Bioengineering Graduate Courses and Technical Electives Master List Fall 2022

BIOE 220A, Molecular Bioengineering This course Introduces students to molecular components of biology with application of engineering principles for analysis. Topics include: molecular components of cells, DNA/RNA structure and function, protein structure/function/folding, gene and protein regulation, DNA replication, and experimental and computational research methods.

BIOE 220B, Cellular Bioengineering introduces students to structural components of cells with application of engineeringprinciples for analysis. Topics include: biomembrane structure and function, membrane proteins, membrane transport, intracellular compartments, intracellular trafficking, chemotaxis, cell cycle, apoptosis, and stem cells.

BIOE 225, Current Topics in Bioengineering Seminar series highlighting current topics and advances in bioengineering presented by UCSB faculty or visiting scientists providing context and motivation for bioengineering learning, introducing students to concepts outside of their primary research specialty, and promoting interdisciplinary thinking and research collaboration.

BIOE 230, Bioengineering Student Seminar Seminar series where students present their original thesis research and also review journal articles that critically analyze contemporary bioengineering research. Three quarters of ENGR 230 are required for the optional BioE graduate emphasis. Presentations will be evaluated and feedback provided.

ENGR 220A, Molecular Bioengineering This course Introduces students to molecular components of biology with application of engineering principles for analysis. Topics include: molecular components of cells, DNA/RNA structure and function, protein structure/function/folding, gene and protein regulation, DNA replication, and experimental and computational research methods.

Technical Electives The optional Bioengineering Emphasis course requirement includes 1 (or more) technical elective(s).

BIOE 210, Biomolecular and Biochemical Methods The goal of the course is to generate in our students an understanding of the logic behind the key tools used to characterize biomolecules and biosystems. Both the mechanisms by which these techniques work, and the rationale for why each would be employed (strengths, weaknesses, potential pitfalls).

BIOE 211, Quantitative Experiments This course is built around experimental design, data analysis, and quantitative modeling of biological processes and phenomena. Topics including experimental design considerations and a priori assumptions, probability, dimensional reduction, hypothesis testing, statistical analysis, and quantitative modeling through ordinary and partial differential equations. Case studies of recent and classic research papers in Bioengineering are used to illustrate key course topics through class discussions.

BMSE 201A, Protein Structure and Function Traces the physical interactions by which sequence-specific polypeptides attain a unique, functional native state. Fold design, fold prediction, and protein folding kinetics are also discussed.

BMSE 201B, Chemistry and Structure of Nucleic Acids Primary, secondary, and higher-order structures of DNA and RNA, thermodynamic stability and folding, protein-nucleic acid interactions, ribozymes, applications to gene regulation, RNA world evolution.

BMSE 202, CH E 202, Biomaterials and Biosurfaces Fundamentals of natural and artificial biomaterials and biosurfaces with emphasis on molecular level structure and function and their interactions with the body. Design issues of grafts and biopolymers. Basic biological, biophysical and biochemical systems reviewed for nonbiologists.

BMSE 204, MCDB 245, Post-translational Protein Processing Structure/function relationships in interesting macromolecules isolated from marine organisms. Focus is on well-characterized pathways from horseshoe crabs, abalones, mussels, and fish as well as others.

BMSE 205A, Biochemical Techniques Practical theory and application of basic biochemical techniques. Topics include SDS-PAGE, buffers, centrifugation, antibody methods, spectroscopy and fluorescence techniques.

BMSE 215, Biophyscal Thermodynmaics An overview of those parts of chemical thermodynamics relevant to the study of biomolecules and biological systems. Topics include fundametnal biopolymer structure formation.

BMSE 219, Microscopy for Quantitative Biology Fluorescence live imaging is a powerful tool to study dynamics of living matter. This course provides an overview on geometric and frontier optics, bright field microscopy fluorescence and absorption spectroscopy. Practicing these concepts students will construct a light-sheet microscope. Goals Fluorescence: Basic components of the microscope for manipulating light; Diffraction and interference for image formation; Complex microscope systems, e.g. EPI, Confocal, 2 photon, Light sheet.

