Appendix. Description of graduate course electives (in order of course subject and number)

• **BCHM/BIOL 536 (Biological & Structural Aspects of Drug Design & Action):** Overview of drug discovery pipeline process, and biological structures and mechanisms-of-action behind currently marketed therapeutics. Includes general principles of target selection, assay development, high-throughput screening, and structure-based drug design. Focuses mainly on small-molecule drugs, with examples of biologics at the end of the course.

• **BCHM 605 (Macromolecules):** This course covers the basic principles underlying the secondary and tertiary structures of proteins and nucleic acids that contribute to their function. Students become familiar with methods used to determine three-dimensional structures and global conformations, enabling their critical evaluation of structural models. Topics include native and engineered biomacromolecules with novel functions, membrane proteins, and drug design.

• **BCHM 610 (Regulation of Eukaryotic Gene Expression):** This course focuses on recent advances in gene expression and its mechanisms, with examples taken from the current primary literature. Topics include transcription, messenger RNA decay, microRNAs, and connections between gene expression steps. Students digest and interpret scientific literature through reading, discussions, and oral presentations, and also gain experience in developing hypotheses by writing research proposals.

• **BCHM 615 (Pathways):** This advanced graduate-level course in cell biology covers the major intracellular signaling pathways and cell cycle regulation of eukaryotes, with readings taken from the primary literature.

• **BIOL 511 (Introduction to X-ray Crystallography):** This course covers the basic laws and principles guiding the analysis of two- and three-dimensionally ordered structures using optical, electron, and X-ray diffraction methods. Topics include: diffraction geometry, detection & wave analysis; crystal symmetry & lattice parameters; the phase problem; the heavy atom method; isomorphous & molecular replacement; direct methods; helical diffraction.

• **BIOL 516 (Molecular Biology of Cancer):** Reviews current research techniques used to examine the biology of eukaryotic cells, and covers seminal discoveries in the areas of cell cycle regulation, DNA, and RNA tumor virology, growth factors and their receptors, signal transduction and oncogenes. For all topics, an emphasis is placed on the molecular mechanisms governing growth regulation and how alterations in these mechanisms can give rise to disease states such as cancer.

• **BIOL 595 (Methods and Measurements in Physical Biochemistry):** Introduction to physical methods such as UV/Vis spectroscopy, circular dichroism, IR and Raman spectroscopy, fluorescence, neutron diffraction, light scattering, x-ray crystallography, NMR and ESR spectroscopy, electron microscopy, and mass spectrometry. Application of these techniques to studies of structure and dynamic behavior of biological macromolecules, protein–ligand and cofactor complexes, and conformational changes associated with biomolecular interactions.

• **CHM 560 (Organic Spectroscopic Analysis):** A core-level course for graduate students with an emphasis on practical applications of spectroscopy toward organic structure analysis. Problem-solving strategies include characterization of functional groups, stereochemical analysis, and fragment-assembly approaches using advanced spectroscopic methods.

• **CHM 632 (Membranes: Structure and Function):** This course covers the properties of lipid membranes and model systems. Topics include the role of membranes in regulating information flow, membrane–protein interactions, scope and limitations of biophysical characterization tools, and experimental approaches for investigating lipid–protein interactions.

• **CHM 634 (Biochemistry: Structural Aspects):** A core-level course for graduate students, with an emphasis on molecules and materials of biochemical interest, including carbohydrates, lipids, amino acids, nucleic acids, proteins, porphyrins, and the biochemistry of bodily fluids.

• **CHM 635 (Biochemistry: Dynamic Aspects):** This course covers several biochemical topics in greater depth, including enzyme kinetics, the behavior of macromolecules in solution, metabolism and related biochemical pathways, protein and nucleic acid biosynthesis, and protein engineering.

• **CHM 651 (Advanced Organic Chemistry):** A core-level course for graduate students, with emphasis on organic structure, molecular orbital theory, conformational and electronic factors, and reaction mechanisms.

