BIOLOGICAL ENGINEERING (BIOE)

BIOE2000 FUNDAMENTALS OF BIOLOGICAL ENGINEERING
This course introduces students to the fundamental concepts of Biological Engineering. Knowledge of thermodynamics and fluid mechanics is critical for students to solve biological engineering problems. Students will learn about energy, entropy and enthalpy in their various forms in a biological setting. Students will also learn basic fluid statics and dynamics. These topics will be applied in assignments, exams and in the laboratory to solve biomedical and biochemical engineering problems. Case studies are presented to allow student to put together their knowledge gained in these topics to solve problems pertaining to human organ systems like heart, lungs and kidneys. ***Prerequisites:*** *CHEM1100; (4 credits) fall*

BIOE2100 BIOSTATISTICS FOR BIOENGINEERS
This course is intended for Biological Engineering students and introduces statistical models for analyzing data in the life and health sciences. The course examines descriptive statistics, probability, sampling, probability distributions, estimation, hypothesis testing, analysis of variance and other statistics models. ***Prerequisites:*** *BIOL1100 and MATH1776 (4 credits) fall*

BIOE2500 BIOLOGICAL INSTRUMENTATION & MEASUREMENT
Methods of using instrumentation for measurements in biological engineering are investigated in this course. Topics include the scientific method, sensors and physical phenomenon, data acquisition, analysis and statistics, and instruments for biological engineering. The laboratory exercises focus on the sensor interface, data acquisition, and development of software algorithms to analyze the data. ***Prerequisites:*** *BIOL1100 and BIOE2000;* ***Corequisite:*** *CHEM1600 (4 credits) spring*

BIOE2550 MICROFLUIDS
Introduction to fundamental principles and methods of microfluidics including capillarity, low Reynolds number flows, diffusion, osmosis, electrical fields, flow through porous media, microfabrication and lateral flow assays with an emphasis on global health diagnostic technologies. Fluid dynamics concepts for bulk flows both in physiological systems and in terms of microfluidic tools for exploring transport phenomena of single cells and tissue scale systems will be covered. ***Prerequisites:*** *BIOE3025 (4 credits)*

BIOE3025 BIOMATERIALS & TISSUE ENGINEERING
This course provides students with an introduction to biomaterials and tissue engineering for therapeutic and diagnostic use. The course will cover tissue organization and pathology, stem cell biology, biomaterial composition and properties and the design of tissue engineered constructs for tissue and organ replacement. The lab portion of this course will introduce students to aseptic tissue culture, 3D bioprinting and common techniques used to generate and assess tissue engineered constructs. ***prerequisites:*** *BIOE2000 and CHEM2500 (4 credits) summer*

BIOE3100 METABOLIC ENGINEERING
An engineering approach to microbiology and bio-based products. As bioengineering continues to grow as a discipline, biomanufacturing using "microbial cell factories" continues to pique the interests of the entrepreneur. Commodity compounds, from amino acids to biopolymers, can be manufactured fermentatively. With a growing list of organismal genome sequences available for analysis and manipulation, organisms (mainly microorganisms) will be utilized and subsequently manipulated by the growing number of molecular biology and synthetic biology techniques available. Students will utilize the methods and concepts taught in this course for problem solving in biotechnology, biomanufacturing and the biopharmaceutical fields. This course discusses cellular and organismal metabolic networks and the mathematical and experimental manipulation of those networks. The techniques of synthetic biology and metabolic flux analysis, core concepts in metabolic engineering, are focused on here. ***Prerequisites:*** *BIOL1000, BIOE2000 and ENGR1800 (4 credits)*

BIOE3500 GENETICS AND TRANSGENICS
This course provides students with an introduction to the fundamental principles of molecular biotechnology and methodologies used for gene manipulation. The didactic portion of this course will cover topics including recombinant DNA technology and molecular cloning, bioinformatics, genome and protein engineering and transgenic plants and animals. The laboratory portion will introduce students to methods commonly used for gene manipulation studies including: cell culture, DNA isolation, restriction enzymes and mapping, cloning strategies, immunological screening of proteins and other essential techniques. ***Prerequisites:*** *BIOL2200 (4 credits) fall*