BMSE 223, Chem 223, MCDB 223, Signal Transduction A cell's growth is controlled by positive and negative cues from its surroundings. A discussion of the cell's signaling mechanisms that recognize these cues and initiate and intracellular set of events that generates a response.

BMSE 229, Protein Biochemistry Discussion topics relevant to structure-function relationships in proteins including the chemical reactivity of amino acid side chains, posttranslational modifications, and the covalent and noncovalent interactions of multimeric structures. Case studies involve recent advances in structure-function relationships of mechanoproteins.

BMSE 235, Experimental Strategies in Molecular Genetics Discussion of experimental strategies used to purify, analyze, and manipulate nucleic acids, isolate molecular clones from complex genomes, physically map genomes, analyze gene expression, and perform reverse genetics.

BMSE 244, Informational Macro- and Supra-Molecules Selected topics at the interface of chemistry and biology; informational molecular coding, molecular machines, self-assembling and self-replicating molecular systems, evolution and selection of molecules with binding and catalytic properties, biopolymer-based materials, special emphasis on cutting-edge technologies.

BMSE 247, EEMB 247, Quantitative Methods in Biology A review of quantitative methods required to develop models of biological and ecological systems. Topics illustrated through computer exercises.

BMSE 252, Principles of Bioenginering An overview of various aspects of bioengineering including modeling of physiological functions, biomedical devices, drug delivery, and tissue engineering.

BMSE 265, BMSE Seminar Discussion Group A weekly seminar discussion group to review, in advance, relevant literature of participating BMSE seminar guests.

BMSE 272, MATRL 272, Mechanical Force and Biomolecules Explores single-molecule biophysics and the role of mechanical force in biomolecular behavior. Emphasis is placed on modern experimental techniques and the effects of mechanical stress on DNA conformation, protein unfolding, and force-generation by motor proteins. Recent literature is used throughout.

BMSE 290A, Group Studies: Biomolecular Materials Synthesis Presentation and discussion of current research, to be selected from the following list: A. Biomolecular Materials Synthesis.

BMSE 290B, Group Studies: Biomineralization Presentation and discussion of current research, to be selected from the following list: B. Biomineralization.

BMSE 290BP, Group Studies: Bacterial Pathogenesis Presentation and discussion of current research, to be selected from the following list: BP. Bacterial Pathogenesis.

BMSE 290C, Group Studies: Bacterial Pathogenesis Presentation and discussion of current research, to be selected from the following list: C. Studies in regulation of cell proliferation; CC. Centromeres and Chromosomes - Models and Analysis; CS. Advanced topics in Chromosome Segregation; PM. Molecular Plant-Microbe interactions.

BMSE 290CE, Group Studies: C. elegans Development Presentation and discussion of current research, to be selected from the following list: CE. C. elegans Development.

BMSE 290DN, Group Studies: Development Neurobiology Presentation and discussion of current research, to be selected from the following list: DN. Developmental Neurobiology.

BMSE 290HW, Group Studies: Marine Structural Proteins Presentation and discussion of current research, to be selected from the following list: HW. Marine Structural Proteins.

BMSE 294B, MCDB 294B, Bioengineering: Career and Development Opp. Based on presentations by experts from the bioengineering industry. Presenters describe their companies' technologies and developments, including biosensors, therapeutics, tissue engineering, quantum dots and advanced instrumentation. Training and educational requirements for different career tracks are discussed.

BMSE 595, Biochemistry/Molecular Biology Literature Seminar A critical review of research in selected areas of biochemistry-molecular biology.

BMSE 595BG, Biochemistry/Molecular Biology Literature Seminar A critical review of research in selected areas of biochemistry-molecular biology.

CH E 202, Biomaterials and Biosurfaces Fundamentals of natural and artificial biomaterials and biosurfaces with emphasis on molecular level structure and function and their interactions with the body. Design issues of grafts and biopolymers. Basic biological, biophysical and biochemical systems reviewed for nonbiologists.

CH E 210A, Fundamentals & Applications of Classical Thermo. & Stat. Mech. Fundamental concepts in classical thermodynamics and statistical mechanics for engineering students. Establishes the framework within which problems can be solved using methodologies that start with molecular level understanding.

