Bioengineering Related Undergraduate Courses 2017-2018

In addition to the courses below, there are many other more general courses not specifically biology-related but that are useful for BIOE training. Please contact Angelina Toporov, Grad Advisor and Emphasis Coordinator for more details via email at atoporov@engineering.ucsb.edu. Please see individual departments for more information about these courses.

CH E 102, Biomaterials and Biosurfaces Fundamentals of natural and artificial biomaterials and biosurfaces with emphasis on molecular level structure and function and the interactions of biomaterials and surfaces with the body. Design issues of grafts and biopolymers. Basic biological and biochemical systems reviewed for nonbiologists. *Instructors: Israelachvili, 3 units.*

CH E 107, Introduction to Biological Processing Familiarizes engineering students with biological processing and production at multiple scales. Chemical engineering principles will be infused with key biological concepts, including an introduction to biochemistry, cell biology, and molecular biology. *Instructors: O'Malley, 3 units.*

CH E 121, Colloids and Biosurfaces Basic forces and interactions between atoms, molecules, small particles and extended surfaces. Special features and interactions associated with (soft) biological molecules, biomaterials and surfaces: lipids, proteins, fibrous molecules (DNA), biological membranes, hydrophobic and hydrophilic interactions, biospecific and non-equilibrium interactions. *Instructors: Israelachvili, 3 units.*

CH E 125, Principles in Bioengineering Applications of engineering to biological and medical systems. Introductionto drug delivery, tissue engineering, and modern biomedical devices. Design and applications of these systems are discussed. *Instructors: Staff, 3 units.*

CH E 126, Non-Newtonian Fluids Overview of soft materials (suspensions, gels, polymers, surfactants, emulsions, powders and granules)

that arise in diverse industries, includingconsumer products, foods, advanced materials, biotechnology, and mineral and energy production. Influence of non-Newtonian rheology (shear- thickening and thinning, viscoelasticity, extension- thickening, yield stresses, normal stress differences, and metastability) upon handling, processing, production, and performance of chemical products. Strategies to design chemical products that meet performance targets, and to scale-up production. Real- world case studies and classroom demonstrations. *Instructors: Squires, Helgeson, 3 units.*

CH E 154, Engineering Approaches to Systems Biology Applications of engineering tools and methods to solve problems in systems biology. Emphasis is placed on integrative approaches that address multiscale and multi-rate phenomena in biological regulation. Modeling, optimization, and sensitivity analysis tools are introduced.*Instructors: Staff, 3 units.*

CH E 170, Molecular and Cellular Biology for Engineers Introduction to molecular and cellular biology from an engineering perspective. Topics include protein structure and function, transcription, post-translational processing, cellular organization, molecular transport and trafficking, and cellular models. *Instructors: O'Malley, Dey, 3 units.*

CH E 171, Introduction to Biochemical Engineering Introduction to biochemical engineering covering cell growth kinetics, bioreactor design, enzyme processes biotechnologies for modification of cellular information, and molecular and cellular engineering. *Instructors: Dey, O'Malley, 3 units.*

CH E 173, Omics-enabled Biotechnology Integrates genomic, transcriptomic, metabolomic, and proteomic approaches to quantify and understand intricate biological systems. Complementary bioinformatics approaches to curate the large datasets associated with these experiments will also be discussed. Recent examples from the literature will reinforce core concepts, ranging from applications to human health to the environment. By the end of the course, students should be able to design an integrated experiment that capitalizes on these omics-based approaches to enhance the scope of their research. *Instructors: O'Malley, 3 units.*

CH E 179, Biotechnology Laboratory The course will provide an introduction to theoretical principles and practical methods used in modern technology, genetic engineering, and synthetic biology. Topics will include protein and cellular engineering using recombinant DNA technologies, mutagenesis, library construction, and biosynthetic display technologies. *Instructors: Staff, 4 units.*

CHEM 112A, Biophysical Chemistry Laws of thermodynamics, chemical equilibria and ligand binding, phase equilibria, electrochemistry, nonelectrolyte solutions, applications to biochemical problems.*Instructors: Staff, 4 units.*

CHEM 112B, Biophysical Chemistry Forces influencing macromolecular conformation, microscopy and diffraction methods, quantum mechanics, statistical mechanics.*Instructors: Staff, 4 units.*

