MINOR in Chemical and Physical Biology (CPB)

(rev. 2/2025)

Note: Any course can fulfill the requirements of a Ph.D. major OR a CPB minor, not both.

QCB Training Program courses

Enrollment	Course	Credits	Title/Description
Trainees are permitted to enroll in graduate program year 1 (with permission of instructor) or year 2	CHEM C680	1.5	**Introduction to Quantitative Biology and Measurement** Core Topics in ligand binding and coupled equilibria and single molecule science, electron microscopy and biological mass spectrometry. Course focuses on the capabilities of each type of measurement: data analysis, sensitivity, resolution, quantitation, and limitations. *This course is required for QCB trainees and can also be used to fulfill the 6 credit CPB minor.*
	CHEM C681	1.5	**Introduction to Chemical Biology I** An application in chemical biology course that covers the chemical origins of biology, polyketides, terpenes and nonribosomal peptide synthesis, solid-phase peptide synthesis, bioorthogonal chemistry, protein labeling and a short primer on enzyme structure and function. *This course is required for QCB trainees and can also be used to fulfill the 6 credits CPB minor.*
Trainees typically enroll in graduate program years 2 & 3	CHEM C689	1	**Quantitative and Chemical Biology Journal Club** Student presentations on topics of interest to QCB training faculty, with four research foci per semester organized by QCB trainers or trainee. *This course is required for QCB trainees. However, it **does not** count toward the 6 credit CPB minor.*
Trainees enroll at end of graduate program year 3	CHEM C699	1	**Independent Study in Quantitative and Chemical Biology** **Prerequisite: C680, C681, and selection as a QCB Fellow.** A 4-8 week off-campus internship, arranged in consultation with the trainee's preceptor and QCB program director. *This course is **optiona**l for QCB trainees but strongly encouraged and **does not** count toward the 6 credit CPB minor.*

The Chemical and Physical Biology (CPB) minor requires completion of C680 and C681 above and a total of 3 credit hours from the electives listed below.

Course #	Credits	**Title** with description and prerequisites
BIOC B525/ CHEM C585	1.5 credits	**Membranes and Membrane Proteins** **Prerequisite: B501/C584 or C483/C484** One semester of undergraduate physical chemistry recommended. Provides a general understanding of the physical and chemical forces that hold membranes together that give rise to the structure and function of biological membrane assemblies; molecular characteristics of lipids and membrane proteins in cell biological processing.
BIOC B530/ CHEM C581	1.5 credits	**Macromolecular Structure and Function** **Prerequisite: B501/C584 or C483/C484 plus C341, or Instructor consent[1]** Undergraduate (bio)physical chemistry (equivalent to C481 or C361) is strongly recommended. Stabilizing forces in macromolecular structures; protein structure analysis; nucleic acid structure and probing; structure determination by NMR and X-ray crystallographic analysis.

BIOC B531/ CHEM C582	1.5 credits	**Biomolecular Analysis and Interaction** **Prerequisite: B501/C584 or C483/C484 plus C341 and B530, or Instructor consent[1]** Undergraduate (bio)physical chemistry (equivalent to C481 or C361) is strongly recommended. Principles of inter- and intramolecular interactions; thermodynamic and kinetic analysis of complex binding; experimental methods for analysis of macromolecular structure and binding. *Sequential with B530/C581.*
BIOC B540/ CHEM C588	1.5 credits	**Fundamentals of Biochemical Catalysis** **Prerequisite: C342, C483/C484, or Instructor consent[1]** General properties of enzymes and basic principles of enzymatic reactions are discussed. Enzyme kinetics; inhibitor types, their importance and their effects on enzymes will be covered. Students will gain facility with thermodynamics, catalytic mechanisms, kinetics and binding equilibria as they apply to proteins.
BIOC B541/ CHEM C589	1.5 credits	**Enzyme Mechanisms** **Prerequisite: C588; C342, C483/C484, or Instructor consent[1]** Enzyme mechanisms demonstrate how chemical principles are employed by living organisms. The course will cover several classes of enzymes, for example, hydrolases, phosphorylases, kinases, carboxylases, and transferases. Focus will also be placed on the roles of cofactors in catalysis. *Sequential with B541/C589.*
CHEM C682	1.5 credits	**Introduction to Chemical Biology II** **Prerequisite: C681** Basic elements of chemical biology applications and uses of technology. Currently focused on macromolecules, DNA as a target for cytotoxic drugs, DNA editing, RNA structure and aptamer design, chemical tools, glycobiology, various mechanisms of chemical signaling, and how these processes can be exploited in a general drug discovery program *Sequential with C681*.
CHEM C502	3 credits	**Inorganic Spectroscopy** **Prerequisite: C361** Chemical applications of group theory and the elucidation of structure and bonding in inorganic molecules and complexes by vibrational, nuclear magnetic resonance, Mossbauer and electronic absorption spectroscopy.
CHEM C562	3 credits	**Computational Quantum Chemistry** **Prerequisite: C561** Elements of quantum theory, solution of elementary problems with chemical applications, approximate methods, atomic structure, molecular symmetry and normal vibrations, the molecular orbital description of molecules.
CHEM C605	1.5 credits	**Biological Regulation** **Prerequisite: C581** Selected aspects of biochemical regulation are discussed, while reinforcing core concepts of biochemistry as discovery-based quantitative, molecular and chemical science. The course is broken up into two sections, the first of which are the "parts", key tools (mass spectrometry) and concepts that are used to develop a series of case studies, focused on mechanism and metabolic logic. *Cross listed as B680 and C455.*
CHEM C612	2 credits	**Spectrochemical Methods of Analysis** New instrumentation and techniques employed in spectrochemistry; in depth treatment of commonly used spectrochemical methods.
CHEM C616	3 credits	**Surface Analysis and Surface Chemistry** An overview of the modern instrumental techniques of surface analysis will be presented, together with a survey of their applications to solve surface chemical problems. Topics include electron and ion spectroscopies, SIMS, LEED, thermal desorption spectroscopy, surface electron and ion microscopies, catalysis, micro-electronics fabrication, and corrosion.