CH E 220A, Advanced Transport Processes Basic principles of fluid mechanics and convective transport processes. Governing equations and boundary conditions. Non-dimensionalization and scaling. Self-similar solutions and similarity transformations. Unidirectional flows. The thin gap approximation, lubrication theory and thin film dynamics. Low Reynolds number flows.

CH E 241, Advanced Science and Engineering of Energy Conversion The course provides a framework for understanding the energy supply issues facing society with a focus on the science, engineering, and economic principles of the major alternatives. Emphasis will be on the physical and chemical fundamentals of energy conversion technologies.

CH E 272, Omics-enabled Biotechnology Integrates genomic, transcriptomic, metabolomic, and proteomic approachesto quantify and understand intricate biological systems. Complementary bioinformatics approaches to curate the large datasets associated with these experiments are also discussed. Recent examples from the literature 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.

CH E 274, Model-guided Engineering of Biological Systems This course will introduce students to foundational principles of biological engineering, integrating mechanistic modeling and quantitative analysis with basic molecular and cell biology. Students will be introduced to modeling of biomolecular interactions including protein-ligand binding, gene expression, and regulation of gene networks and metabolic pathways. Fundamental concepts will include rate processes, binding equilibria kinetics, gene expression modeling, network dynamics, and modeling of coupled mass transport reaction. At the end of this course, students are expected to have a deep understanding of how these modeling tools provide a uniquely powerful avenue for biological and chemical engineers to study molecular and cellular processes as well as (semi)-predictively engineer these processes to drive cutting-edge advances in the healthcare. Students enrolled in the course will be required to complete a term project involving application of Poisson statistics the Gillespie algorithm to model a biological process (e.g., gene expression) in a stochastic framework. In addition, Ph.D. students will be expected to implement 4-6 classic papers in biological modeling, reproducing key results, and discussing (by in silico experimentation) how the model might be extended in new directions.

CH E 294B, Bioengineering Based on presentations by experts from the bioengineering industry. Presenters describe their companies' technologies and developments, including biosensors, therapeutics, tissue engineering, quantum dots and advanced instrumentation. Training and educational requirements for different career tracks are discussed.

CHEM 223, BMSE 223, MCDB 223, Current Events Organic Chemistry Faculty and students present and critically discuss current chemical literature.

CHEM 226, Computational Chemistry Introduction to computational chemistry and molecular modeling. Applications of molecular mechanics, quantum mechanics, and computer graphical interfaces to problems in chemistry, biochemistry, drug design, and pharmacology.

CHEM 239, Selected Topics in Organic Chemistry Selected topics from organic chemistry the contents of this course will vary.

CHEM 242A, Chemical Aspects of Biological Systems Macromolecular biosynthesis and specialized cellular processes. A survey of nucleic acid and protein biosynthesis, characterization of lipids and membranes; function of membranes in transport, energy transduction, and cellular control; mechanisms of muscle contraction and cell motility; neurochemistry.

CHEM 242C, Chemical Aspects of Biological Systems Macromolecular biosynthesis and specialized cellular processes. A survey of nucleic acid and protein biosynthesis, characterization of lipids and membranes; function of membranes in transport, energy transduction, and cellular control; mechanisms of muscle contraction and cell motility; neurochemistry.

CHEM 243,The RNA World Introduction to RNA structure and thermodynamics. Biological roles of RNA in contemporary organisms. Implications for the origins of life.

CHEM 245, Computational Biochemistry Introduction to molecular modeling and molecular dynamics. Discussion of practical considerations of energy minimization, solvent modeling, structure-based drug design. Practical computer graphics experience.

CHEM 246, Membrane Biochemistry Introduction to the strutures and roles of lipids and their behavior, liposomes, membrane proteins and kinetics, protein, sorting, and signal transduction.

CHEM 251, Protein Processing Structure/function relationships in interesting macromolecules isolated from marine organisms. Focus is on well-characterized pathways from horseshoe crabs, abalones, mussels, and fish as well as others.

