Shanghai Jiao Tong University – Zhiyuan College - 2018

Period a – July 3-6 and 10-13 1 credit each: 16 hours, 2 hr x 8 days, M-Th)
Period b – July 17-20 and 24-27 1 credit each: 16 hours, 2 hr x 8 days, M-Th)

Section 1a. Prof. Brian P. Coppola, University of Michigan: Bio-Organic Mechanisms
Section 1b. Prof. William Pomerantz, University of Minnesota: Introduction to Chemical Biology
Section 2a. Prof. Zhan Chen, University of Michigan: Instrumental analysis
Section 2b. Prof. James Penner-Hahn, University of Michigan: Introduction to Biophysics

1a. Bio-Organic Mechanisms
Mechanistic organic chemistry is a powerful tool. There is no biological reaction of organic compounds that does not follow the basic rules of organic chemistry. In each of the class sessions, there will be problems that begin with a review of a fundamental area of mechanism in organic chemistry followed by an application of that area to biological molecules. The focus is on organic chemistry, not biochemistry.

Organic chemistry topic	*Bio-organic topic*
Day 1: Bronsted acid/base; structure & isomerism	enzyme catalysis
Day 2: Substitution/Elimination reactions	biological oxidation/reduction
Day 3: Electrophilic addition reactions/ EAS	epoxides & cationic cyclization
Day 4: Carbonyl Addition Reactions	carbohydrates & vitamin B6
Day 5: Substitution Reactions at sp2¬ centers	proteases
Day 6: Carbonyl Condensation Reactions	fatty acid synthesis
Day 7: Pericyclic Reactions	biological examples
Day 8: Examination	

1b. Introduction to Chemical Biology
Chemical Biology encompasses chemical research that expands our understanding of biology, and biological research that expands our understanding of chemistry. In this course, I will emphasize the design and employment of molecules to understand and manipulate biological systems and processes at the molecular level. The course will explore micro and macromolecular structures with a focus on mechanistic organic chemistry. Examples will include peptide synthesis and glycobiology, synthetic nucleic acids, chemical strategies and tools to monitor biological systems, and research into stem cell biology.

Day 1: General Introduction and Bio-labelling
Day 2: Basic Amino Acid Structure and Protecting Group Chemistry.
Day 3: Coupling Reactions. Solid Supports and Linkers.
Day 4: Solid Phase Peptide Synthesis. Native Chemical Ligation.
Day 5: Carbohydrate Reactivity. Oligosaccharides and Carbohydrate Inhibitors.
Day 6: Nucleic Acids. Base-Pairing and Synthetic Monomers.
Day 7: Biological and Chemical Synthesis of Oligonucleotides
Day 8: Examination

2a. Instrumental analysis
This course introduces the principles and techniques of modern instrumental analysis. A variety of instrumental analytical techniques including atomic absorption and emission spectroscopy, fluorescence spectroscopy, infrared spectroscopy, Raman spectroscopy, surface plasma resonance, NMR, and mass spectrometry will be discussed. The current development and updated applications of these techniques will be introduced.

Day 1: Introduction of spectroscopy, optical components, lasers, detectors
Day 2: Introduction of data analysis, optical imaging, SEM, STM, AFM
Day 3: Fluorescence spectroscopy and imaging, biosensing, biomedical applications
Day 4: FTIR, Raman, Surface plasma resonance
Day 5: Nonlinear optical spectroscopy and imaging
Day 6: Electrochemistry and biomedical applications
Day 7: Mass spectrometry and biomedical applications
Day 8: Examination

2b. An Introduction to Biophysics
Biophysics, as a distinct discipline, traces its origins to 1847, when four leading physicians (Emil du Bois-Reymond, Ernst von Brücke, Hermann von Helmholtz, and Carl Ludwig) first proposed creating a research program based on the, at that time novel, proposition that living organisms are governed by the same laws that explain physical and chemical phenomena (in contrast to life being governed by special biological laws with vital forces that differ from those that operate in the domain of inorganic nature). An early focus was on neuro- and muscle physiology and, as quantitative tools improved, the characterization of enzyme kinetics. As new tools have been developed (crystallography, optical and electron microscopies, magnetic resonance, theoretical modeling, etc.) they have been added to the biophysicists toolbox. This course will review the basic building blocks of life and then explore modern biophysical methods with a focus on understanding how these tools can improve our understanding of biology, governed by the advice of A.V. Hill that "the employment of physical instruments in a biological laboratory does not make one a biophysicist," rather it is "the study of biological function, organization, and structure by physical and physicochemical ideas and methods"

Day 1: Structures of biological molecules (proteins, carbohydrates, lipids, nucleic acids)
Day 2: Biological membranes (membrane function, components)
Day 3: Biological membranes (membrane permeability and transport)
Day 4: Cells (structure, components, life-cycle)
Day 5: Biophysical tools (voltage and current measurements, x-ray and electron scattering)
Day 6: Biophysical tools (scanning probe and magnetic microscopies)
Day 7: Biophysical tools (other spectroscopies and theoretical methods)
Day 8: Examination