CHEM C620	2 credits	**Measurement Science** Topics related to measurement in the chemical sciences and interdisciplinary fields of science and engineering. Special attention to perspectives on advanced instrumentation and application of new hybrid techniques to areas such as biomedical, environmental, energy, or other areas of interest.
CHEM C632	3 credits	**Metal Ions in Biological Systems** Introduction to the field of bioinorganic chemistry and spectroscopic methods for determining structure/function relationship of metal ions in biology. Emphasis on oxygen carriers, metal ion transport and storage, as well as oxidoreductases involved in oxygen, hydrogen, and nitrogen metabolism.
CHEM C634	3 credits	**Transition Metal Chemistry** Survey of the prop-erties of the transition metals with emphasis on common oxidation levels, coordination geometries, and compounds with "classical" ligands; "hard" and "soft" acids and bases; d-orbitals and their energies in different geometries; formation constants and the Chelate Effect; metal-ligand multiple bonding, metal-metal bonds; coordination clusters and their biological relevance.
CHEM C637	3 credits	**Physical Methods in Structural Chemistry** Application of X-ray diffraction, dynamic NMR and mass spectroscopy to structural and mechanistic problems throughout the periodic table, with emphasis on what techniques are optimal for particular questions, as well as the potential weaknesses of each.
BIOC B680/ CHEM C687	1.5 credits	**Special Topics: Biomolecular NMR Spectroscopy** **Prerequisite: B530/C581 or Instructor consent[1]** Modern NMR structure determination of proteins, protein-ligand complexes, and regulatory RNAs, from sample preparation to residue-specific resonance assignments to structure determination. Hands-on component featuring two-dimensional NMR.
BIOL Z620/ BIOC B680	1.5 credits	**Special Topics: Electron Microscopy** **Prerequisite: Instructor consent[1]** The theory and practice of electron microscopy oriented toward biological applications, with a significant "hands-on" component on IUB-EMC instrumentation including the JEOL 1010 and JEOL 1400plus TEMs and JEOL 3200FS (S)TEM systems.
BIOL Z620/ BIOC B680	1.5 credits	**Special Topics: Digital Imaging Light Microscopy** **Prerequisite: Instructor consent[1]** A general introduction to the theory and practice of microscopy is provided starting with the properties of light interacting with matter. The principles of modern optical imaging devices and electronic detectors are covered in detail and with perspective on techniques. Students spend equal time in lecture and in the Light Microscopy Imaging Center working in small groups with different imaging systems.
BIOC B511	3 credits	**Duplicating and Expressing the Genome** Attain an advanced level of understanding of the molecular basis of DNA replication and its control; comprehend the molecular basis of gene expression and its control; understand the interplay between chromatin and nuclear structure and replication and transcription; evaluate primary literature in this field.
BIOL L519	3 credits	**Bioinformatics: Theory and Application** Overview of theory and applications in bioinformatics, based on fundamentals of molecular biology and information sciences. Common problems, data, and tools in the field are outlined. These include biosequence analysis, alignment and assembly, genomics, proteomics and phylogenetics, biological databases and data mining, and Internet bio-information services.
MSCI M508	2 credits	**Precision Medicine of Cancer** This course highlights scientific evidence for precision medicine approaches and discusses what is needed to move the concept of precision medicine into clinical practice. As oncology is the clear choice for enhancing the near-term impact of precision medicine, this course will focus on individualized, molecular approaches to cancer, while also incorporating how findings in the cancer field provide a strong framework for accelerating the adoption of precision medicine in other diseases.