CHEM 112C, Biophysical Chemistry Laws of thermodynamics, chemical equilibria and ligand binding, phase equilibria, electrochemistry, nonelectrolyte solutions, applications to biochemical problems. *Instructors: Staff, 4 units.*

CHEM 112L, Biophysical and Bioanalytical Laboratory Application of modern biophysical and bioanalytical techniques to study the structure, function, and properties of biomolecules. Fluorescence spectroscopy, mass spectroscopy, FTIR, 2D-NMR, diffraction techniques, circular dichroism.*Instructors: Staff, 3 units.*

CHEM 125L, Laboratory Techniques in Biochemistry Application of molecular biology techniques to perform mutagenesis and cloning; restriction endonucleases, PCR, plasmid purification and DNA analysis. Protein purification and analysis methods: expression of proteins in bacterial systems. *Instructors: Staff, 4 units.*

CHEM 126, Computation Chemistry and Molecular Modeling Introduction to computational chemistry and molecular modeling. Applicationof molecular mechanics, quantum mechanics and computer graphical interfacesto problems in chemistry, biochemistry, drug design and pharmacology. *Instructors: Staff, 4 units.*

CHEM 134, Chemical Synthesis of Biological Molecules The synthesis, manipulation, and modification of biological molecules including peptides, carbohydrates, nucleic acids, and other metabolites are essential to advances in biomedicine. This course surveys chemical methods for the production of these molecules and their application to biological problems. *Instructors: Staff, 3 units.*

CHEM 141, Epigenetics: Biology, Mechanisms and Therapies Covers epigenetic processes and molecular mechanisms in bacteria, fungi, plants, mammals, imprinting, gene regulation, repeat-induced point mutation (RIP), X- chromosome inactivation, epigenetic mechanisms including DNA methylation, histone modification, chromatin remodeling, RNA silencing, and epigentically based therapeutics and pharmaco-epigenetics. *Instructors: Staff, 3 units.*

CHEM 143, The RNA World Introduction to RNA structure and thermodynamics. Biological roles of RNA in contemporary organisms. Implications for the origins of life. *Instructors: Staff, 3 units.*

CHEM 145, Computational Bioechemistry Introduction to molecular modeling and molecular dynamics. Discussion of practical considerations of energy minimization, solvent modeling, structure-based drug design. Practical computer graphics experience. *Instructors: Staff, 3 units.*

CHEM 146, Membrane Biochemistry Introduction to the structures and roles of lipids and their phase behavior, liposomes, membrane proteins and kinetics, protein sorting, and signal transduction. *Instructors: Staff, 3 units.*

CHEM 147, Astrobiology and the Origins of Life Discusses the origins and evolution of the solar system and the earth, the origins and evolution of life on earth, and the possibilities for life elsewhere in the cosmos, all from the perspective of contemporary, terrain biochemistry. *Instructors: Staff, 3 units.*

CHEM 151, Post-translational Protein Processing Structure/function relationships in interesting macromolecules isolated from marine organisms. Focus is on well-characterized pathways from horseshoe crabs,

abolones, mussels, and fish as well as others. *Instructors: Staff, 4 units.*

CHEM 153, Advanced Analytical Techniques Principles of analytical methodology, as in spectroscopy, electroanalysis, and chromatography. Applications to environmental problems, forensic and clinical analysis, and industry. Analysis of solids and surfaces. *Instructors: Staff, 4 units.*

CHEM 154A, Magnetic Resonance in Bilogical Systems A discussion of the theory and practice of magnetic resonance methods used in studies of proteins, nucleic acids, and polysaccharides. *Instructors: Staff, 3 units.*

CHEM 154B, Magnetic Resonance in Bilogical Systems A discussion of the theory and practice of magnetic resonance methods used in studies of proteins, nucleic acids, and polysaccharides. *Instructors: Staff, 3 units.*

CHEM 161, Enzyme Mechanisms Chemistry, structure and function of enzymes; theory, experimental design, and data analysis. Enzyme models and non-classical enzymes. *Instructors: Staff, 3 units.*

CHEM 162A, Drug Design Sources for new drugs. Biochemistry of diseases. Target validation techniques. Mechanism of action of enzymes and receptors. Enzyme inhibition and receptor binding studies. Structure based drug design: conformational analysis, docking and binding affinity calculations. Course also teaches proposal writing skills. *Instructors: Staff, 3 units.*