CHEM 259, Selected Topics in Biological Chemistry Selected topics from bio-organic, biophysical, or biological chemistry. The content of this course will vary.

CHEM 262A, 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 base drug design: conformational analysis, docking and binding affinity calculations. Course also teaches proposal writing skills.

CHEM 274, Solid State Inorganic/Materials An introductory course describing the synthesis, physical characterization, structure, electronic properties and uses of solid state materials.

CHEM 290, Seminar in Chemistry and Biochemistry Presentation of seminar required of all departmental graduate students.

CMPSC 281B, Advanced Topics in Computer Vision Advanced topics in computer vision: image sequence analysis, spatio-temporal filtering, camera calibration and hand-eye coordination, robot navigation, shape representation, physically-based modeling, regularization theory, multi-sensory fusion, biological models, expert vision systems, and other topics selected from recent research papers.

CMPSC 291A, Bionic Vision What would the world look like with a bionic eye? This graduate course will introduce students to the multidisciplinary field of bionic vision, with an emphasis on both the computer science and neuroscience of the field. The course will give an overview of current bionic eye technology designed to restore vision to people living with incurable blindness. Students will be exposed to the neuroscience of the human visual system, key engineering concepts for designing a brain-computer interface, and computational principles underlying the encoding of a visual scene into an artificial stimulus that the brain can interpret. We will cover recent advances in theory and applications, and discuss outstanding challenges with existing devices. The course will conclude with a team project giving students the opportunity to gain hands-on experience of working on open problems using methods and tools best suited to their scientific background.

DYNS 592, DYNS Seminar Research seminar for special interest groups in dynamical neuroscience.

ECE 235, Stochastic Processes in Engineering A first-year graduate course in Stochas TIC processes, including: review of basic probability; gaussian, poisson, and Weiner processes; wide-sense stationary processes; covariance function and power spectral density; linear systems driven by random inputs; basic Wiener and Kalman filter theory.

ECE 277, Pattern Recognition Principles and design of pattern recognition systems. Statistical classifiers: discriminant functions; bayes, minimum risk, k-nearest neighbors, perceptrons. Clustering and estimation; criteria; k-means, fuzzy, hierarchal, graph- theoretic, simulated and determininstic annealing; maximum likelihood and bayesian methods: nonparametric methods. Overview of applications.

ECE 278A, Digital Image Processing Two-dimensional signals and systems. Two-dimensional Fourier and z- transforms. Discrete Fourier transform, two-dimensional digital filters. Image processing basics, image enhancement and restoration. Special image processing software available for laboratory experimentation.

ECE 281B, Advanced Topics in Computer Vision Advanced topics in computer vision: image sequence analysis, spatio- temporal filtering, camera calibration and hand-eye coordination, robot navigation, shape representation, physically-based modeling, multi- sensory fusion, biological models, expert vision systems, and other topics selected from recent research papers.

ECE 594, Measuring and Manipulating Neuronal Activity Neuroengineering technology, including optical and electrical methods, for measuring and manipulating neural activity with the resolution to see individual neurons and synapses. Applications to neuroscience research, ML/AI, brain-machine interfaces, and other devices for humans.

ECE 594EG, Computational Systems Biology This multidisciplinary graduate course focuses on data-centric quantitative modeling of biological systems. It introduces a selection of basic and advance computational methods to gain predictive understanding from biolgoical data. The course covers modeling, analysis and synthesis of processes ranging from molecular bioengineering to physiology. The modeling part will deal with rigourous aproaches to select the most appropriate model for a biological process, and to quantify undertainty in design and prediction The analysis part will deal wit probabilistic and causal methods for the reverse engineering of biological circuitry on the basis of noisy data. The course will consist of lectures and three assignments. The course is aimed at a non-specialized audience with a quantitative background.

ECE 594N, Biological Shape Analysis Geometric transformations, mathematical models of shapes, articulated shapes, shapes of landmarks, curves, surfaces, shape deformations, shape statistics and machine learning, applications to the analysis of shapes of proteins, cells, organs for computational biology and medicine.

