enlisted from the Harvard faculty and pharmaceutical scientists will participate in teaching throughout this course.

BCMP250. Biophysical and Biochemical Mechanisms of Protein Function - BCMP236 or BCMP250 is REQUIRED
Josefina del Marmol
T, Th 11:00 – 12:00
Biophysical and Biochemical Mechanisms of Protein Function focuses on the molecular mechanisms that underlie essential biochemical processes such as signal transduction. Major topics include biochemical thermodynamics and conformational equilibria, protein structure and folding, receptor pharmacology, allostery, and enzymatic mechanisms of signaling. The course includes both content lectures and research frontiers seminars focused on current research in biochemistry with an emphasis on signal transduction in therapeutically relevant pathways.
Recommended prep: A foundational biochemistry course is recommended as a prerequisite (we expect students to have a solid understanding of the core concepts in biochemistry and molecular biology, including knowledge of the amino acids and their properties as well as the central dogma).

CHEM171. Biological Synthesis
Emily Balskus
T, Th 1:30-2:45PM

This course will examine synthesis from a biological perspective, focusing on how organisms construct and manipulate metabolites, as well as how biological catalysts and systems can be used for small molecule production. Topics to be covered include mechanistic enzymology, biosynthetic pathways and logic, biocatalysis, protein engineering, and synthetic biology.

MICROBI 201. Molecular Biology of the Bacterial Cell

David Z. Rudner, Thomas G. Bernhardt, Simon L. Dove, Sophie Helaine, and Marco Jost
T, Th 9:30-11:30.
This course is devoted to bacterial structure, physiology, genetics, and regulatory mechanisms. The class consists of lectures and group discussions emphasizing methods, results, and interpretations of classic and contemporary literature.

BCMP 234. Cellular Metabolism and Human Disease

Class Number: 11232
Thomas Michel, Bruce Levy, D. Moody, Joseph Loscalzo, Raul Mostoslavsky, Sudha Biddinger, Marcia Haigis, Paul Schmidt, Mark Puder, Lynn Bry, Eric Estrick, David Cohen, Elizabeth Henske, and Margaret Stefater-Richards
M, W, F 9-10:30.
Cellular and organismal metabolism, with focus on interrelationships between key metabolic pathways and human disease states. Genetic and acquired metabolic diseases and functional consequences. Interactive lectures and critical reading conferences are integrated with clinical encounters.

MCB 112. Biology Sequence Analysis

Sean Eddy
M, W, F 3-4:15
Biology has become a computational science, requiring analysis of large data sets from genome sequencing and other technologies. This course teaches computational methods in biological sequence analysis, using an empirical and experimental framework suited to the complexities of biological data, emphasizing computational control experiments. The course is primarily aimed at biologists learning computational methods, but is also suited for computational and statistical scientists learning about biological sequence data.

MICROBI 210. Microbial Sciences: Chemistry, Ecology and Evolution

Michael Gilmore, Peter Girguis
F 9:45-11:45
This is an interdisciplinary graduate-level and advanced undergraduate-level course in which students explore topics in molecular microbiology, microbial diversity, host-microbe associations in health and disease, and microbially-mediated geochemistry in depth. This course will be taught by faculty from the Microbial Sciences Initiative. Topics include the origins of life, biogeochemical cycles, microbial diversity, and ecology. Course will limit enrollment to 20 students.
Recommended prep: For graduate and advanced undergraduate students, Life Sciences 1a and 1b or their equivalent are required, or permission of instructor. MCB 60 or equivalent is recommended.

SCRB 157. A World of RNA: An RNA-centric view of life

Ryan Flynn
T, Th 1:30-2:45

RNA is one of the major biopolymers of life and may have indeed initiated life as we know it, yet much of the study of RNA is as a passive carrier of information. This course focuses on how RNA operates as a highly bioactive molecule in the natural world and how we leverage these activities for therapeutic benefit.

IMMUN 202 Immune and Inflammatory Diseases
Wendy Garrett
T, Th 1:30-3:30
IMMUN 202 builds on IMMUN 201 and explores fundamental principles of immunology in the context of immune and inflammatory diseases. Through a series of lectures and discussion, students will survey a broad range of diseases in which the immune system is essential. Topics will include not only diseases that mobilize classical immunity but also conditions to which we now know the immune systems contributes. Students will use oral (paper discussions) and written exercises (problem sets) to learn how to critically evaluate and synthesize major concepts and tools essential for the study of immunology.
Recommended prep: Immunology 201 or its equivalent.

BPH Pathophysiology of Human Disease
Nancy Long Sieber, Kristopher Sarosiek
M, W 2-3:30
This course explores the pathogenesis of disease by examining mechanisms operating at the molecular, cellular, system and whole-body levels. We will discuss diseases of the major body systems, as well as hematological disorders, cancer, the normal and abnormal function of the immune system, as well as aging and death. Throughout the course we will look for common underlying pathogenic pathways and integrate relevant public health perspectives on the epidemiology or control of diseases.
Recommended prep: Prior coursework in normal physiology is recommended but not mandatory

STAT 114 Introduction to Bioinformatics and Statistical Genetics
James Xenakis
T, Th 10:30-11:45 (spring)
This course is an introduction to bioinformatics and statistical genetics. The course will cover basic technology platforms, data analysis problems and algorithms. We will study statistical procedures commonly used in mammalian genetics (e.g., mouse and human). Topics include sequence alignment, differential gene expression analysis, QTL mapping and genome-wide association studies.