BIOE3550 UNIT OPERATIONS & PROCESS CONTROL
This course provides a detailed overview of the important aspects of biomanufacturing and bioprocessing. Mass and energy balances related to biomanufacturing processes will be discussed, as well as the roles of thermodynamic properties in process control. The laboratory portion of this course will provide a hands-on introduction to several key aspects of real-time process control, such as temperature, flow and pH control. The importance of each of these techniques, more importantly the importance of carrying out each technique correctly and efficiently will be emphasized with "real-world" industrial examples offered as case studies. ***Prerequisites:*** *BIOE2500 & CHEM1600 (4 credits) summer*

BIOE3650 COMPUTATIONAL BIOLOGY
Introductions to concepts, techniques and programming skills for computational biology, including simulation and game theory. The system models include central control, multiple actor based, deterministic, stochastic, differential equations, and spatial representation and graphics (at least two dimensional). ***Prerequisites:*** *MATH2500 and BIOE2500 (4 credits)*

BIOE3800 SPECIAL TOPICS IN BIOLOGICAL ENGINEERING
These courses present topics that are not covered by existing courses and are likely to change from semester to semester. Refer to the semester schedule for the courses offered that semester. Contact the faculty assigned for more information about the course topic. (1 - 4 credits)

BIOE4000 CELL PHYSIOLOGY AND SIGNALING
This course focuses on cellular function and communication via chemical and electrical stimuli. Topics include membrane-bound and intracellular receptor proteins, cellular responses to receptor activation, specific signal transduction pathways, membrane potentials and transport physiology. Additionally, this course will introduce students to mathematical and computational modeling of receptor/ligand binding events and the associated physiologic responses. ***Prerequisites:*** *BIOE2000, BIOL2200 & CHEM3550 (4 credits) spring*

BIOE4100 STEM CELL BIOTECHNOLOGY AND REGENERATIVE MEDICINE
Over the last decade, regenerative medicine has made significant progress in the identification and use of novel therapeutic agents to treat degenerative disorders. This course will explore the state of the art in regenerative medicine by introducing students to stem cells, tissue engineering, and the clinical application of these therapeutic platforms. The regulatory concerns surrounding these technologies will also be discussed. The lab portion of this course will provide students with hands-on experience in the culture of stem cells and the characterization of stem cell phenotype and bioactivity. Ultimately, students will be responsible for designing and testing a biological assay to measure stem cell potency as a means to predict therapeutic function. ***Prerequisite:*** *BIOE3025 (3 credits) summer*

BIOE4400 SYNTHETIC BIOLOGY
This course provides a detailed overview of the important aspects of the emerging field of synthetic biology. The field of synthetic biology spans the boundaries of biology, chemistry and engineering with the goal of engineering biomolecular systems and cellular capabilities for a variety of applications. This course will cover three foundational parts of synthetic biology, including the biological background of gene regulation, experimental methods for genetic circuit construction and a mathematical basis of network modeling. Successful examples in biofuels, biomedicine and other areas will be discussed in detail to demonstrate the potential impact of the field in these application areas. ***Prerequisite:*** *BIOE3500 (4 credits)*

BIOE4500 BIOTRANSPORT PHENOMENA
This course explores transport phenomena (momentum, heat, and mass transfer) as related to biological systems. This includes microscale and molecular processes for membrane transport and perfusion, such as diffusion, osmosis, passive and active transport, and electrophysiology. Dynamics of mechanical flow for fluid and heat are introduced for cells, tissues and organ systems. Topics include fermentation processes in general; growth of bacteria, yeasts, animal and human cells; and mass transfer processes of the human body. ***Prerequisites:*** *BIOE2000, BIOE2500 and MATH2500 (4 credits) summer*