ECE 594Q, Nanotechnology Instruction in these variable unit courses may be carried out by lecture, by laboratory, or by a combination of these. These courses provide a study of topics of current interest in various areas of electrical and computer engineering.

ECE 594T, Haptics - Touch Perception, Interaction, and Engineering Haptics lies at the intersection of robotics, human-computer interaction, and computational and human perception. The term "haptics" is often used to refer to science and engineering related to the sense of touch. This course introduces human haptics, including sensory specializations and touch perception. It reviews the engineering of electronic technologies for haptic (touch) feedback, emerging technologies, and the design of haptic systems for human-computer interaction, sensory substitution, virtual reality, augmented reality, and other emerging areas. The class involves a mix of readings, hands-on activities, lecture/discussion, and projects. Haptics is a rapidly evolving field, and this course offers us the opportunity to engage with current research through articles, lectures, videos, and our own experiments.

ECE 594Z, Special Topics in Electrical and Computer Engineering: Imaging Syste Instruction in these courses may be carried out by lecture, by laboratory, or by a combination of these. These courses provide a study of topics of current interest in various areas of electrical and computer engineering.

ECE 595E, Group Studies in Electrical and Computer Engineering Instruction in research group meetings carried out by lecture, by laboratory, or by a combination of the two. Courses provide a critical review of research in various areas of electrical and computer engineering. E. signal processing.

EEMB 247, BMSE 247, Quantitative Methods in Biology See BMSE 247 for course description.

EEMB 276, Advanced Biostatistics Accelerated overview of parametric and nonparametric 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.

EEMB 276L, Advanced Biostatistics Lab Students use computerized sampling to measure 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.

EEMB 511, Writing Science-EEMB Colloquium A hands-on workshop to polish writing skills. Modules focus on "story telling" to make ideas compelling, streamlining to make writing compact and effective, and developing flow of ideas and paragraphs. Students work on a chapter, paper, or proposal.

EEMB 595AL, Energetics of Animal Locomotion A critical review of research in selected fields of biology.

EEMB 595EV, Evolutionary Biology A critical review of research in selected fields of biology.

EEMB 595T, Parasitology A critical review of research in selected fields of biology.

EEMB 595TE, Theoretical Ecology and Evolution Focus on Bayesian Methods, featuring special guest instructor Grace DiRenzo.

MATRL 200C, Structure Evolution Study of phenomena underlying the evolution of structure across the relevant length and time scales in Materials. Structural defects. Drving forces, mechanisms and kinetics of structural change. Diffusional transport. Fundamentals of phase transformations. Crystallization. Evolution of microstructural features and patterns.

MATRL 222A, Structure Evolution Study of phenomena underlying the evolution of structure across the relevant length and time scales in Materials. Structural defects. Drving forces, mechanisms and kinetics of structural change. Diffusional transport. Fundamentals of phase transformations. Crystallization. Evolution of microstructural features and patterns.

MATRL 222B, Colloids and Interfaces II Interparticle interactions, coagulation, DLVO theory, steric interactions, polymer-coated surfaces, polymers in solution, thin film viscosity. Surfactant and lipid self-assembly: micelles, microemulsions. Surfaces: wetting, contact angles, surface tension. Surfactants on surfaces: Langmuir-Blodgett films, adsorption, adhesion. Non-equilibrium and dynamic interactions.

MATRL 226, Symmetry and Tensor Properties of Materials Description of the principles of crystal symmetry, functional materials, and their properties, including dielectrics, piezoelectrics, and magnetic and transport phenomena. Fundamental concepts, tensorial and mathematical description of functional behavior.

MATRL 228, Computational Materials Basic computational techniques and their application to simulating the behavior of materials. Techniques include: finite difference methods, MonteCarlo, molecular dynamics, cellular automata, and simulated annealing.

MATRL 270, Biomaterials and Biosurfaces The first part of this course will explore the fundamentals of natural and artificial biomaterials and biological surfaces (biosurfaces), with an emphasis on surface and contact mechanics. The second part will focus on biosurfaces and delve into molecular-level structure and function. The third part will explore the dynamic interactions between biomaterials and surfaces with the body and designing for biocompatibility.