CHEM 162B, Drug Design Medical Chemistry for lead optimization, combinatorial synthesis, quantitative structure-activity relationships, pharmocokinetics, drug metabolism and toxicity, pharmacogenomics. Drugs that interact with DNA and protein drugs. Clinical trials, intellectual property in drug design. Students develop their own drug design project. *Instructors: Staff, 3 units.*

CMPSC 111, Introduction to Computational Science Introduction to computational science, emphasizing basic numerical algorithms and the informed use of mathematical software. Matrix computation, systems

of linear and nonlinear equations, interpolation and zero finding, differential equations, numerical integration. Students learn and use the Matlab language. *Instructors: Petzold, 4 units.*

CMPSC 130A, Data Structures and Algorithms I The study of data structures and their applications. Correctness proofs and techniques for the design of correct programs. Internal and external searching. Hashing and height balanced trees. Analysis of sorting algorithms. Memory management. Graph traversal techniques and their applications. *Instructors: Gonzalez, 4 units.*

CMPSC 138, Automata and Formal Languages Formal languages; finite automata and regular expressions; properties of regular languages; pushdown automata and context-free grammars; properties of context-free languages; introduction to Turing machines and computability. *Instructors: Egecioglu, 4 units.*

CMPSC 165A, Artifical Intelligence Introduction to the field of artificial intelligence, which seeks to understand and build intelligent computational systems. Topics include intelligent agents, problem solving and heuristic search, knowledge representation and reasoning, uncertainty, probabilistic reasoning, and applications of AI. *Instructors: Turk, 4 units.*

CMPSC 174A, Fundamentals of Database Systems Database system architectures, relational data model, relational algebra, relational calculus, SQL, QBE, query processing, integrity constraints (key constraints, referential integrity), database design, ER and object- oriented data model, functional dependence, lossless join and dependency preserving decompositions, Boyce-Codd and Third Normal Forms. *Instructors: Su, 4 units.*

CMPSC 181, Introduction to Computer Vision Overview of computer vision problems and techniques for analyzing the content of images and video. Topics include image formation, edge detection, image segmentation, pattern recognition, texture analysis, optical flow, stereo vision, shape representation and recovery techniques, issues in object recognition, and case studies of practical vision systems. *Instructors: Turk, Wang, 4 units.*

CMPSC 185, Human-Computer Interaction The study of human-computer interaction enables system architects to design useful, efficient, and enjoyable computer interfaces. This course teaches the theory, design guidelines, programming practices, and evaluation procedures behind effective human interaction with computers. *Instructors: Hollerer, 4 units.*

ECE 141A, Introduction To Nanoelectromechanical and Microelectromechanical Syst Introduction to nano- and microtechnology. Scaling laws and nanoscale physics are stressed. Individual subjects at the nanoscale including materials, mechanics, photonics, electronics, and fluidics will be described, with an emphasis on differences of behavior at the nanoscale and real-world examples. *Instructors: Pennathur, Turner, 3 units.*

ECE 162C, Optoelectronic Materials and Devices Optical transitions in solids. Direct and indirect gap semiconductors. Luminescence. Excitons and photons. Fundamentals of optoelectronic devices: semiconductor lasers, Led's photoconductors, solar cells, photo diodes, modulators. Photoemission. Integrated circuits.*Instructors: Coldren, 3 units.*

ECE 179D, Introduction to Robotics: Dynamics and Control Dynamic modeling and control methods for robotic systems. LaGrangian method for deriving equations of motion, introduction to the Jacobian, and modeling and control of forces and contact dynamics at a robotic end effector. Laboratories encourage a problem-solving approach to control.*Instructors: Byl, 4 units.*

ECE 181, Introduction to Computer Vision Overview of computer vision problems and techniques for analyzing the content of images and video. Topics include image formation, edge detection, image segmentation, pattern recognition, texture analysis, opticalflow, stereo vision, shape representation and recovery techniques, issues in object recognition, and case studies of practical vision systems.*Instructors: Meinhart, 4 units.*

EEMB 154, Integrative Physiology A rigorous introduction to how animals function, integrating information and concepts appropriate to the understanding of physiological processes fromthe level of molecules to whole organisms. . *Instructors: Rice, 5 units.*

EEMB 176, Advanced Biostatistics Accelerated overview of parametric and nonparametric statistical techniques that are used in the biological sciences. The course unifies nearly all traditional statistical tests by expressing them all as a single unified testing protocol. *Instructors: Rice, 5 units.*