• **CHM 652 (Synthetic Organic Chemistry):** An advanced treatment of synthetic methods for the preparation of and interconversion between major classes of functional groups, with application toward multistep synthesis. Emphasis is placed on strategies for efficient synthesis, stereochemical control, and mechanistic understanding of the reactions employed.

• **CHM 696A (Chemical Biology):** This course covers current issues in chemical biology that are commonly featured in drug discovery and design. Topics include protein–protein interactions using synthetic probes, molecular-based strategies for combating antimicrobial drug resistance, design of antiviral agents, strategies for cell targeting and uptake, and synthetic modulators of the cell cycle.

• **CHM 696D / MCMP 690K (Aspects of Drug Design and Medicinal Chemistry):** Covers fundamental concepts and strategies for molecular drug design, and its integration into the drug discovery and development process. Topics include lead discovery and modification, structure–activity relationships, receptor targeting, enzyme inhibitors, prodrug design, peptidomimetics, and natural product-inspired drug discovery.

• **CS 59000 (Computing for Life Sciences):** Basic bioinformatics algorithms and Python programming. Course topics include biological databases, algorithms for biological sequence (DNA, protein), sequence alignment and database search, sequence motif search, protein tertiary structure analysis, protein–protein interactions, and comparative genomics.

• **IPPH/TLI 521 (Drug Development):** This course reviews the basics of drug discovery and development, with emphasis on the regulatory aspects of these activities. Animal preclinical research and human clinical research are discussed in detail. In addition, the process for the assembly of an IND and NDA is discussed along with human clinical trials (Phases I–III). CMC (chemistry manufacturing and control) aspects of drug development are presented along with ICH documents and manufacturing process analytical technologies. The course concludes with a brief review of international regulatory issues and patents.

• **IPPH/TLI 522 (Good Regulatory Practices):** This course reviews FDA and ICH regulations on good manufacturing, good laboratory, and good clinical practices. The meaning of these regulations, the globalization of practices, and the roles and responsibilities of various professionals implementing these regulations are addressed. Emphasis on the assembly and submission process of an IND or NDA, and the function of the regulatory affairs department in a pharmaceutical company.

• **MCMP 570 (Basic Principles of Chemical Action on Biological Systems):** This core-level course introduces fundamental concepts at the chemistry-biology interface, and how potential therapeutic agents are designed and evaluated. Scientific areas discussed include receptor site theory (protein-ligand interactions, steric and electronic complementarity, and conformational effects), computational approaches to drug design, modes of receptor action (agonism, antagonism, allosterism), kinetics of drug action (reversible and irreversible inhibition, allosteric inhibition), signal transduction pathways, and case studies on selected molecular targets.

• **MCMP 617 (Molecular Targets: Neuro Function and Dysfunction):** This course introduces basic biological and medicinal chemistry principles applied toward drug development related to treating psychiatric disorders and diseases of the central nervous system (CNS). Examples of neuroactive targets include G protein-coupled receptors, neurotransmitter transporters, and ion channels. Neurosecretion and neurodegenerative processes will also be discussed, as well as target validation and genetic models used to identify CNS targets.

• **MCMP 618 (Molecular Targets: Cancer):** This course provide the fundamentals of cancer biology, with application of basic scientific principles from medicinal chemistry, molecular pharmacology, and recent advances in biology toward the development of new anti-cancer drugs. Examples of drug targets from recently approved drugs as well as those under investigation are discussed, including kinases, monomeric G proteins, prenyltransferases, transcription factors, nuclear receptors, cell cycle proteins, cytoskeletal proteins, and topoisomerases.

• **MCMP 690K (Aspects of Drug-Design and Medicinal Chemistry):** See CHM 696D.

• **STAT 503/511 (Statistical Methods):** Entry-level courses taken by graduate students from diverse fields, with emphasis on the practical aspects of experimental data analysis using statistical software. Topics include descriptive statistics, elementary probability and sampling distributions, inference and testing hypotheses, normal, binomial, and Poisson distributions, one-way analysis of variance, contingency tables, and regression.