MATRL 271B, Structure and Characterization of Complex Fluids Complex fluids are multi-component solutions consisting of a solvent and one or more dissolved species. These solutes can vary in size, shape, rigidity, electric charge, polarizability, and homogeneity; further, while typically larger than the solvent, they are still small enough to be strongly affected by thermal fluctuations. This variety creates multiple types of interactions, which leads to physically, technologically, and/or biologically interesting behavior of the solution. In this course, we will explore the microscopic origins of the physical properties of some complex fluids. We will focus on the equilibrium or near-equilibrium structure of the systems. Specifically, we will discuss the following: 1) Polymers, including random-walks, persistence, gyration radius, self-avoidance, and Flory theory. 2) Colloids, including their interactions as modulated by van der Waals forces, polymer brushes, depletion, and solution electrostatics. 3) Biomolecules, including physical principles of nucleic acid and protein structure, such as the role of water and hydrophobicity; self-assembly; cooperativity; and the folding problem.

MATRL 271C, Properties of Macromolecules Fundamentals of the properties of macromolecular solutions, melts, and solids. Viscosity, diffusion and light scattering from dilute solutions. Elements of macromolecular solid state structure. Thermal properties and processes. Mechanical and transport properties. Introduction to electrical and optical properties of macromolecules.

MATRL 272, Mechanical Force and Biomolecules In this course, we will explore the field of single-molecule bio-physics, and in particular the role of mechanical force in biomolecular behavior. Mechanical forces are critical to a wide range of biological processes, and modern techniques allow the experimentalist to study those processes by directly measuring forces generated by biomolecules and/or perturbing the system with an applied force. The course will start off with an introduction to the experimental techniques used to apply force to single biomolecules (e.g., optical/magnetic traps, AFM, etc.), with a focus on quantitative calibration approaches. The remainder of the course will cover various aspects of the molecular biophysics of mechanical force, including the linear elasticity of biomolecules; DNA torsional mechanics and topology (twist, writhe); force-induced unfolding and unzipping transitions; and force-generation by motor proteins. Stochastic physical models of molecular behavior (e.g., Langevin, Kramers) will be a theme throughout. The course will draw on recent literature, culminating with student presentations of recently-published papers from the field.

MATRL 276A, Biomolecular Materials I: Structure and Function Survey of classes of biomolecules (lipids, carbohydrates, proteins, nucleic acids). Structure and function of molecular machines (enzymes for biosynthesis, motors, pumps).

MATRL 276B, Biomolecular Materials II: Applications Interactions and self assembly in biomolecular materials. Chemical and drug delivery systems. Tissue engineering. Protein synthesis using recombinant nucleic acid methods: advance materials development. Nonviral gene therapy.

MATRL 278, Interaction in Biomolecular Complexes Focuses on the interactions, structures, and functional properties of complexes comprised of supramolecular assemblies of biological molecules. Systems addressed include lipid molecules. Systems addressed include lipid membranes, lipid-DNA complexes, and assemblies of proteins of the cell cytoskeleton.

MATRL 284, Synthetic Chemistry of Macromolecules Molecular architecture and classification of macromolecules. Different methods for the preparation of polymers: free radical polymerization, ionicpolymerization, condensation polymerization and coordination polymerization. Bulk, solution, and emulsion polymerization. Principles of copolymerization, blockcopolymerization, grafting, network formation, chemical reactions on polymers.

MCDB 208C, Computational and Systems Biology Models of Biochemical and Cellular Systems. Introductory systems-biology approach to model the design and the function of biological systems. Students will develop an intuition about physical concepts that are fundamental to discuss how biological organisms acquire and process information from the environment. Those concepts and tools will cover probabilities and basic dynamical systems theory. Students will build models of processes of increasing complexity, ranging from viral dynamics, bacterial resistance to drugs, the maintenance of homeostatic equilibrium (trp operon), biological oscillators (mitotic clock) and genetic switches underlying cellular decisions (bacteriophage lambda and lac operon).