MSCI M580	3 credits	**Molecular Biology of Cancer** Cancers are genetic diseases produced by mutations in the genes that control cell signaling and cell fate. This class will provide an in-depth study of cell signaling and mechanisms by which cell fate is regulated. These concepts will be used to develop a comprehensive understanding of how tumor cells develop, recruit the support from normal cells, modulate the immune system, metastasize and are treated.
NEUS N566	3 credits	**Developmental and Cellular Neuroscience** **Prerequisite: Knowledge in basic neuroscience and biology; Instructor consent[1]** This course examines the vertebrate nervous system from a cellular and molecular perspective. It covers the unique structural and functional properties of both neurons and glia, explores in depth the development of the nervous system, and covers at a molecular level the biological basis for learning and memory.
PSY P657	1-4 credits	**Topical Seminar: The Science Behind Brain Development and Function** Reviews human brain anatomy and the vasculature, protection of the brain from insults; neural circuits associated with sensory processing and cognitive behaviors and their development; a comprehensive discussion of molecular, biochemical, imaging, electrophysiological, and behavioral methods that are used in neuroscience research.
PSY P657	1-4 credits	**Topical Seminar: Molecular, Cellular, and Circuit Mechanisms of Addition** The objective is to introduce an emerging concept that addiction should be considered as a brain disorder driven by maladaptive plasticity processes. The neurobiological basis of the normal and abnormal plasticity processes in the healthy and the addicted brain, respectively, will be studied.
PSY P657	1-4 credits	**Topical Seminar: Neurobiology of Cognition** Organizational principles of cortical networks; diversity of cell types and their networks in the cerebral cortex; communication between nerve cells within and between cortical and subcortical regions; brain rhythms (theta and gamma oscillations); structure and function of cells of the hippocampus, amygdala, prefrontal cortex and glial cells under normal and pathological conditions.
PSY P667	3 credits	**Neuropsychopharmacology** Analysis of neural mechanisms of drug effects on animal and human behavior, based on behavioral and biological experiments.
PHYS P575	3 credits	**Introduction to Biophysics** An introduction to biophysics. Topics include properties of biomolecules and biomolecular complexes; biological membranes, channels, neurons; Diffusion, Brownian motion; reaction-diffusion processes, pattern formation; sensory and motor systems; psychophysics and animal behavior, statistical inference.
PHYS P582	3 credits	**Biological and Artificial Neural Networks** Biological details of neurons relevant to computation. Artificial neural network theories and models, and relation to statistical physics. Living neural networks and critical evaluation of neural network theories. Students' final projects will consist of programming networks and applying them to current research topics.
PHYS P583	3 credits	**Signal Processing and Information Theory in Biology** Probability and statistics. Filtering. Correlation functions and power spectra. Time invariant and time-varying systems. Shannon Information. Coding and decoding. Processing of sensory signals and other applications to neurobiology and psychophysics.
BIOC B601/ CHEM C683 (***inactive***)	1.5 credits	**Advanced Nucleic Acid Biochemistry** **Prerequisite: B501/C584 or Instructor consent[1]** Mechanistic analysis of nucleic acid metabolism; specificity and role of DNA polymerases and repair pathways; DNA replication and recombination mechanisms; RNA structural motifs and physical properties; RNA synthesis and processing in gene expression; catalytic RNA molecules; applications of RNA molecules.

BIOC B602 (***inactive***)	1.5 credits	**Advanced Protein Biosynthesis and Processing** **Prerequisite: B501/C584 or Instructor consent[1]** Detailed analysis of protein synthesis, post-translational modification, and macromolecular assembly, including the role these modifications play in mature protein function, biosynthesis, structure, function, and analysis of complex oligosaccharides.
BIOC B604/ CHEM C686 (***inactive***)	1.5 credits	**Structural Methods** **Prerequisite: B530/C581 or Instructor consent[1]** Fundamental principles of circular dichroism, nuclear magnetic resonance and X-ray crystallography in the study of protein and nucleic acid structures. Theoretical and practical aspects will be presented, with particular emphasis on application strategies.

[1]**Instructor consent**: To receive consent, please e-mail the professor assigned to the course to request permission to enroll in course of interest. If it is a specialized course, it would be helpful to provide the professor information regarding your previous courses taken to demonstrate basic knowledge of selected topic.