QCB TRAINING PROGRAM/QB MINOR

CURRICULUM ELECTIVES

Note: A single course can only count once towards a Ph.D. core course or an elective towards the QB minor

Required QCB Training Program Courses

	Course	Credits	Title/Description
Year 2	CHEM C680	1.5	**Introduction to Quantitative Biology and Measurement** Core Topics in solution scattering methods, electron microscopy, light microscopy/imaging, and biological mass spectrometry. Course focuses on the capabilities of each type of measurement: data analysis, sensitivity, resolution, quantitation, and limitations. Introduction to cutting-edge instrumentation available for use in thesis research, research findings or new approaches used in (C689).
	CHEM C681	1.5	**Introduction to Chemical Biology I** Basic elements of chemical biology with a chemistry-centered focus. This course will cover peptide synthesis and ligation methods, oligonucleotide synthesis, diversity oriented synthesis and combinatorial libraries, bio-orthogonal reactions, high-throughput screening methods and their use in drug discovery, and secondary metabolism.
	CHEM C689	1	**Quantitative & Chemical Biology Journal Club** Molecular dynamics and special techniques for simulating nanosystems. Nanocharacterization measurements. Applications to microbiology, drug and vaccine design, nanocapsules for drug delivery, design of nanocharacterization technologies, and contemporary problems in chemical biology and nanoscience.

Year 3	CHEM C689	1	**Quantitative & Chemical Biology Journal Club**
	CRSE XXX	1 course at 3 credits **OR** 2 courses at 1.5 credit	Approved electives listed below up to 3 credits

Quantitative Biology (QB) Minor requires completion of C680 + C681 and 3 credit hours from the electives listed above or below.

Approved electives 3 credits or 2 courses at 1.5 credits

Course #	Credits	**Title** with description
CHEM C502	3 credit	**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 C588/ BIOC B540	1.5 credit	**Fundamentals of Biochemical Catalysis** 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.

CHEM C589/ BIOC B541	1.5 credit	**Enzyme Mechanisms** **Prerequisite: C588** 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.
CHEM C620	1- 3 credit	**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 credit	**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 C682	1.5 credit	**Introduction to Chemical Biology II** Basic elements of chemical biology applications and uses of technology. This course will cover microarray technology, protein labeling, chemical genetics; small molecule interactions with proteins/DNA; modulation of protein-protein interactions; RNA aptamers and molecular evolution.
CHEM C683	1.5 credit	**Advanced Nucleic Acid Biochemistry** 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 processing in gene expression; catalytic RNA molecules; applications of RNA molecules.
CHEM C668	1.5 credit	**Seminar Physical Chemistry** Topics such as materials chemistry or chemical applications of matrix algebra and group theory, digital computing techniques, solid state chemistry, high temperature processes, electrochemistry, theory of solutions, spectroscopy, and surface chemistry. (May be repeated with different topic.)
BIOC B511	3 credit	**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.
BIOC B530/ CHEM C581	1.5 credit	**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 credit	**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.
BIOC B540	1.5 credit	**Fundamentals of Biochemical Catalysis** **Prerequisite: C342, C483/C484, or Instructor consent[1]** Theory and analysis of biochemical catalysis; enzyme kinetics and inhibition; intermediate detection; protein modification and bioorthogonal chemistry.

BIOC B541/ CHEM C589	1.5 credit	**Enzyme Mechanisms** **Prerequisite: C342, C483/C484, or Instructor consent[1]** Theory and analysis of biochemical catalysis; post-translational modifying enzymes; redox cofactors; natural product biosynthesis; P450 mechanisma; proteomics.
BIOC B601	1.5 credit	**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	1.5 credit	**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 B603/ CHEM C685	1.5 credit	**Advanced Macromolecular Structure and Interactions** **Prerequisite: B503/C581 or Instructor consent[1]** Supplements and extends B503/C581; emphasis on stability and folding mechanisms of proteins and nucleic acids and detailed thermodynamic analysis of binding interactions.
BIOC B604/ CHEM C686	1.5 credit	**Structural Methods** **Prerequisite: B503/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.
BIOC B605/ CHEM C585	1.5 credit	**Structure and Function of Membranes** **Prerequisite: B501/C584, B503/C581 or Instructor consent[1]** Biochemistry and biophysics of lipids, membranes, and membrane proteins; fundamentals of membrane transport; interfacial catalysis; transmembrane signal transduction.
BIOC B680/ CHEM C687	1.5 – 3 credit	**Special Topics in Biochemistry – Biomolecular NMR Spectroscopy** **Prerequisite: Instructor consent[1]**
BIOC B680/ CHEM C687	1.5 - 3 credit	**Special Topics in Biochemistry – Digital Imaging Light and Electron 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.
BIOL L519	3 credit	**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.
PHYS P575	3 credit	**Introduction to Biophysics** Physics P575 presents 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 P581	3 credit	**Modeling and Computation in Biophysics** Introduction to modeling and computational methods applied to phenomena in Biophysics. Topics: population dynamics; reaction kinetics; biological oscillators; coupled reaction networks; network theory; molecular motors; limit cycles; reaction diffusion models; the heart; turning instability; bacterial patterns; angiogenesis.
PHYS P582	3 credit	**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 credit	**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.
PHYS P676	3 credit	**Selected Topics in Biophysics** This course presents papers on current topics in Biophysics, together with key classical papers related to those topics. Student participation in discussions is essential. Each student is expected to write two essays on two of the topics presented.

[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.

Course Missing Date and Time

If there is no date or time provided to a course listing in the academic bulletin, it means the course will be arranged to student availability by the assigned instructor. Please contact the professor via e-mail to facilitate date and time arrangements.