STEP II: Biomedical Engineering Program

COURSE #: BIOMEDE 221	**COURSE TITLE: BIOPHYSICAL CHEMISTRY AND THERMODYNAMIC**
TERMS OFFERED: Fall	**PREREQUISITES: Math 116 and Chem 130**
TEXTBOOKS/REQUIRED MATERIAL: "Biological Thermodynamics" by Donald T. Haynie, Cambridge University Press, Cambridge UK, 2001	**COGNIZANT FACULTY: M. Mayer** **DATE OF PREPARATION: July-September 2004**
INSTRUCTOR(S): M. Mayer	**SCIENCE/DESIGN: 4/0**
CATALOG DESCRIPTION: This course covers the physico-chemical concepts and processes relevant to life. The emphasis lies on the molecular level. The course starts by looking at nature's engineering solutions and then examines a selection of the concepts and processes that make biological systems work. It deals with questions like: Why do biochemical reactions occur in the first place? What does it mean when reactions reach equilibrium and how does nature shift equilibria? Why is water so special and what are the biological consequences? How does nature build biomembranes and why are these structures stable although they are only 5 nanometers thick? How can nerves transmit signals so quickly? How do proteins fold and what goes wrong in prion diseases? How do molecules recognize each other?	**COURSE TOPICS:** (1) Biomimetics (and Motivation) (2) Energy and Driving Forces - Thermodynamics (3) Biochemical Equilibria (4) Aqueous Solutions, Osmotic Pressure (5) Molecular Self-Assembly in Chemistry and Biology (6) Bio-Electrochemistry (7) Biopolymers, Protein Structure, X-helix, B-sheets, Amino Acid Side Drains (8) Molecular Recognition in Biology / Binding Equilibria

COURSE OBJECTIVES	Links shown in brackets are to the departmental educational objectives. 1. To review the basics of (weak and strong) chemical bonds [1,12]. 2. To illustrate the importance of thermodynamics for metabolism and physiology [1,12,13]. 3. To teach students the concept of chemical equilibria, shifts in equilibria, and coupled reactions (metabolic cycles) [1,12,13]. 4. To teach important aspects of aqueous solutions (activity, chemical potential, colligative properties, diffusion, hydrophobic effect) [1,13]. 5. To examine the driving forces for self-assembly (e.g. biomembranes and protein subunits) [5,10,13]. 6. To teach the basics of signal transduction (membrane potential, ion channels, nerve signals) [1,10,13]. 7. To teach the ubiquitous concept of molecular recognition in biology [13]
COURSE OUTCOMES	Links shown in brackets are to the course objectives. 1. Apply thermodynamics to biological/biomedical problems (e.g. determine binding constants) [1,2,4,7]. 2. Understand how cells synthesize ATP by coupling reactions and using chemiosmosis [2,3,5]. 3. Learn how biology uses self-assembly to build biomembranes and functional nano-components [2,5,7] 4. Learn how cells build a membrane potential and use it for energy conversion and signaling [2,5,6,7] 5. Learn the basics of protein folding, protein function, molecular recognition, and protein denaturation [1,2,4,5,6,7] 6. Understand real solutions and colligative properties (osmotic pressure)
ASSESSMENT TOOLS	Links shown in brackets are to the course outcomes. 1. "Lecture minutes" during the last five minutes of each class. The students answer three questions: i) What was the most important topic/concept of this lecture? ii) Was there anything you did not understand? iii) Was this lecture useful? [1-5] 2. In class discussion and exercises with collaborative, group problem solving [1-5]. 3. Graded homework assignments (weekly) [1-5]. 4. Written examinations (two midterm exams and one, cumulative final exam) [1-5]. 5. End of term course evaluations by each student [1-5].