EEMB 176L, Advanced Biostatistics Students use computerized sampling to evaluate the robustness and power of a wide diversity of parametric vs. nonparametric tests. Students also learn to use computerized software to carry out all the tests described in the lecture class. *Instructors: Rice, 2 units.*

MCDB 123, Experimental Strategies in Physical Biochemistry Presentation of selected contemporary concepts and methodologies for determining the structure, size, shape, charge, and interactive behavior of biological macromolecules. *Instructors: Waite, 4 units.*

MCDB 126, Basic Pharmacology Designed to provide the student with a comprehensive knowledge of the history and scope of pharmacology as a basic science. Emphasis on the principlesof drug action and the relationship of pharmacology to physiology, chemistry, and biochemistry. *Instructors: Waite, 4 units.*

MCDB 132, Bacterial Pathogenesis The mechanisms by which bacterial pathogens cause disease. Investigation of the bacterial gene products that are produced during infection to understand the metabolic, physiological, and genetic factors that contribute to the virulence of bacterial pathogens. *Instructors: Waite, 4 units.*

MCDB 133, Molecular and Cellular Immunobiology Introduction to the current concepts of immunology. Emphasis on immunoglobulin structure and function, cell-cell cooperation in the immune response, and the role of major histocompatibility complex and cytokines in regulating immune responsiveness. *Instructors: Sears, 5 units.*

MCDB 138, Medical Immunology Interplay between the immune system and human disease is mechanistically evaluated by examining protective immunity against parasites and cancer, and immune dysfunction

in transplantation, allergic, and autoimmune diseases, and AIDS. Computer exercises evaluate medical, case-based studies of human immune disorders. *Instructors: Sears, 4 units.*

MCDB 139, Medical Microbiology Study of the characteristics of bacteria and viruses, both pathogenic and adventitious, as they are associated with diseases of humans. *Instructors: Staff, 4 units.*

MCDB 146, Stem Cell Biology in Health and Disease Basic biology of embryonic and adult stem cells and nuclear transfer, with emphasis on latest findings from the current literature. *Instructors: Clegg, 4 units.*

ME 128, Design of Biomedical Devices Introductory course addresses the challenges of biomedical device design, prototyping and testing, material considerations, regulatory requirements, design control, human factors and ethics. *Instructors: Laguette, 3 units.*

ME 141A, Introduction to Nanoelectromechanical and Microelectromechanical systems (NEMS/MEMS) Introduction to nano- and microtechnology. Scaling laws and nanoscale physics are stressed. Individual subjects at the nanoscale including materials, mechanics, photonics, electronics, and fluidics will be described, with an emphasis on differences of behavior at the nanoscale and real-world examples. *Instructors: Pennathur, Turner, 3 units.*

ME 141B, MEMS: Processing and Device Characterization Lectures and laboratory on semiconductor-based processing for MEMS. Description of key equipment and characterization tools used for MEMS and design, fabrication, characterization and testing of MEMS. Emphasis on current MEMS devices including accelerometers, comb drives, micro-reactors and capacitor-actuators. *Instructors: Pennathur, Turner, 4 units.*

ME 146, Molecular and Cellular Biomechanics Course introduces fundamental concepts in molecular and cellular biomechanics. Will consider the role of physical, thermal and chemical forces, examine their influence on cell strength and elasticity, and explore the properties of enzymatically-active materials. *Instructors: Valentine, 3 units.*

MTRL 135, PHYS 135, Biophysics and Biomolecular Materials Structure and function of cellular molecules (lipids, nucleic acids, proteins, and carbohydrates). Genetic engineering techniques of molecular biology. Biomolecular materials and biomedical applications (e.g., bio-sensors, drug delivery systems, gene carrier systems). *Instructors: Safinya, Staff, 3 units.*

PHYS 135, Biophysics and Biomolecular Materials Structure and function of cellular molecules (lipids, nucleic acids, proteins, and carbohydrates). Genetic engineering techniques of molecular biology. Biomolecular materials and biomedical applications (e.g., bio-sensors, drug delivery systems, gene carrier systems). *Instructors: Staff, 3 units.*

PHYS 144L, Experimental Research in Biophysics Offers qualified undergraduates the opportunity to work in research laboratories in biophysics. *Instructors: Staff, 3 units.*