MCDB 212, Molecular Virology Consideration of selected animal viruses in terms of structure, mechanism of genetic expression, and effects of viral gene expression on cell function, as well as aspects of the virus-host interaction including viral persistence, interference, and interferon.

MCDB 221, Preparation and Evaluation of Research Proposals and Scientific Pres
Instruction in preparation writing, and evaluation of research grant

proposals. Overview of federal funding mechanisms, ethics in research, the peer review and proposal evaluation processes, and general strategies in communication of scientific ideas including poster and oral presentations. This course is writing based and includes instruction and guidance on applying to NSF and NIH Pre-Doctoral Fellowships.

MCDB 223, Ch E 223, BMSE 223, Signal Transduction See BMSE 223 for course description.

MCDB 225, Development The molecular mechanisms of pattern formation and cellular differentiation that underlie developmental processes in a variety of important model systems.

MCDB 226, Basic Pharmacology Will cover a wide range of drugs with a focus on drugs used to treat disorders of the nervous and cardiovascular systems, antibacterial agents, antivirals, and anticancer drugs. Will will also look at the pharmacology of inflammation and coagulation. The goal is to understand the underlying physiology behind disorders of these systems and the mechanisms of the drugs used to treat them. Additional out-of-class hours are necessary.

MCDB 226A, Basic Pharmacology History and scope of pharmacology as a basic science; principles of drug action and relationship of pharmacology to physiology, chemistry, biochemistry emphasized.

MCDB 226AL, Basic Pharmacology Lab Analysis of drug sites and mechanisms of action using isolated tissues, organs, and intact animal preparations.

MCDB 226C, Basic Pharmacology: Principles and Chemotherapy Fundamental principles of pharmacology, drug-receptor theory, biochemical mechanisms of action of drugs.

MCDB 229, Protein Biochemistry Discussion topics relevant to structure-function relationships in proteins including the chemical reactivity of amino acid side chains, posttranslational modifications, and the covalent and noncovalent interactions of multimeric structures. Case studies involve recent advances in structure-function relationships of mechanoproteins.

MCDB 231, General Microbiology Introduction to biological properties of microrganisms historical foundations of the field of microbiology; a study of major groups of microorganisms, their structure, physiology, cultivation, and pathogenicity.

MCDB 245, BMSE 204, Post- Translational Protein Processing See BMSE 204 for Course Description.

MCDB 246, 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.

MCDB 251, Neurobiology I: Cellular Organization and Biophysics of the Nervous Nervous system properties ranging from single cells to whole organisms, using examples from vertebrates/invertebrates studied in terms of morphology, physiology, behavior.

MCDB 253, Neurobiology III: Developmental Neurobiology This course begins with fertilization and moves through sequential stages in the development of the nervous system, including cell migration and differentiation, axon outgrowth and pathfinding, programmed cell death, synaptogenesis, learning, memory, neurodegenerative conditions and current strategies for neuronal regeneration.

MCDB 263, Progress in Biochemistry and Molecular Biology Research seminars presented by invited speakers on current research topics.

MCDB 266, Optogenetics and Functional Imaging Class is a journal club based on primary literature with rotating presenters and active discussion. This quarter we wil focus on Channelrhodopsin and GCaMP, covering the original papers, new variants, and best use cases. Optogenetics is ten years old now and has proven to be a powerful technique to identify behaviorally critical brain regions and map nural circuit connections. Imaging neuronal activity, in the the whole brain of behabing animals, is now possible. Come learn about the development, potential anc caveats of these tools.

MCDB 272, Biological Dynamics An introduction to mathematical models and computer simulations used to describe and understand time varying biological systems. Learning Objectives: Survey mathematical methods for describing the dependence on time of biological phenomena. Illustrate how to construct mathematical models to gain insights into complex biological systems. Develop working knowledge of a python code base that enables future evaluation of common classes of models applied to the study of biological dynamics.

MCDB 290DN, Developmental Neurobiology Presentation and discussion of current research.

MCDB 290MR, Introduction to Microscopy for the Bio-sciences An introduction to microscopy emphasizing light microscopy techniques and principals. A wide variety of microscopy techniques will be introduced while students gain hands-on experience with transmitted light and fluorescence imaging and exposure to high-end imaging instruments.