CELLBIO 201. Principles of Cell Biology
Susan Shao and Lucas Farnung
M, W, F 10:30-12:00,
CB201 is a graduate level course in which students examine fundamental concepts and methodologies in cell biology with faculty from the field. Through content lectures, methods lectures, student presentations, and discussion sections, students will explore a broad range of topics including: the cytoskeleton, protein folding and quality control, the ubiquitin-proteasome system, autophagy, protein translocation across membranes, vesicular trafficking, organelle biology, chromosome organization, epigenetics, cell cycle regulation, and signal transduction.
Recommended prep: Introductory knowledge in biochemistry, genetics, and cell biology.

CELLBIO 211. Molecular and Systems Level Cancer Cell Biology

Peter Sicinski, Marc Vidal

M, W 1-2:30

This semester long course will explore molecular basis of cancer formation through introduction of a wide range of topics that highlight foundational research and concepts, current major findings, and future directions. You will learn how cancer cells reprogram metabolism to feed their own needs, and that in over 50% of human cancers mutations are present in genes encoding chromatin-associated proteins and protein complexes. You will understand how the properties of cellular systems might be perturbed in cancer and what computational approaches are used in cancer research and discovery. Deep dive into cancer cells will reveal that even within the same tumor, cells can display startling differences for many features making intratumor heterogeneity a major obstacle toward understanding and treatment of cancers. You will learn about small molecule probes and how they offer a unique opportunity to understand the biological rationale for potential cancer therapeutics, how immune cells employ different cellular and molecular mechanisms to eliminate transformed cells, and you will learn about the rapid pace of cancer drug development highlighting results from recent clinical trials that have led to transformative FDA approvals. The topics are organized into eight modules and led by one faculty member. Faculty joining us this Spring are experts in the various fields and will provide you with an integrated perspective on past, current, and future approaches in cancer biology research. Modules consist of three sessions – an introductory lecture that provides an overview of the topic, a keynote lecture that talks about recent discoveries in the field, and a group discussion that gives you the opportunity to synthesize the knowledge and think critically about the scientific questions in the field, while focusing on building and improving scientific communication skills through the practice of presentation, discussion, and peer evaluation & feedback.

Note: Given alternate years with Cell Biology 212

CELLBIO 212. Biology of the Cancer Cell: From Molecular Mechanisms to Therapeutic Implications – not offered this year (alternates with CellBio 211)

Alex Toker

M, W 12:30-2:00

This semester-long course will take you on a molecular approach journey to examine the basis of human cancer – from deep dive on genetic aberrations in a cancer cell, to signaling pathways, and big picture cellular and organismal perspectives on cancer. Some of the main concepts we will cover include cancer genetics and epigenetics, tumor suppressor genes and oncogenes, signal transduction, DNA damage and repair, angiogenesis, metastasis and invasion, apoptosis, cancer stem cells, and tumor immunology and immunotherapy. Faculty joining us this Spring are experts in the various fields and will provide you with an integrated perspective on past, current, and future approaches in cancer biology research. Many of our faculty are also clinical oncologists and hematologists, providing you with an insight into how molecular advances are impacting patient care now and are likely to do so in the future. After each part of the course, you will participate in student workshops, where you will get the opportunity to dissect and learn about the major components of a research proposal and how to successfully write one. You will also have the opportunity to engage in an iterative writing and evaluation process with your peers while practicing giving feedback and critique.

Note: Given alternate years with Cell Biology 211

Recommended prep: Advanced biochemistry, molecular genetics, and cell biology.

Fall Semester (conflict with Chem110 so possible for second year)

STAT 100. Introduction to Statistics and Data Science

James Xenakis and Julie Vu

M, W 10:30 – 11:45 (conflict with CHEM 110)

Introduction to key ideas underlying statistical and quantitative reasoning, and the practice of data science. Course topics include methods for organizing, summarizing and visualizing data; basics of probability; elements of study design; data ethics; parameter estimation and hypothesis testing in one- and two-sample problems; regression with one or more predictors; and basic analysis of categorical data. Students will learn a reproducible workflow for analyzing data in the statistics package R. No prior statistics or computing knowledge is assumed.

BCMP 200. Molecular Biology

Joseph John Loparo, Frank Slack, Lee Stirling Churchman, Alan Brown, Johannes Walter and Karen Adelman

M, W, F 11:00-12:00 (conflict with CHEM 110)

Principles of Molecular Biology is a course organized around the Central Dogma of Biology with presentations covering fundamental aspects of DNA and RNA structure, their function and their interactions with proteins. The course opens with a discussion of the physical and chemical properties that drive the interactions of proteins with nucleic acids. This is used as a basis for understanding the material presented in the subsequent five modules, which cover DNA replication, DNA repair, gene regulation, transcription and translation. Throughout this course an emphasis will be placed on how the structure of small molecular machines (proteins) define their function in the processes and pathways that are introduced.

Recommended Prep: Intended primarily for graduate students familiar with basic molecular biology or with strong biology/chemistry background.

HBTM 235. Principles of Human Disease: Physiology and Pathology

Constance L. Cepko (Medical School), and members of the Department

M, W, F 9-10:30 (conflict with CHEM 110)

This course covers the normal physiology and pathophysiology of selected organs, through lectures, readings, tutorials based on clinical cases, and patient presentations. Human biology is emphasized, with some examples also drawn from model organisms. Using a combination of lectures and case-based small group tutorials, the course will survey some key areas of human physiology: cardiovascular, pulmonary, renal, and gastrointestinal systems, as well as neurobiology, endocrinology, cancer and immunology. Molecular and cellular approaches to drug discovery and therapeutics will be presented where appropriate, with a particular emphasis on the current state-of-the-art in our scientific and clinical understanding.

Recommended prep: Knowledge of introductory biochemistry, molecular biology, and cell biology required (MCB52 and MCB54 or equivalent for undergraduates is recommended).