MCDB 294B, BMSE 294B, Bioengineering: Career and Development Opp. Based on presentations by experts from the bioengineering industry. Presenters describe their companies' technologies and developments, including biosensors, therapeutics, tissue engineering, quantum dots and advanced instrumentation. Training and educational requirements for different career tracks are discussed.

ME 211, Pattern Formation and Self-Organization Introductory course to the processes of pattern formation and self- organization in natural systems (physical and biological systems), as well as in engineering. The goal of the course is to explain how ordered spatial structures appear in different systems. We will discuss the common aspects and the differences in the mechanisms that establish the patterns, and introduce various techniques used in different disciplines to study the formation of spatially extended structures.

ME 219, Mechanics of Materials Matrices and tensors, stress deformation and flow, compatibility conditions, constitutive equations, field equations and boundary conditionsin fluids and solids, applications in solid and fluid mechanics.

ME 220A, Fundamentals of Fluid Mechanics Introductory course in fluid mechanics. Basic equations of motion (continuity, momentum, energy, vorticity), coordinate transformations, "potential" flow, thin airfoil theory, conformal mapping, vortex dynamics, boundary layers, stability theory, laminar/turbulent transition, turbulence. Inviscid/viscid, irrotational/rotational, incompressible/ compressible flow examples.

ME 221, Advanced Viscous Flows Review the Navier-Stokes equations in velocity, pressure, and vorticity variables. Analyze details of important low and moderate Reynolds number flow applications and then high Reynolds number flows with boundary layer phenomena. Compare exact, approximate, numerical, and experimental solution methods.

ME 225BP, Methods in Mechanobiology and Biofabrication ICell mechanobiology topics including cell structure, mechanical models, and chemo-mechanical signaling. Review and apply methods for controlling and analyzing the biomechanics of cells using traction force microscopy, AFM, micropatterning and cell stimulation. Practice and theory for the design and application of methods for quantitative cell mechanobiology. Weekly lecture and hands-on laboratory sessions.

ME 225DL, Introduction to Deep Learning This course introduces basic and recently developed results in the field of deep learning. It is the second part of a two-quarter series on machine learning and deep learning. The first part covered basic machine learning, while this course focuses solely on deep learning. Specifically, this class covers feedforward neural networks, backpropagation, optimization approaches for deep learning, methods for quantifying network expressivity, deep learning regularization methods, convolutional neural networks, sequence modeling with recurrent neural networks, deep residual learning, and recently developed architectures for deep learning.

ME 225ED, Bio-inspired Design In this course, students will learn how Nature can support the creative design process. Students will study evolutionary adaptation as a source for inspiration, extracting design principles to leverage the functionality, adaptability and robustness of biological systems. To advance student knowledge of biological strategies and facilitate quantitative analysis of the proposed solutions, the course focuses on biologically inspired design in fluids. Over the quarter, the students will learn how biological systems deal with fluids and the bio-inspired design process. The course includes lectures, case studies and hands-on design activities. Final projects will involve a team of students. Each team will select a biological system from our local zoo and define a design problem it solves. The students will then expand their search to learn about relevant biological systems. Students will (1) identify the design principles used by the biological system(s), (2) propose a bio inspired design to achieve the identified function, and (3) produce a demo of the design principle and prepare a pamphlet describing their work to a general audience.

ME 225RS, Engineering Biomaterials This lecture-based course will provide an overview of material structure-property relationships, processing, and characterization techniques for metals, polymers and ceramics. We will discuss the unique design constraints imposed by the human body and discuss strategies to enhance biocompatibility. Throughout the course, emphasis will be placed on applications of biomaterials engineering in medical devices.

ME 225SD, Mechanics and Measurements This course is designed for graduate or senior-level undergraduate students who plan to perform experiments, and theoretical or computational students who wish to understand the limitations of the experimental methods from which they are drawing their conclusions. The course will cover, among other topics: sampling, analog/digital devices, data acquisition, methods and their limitations for measuring force, displacement, temperature, etc., data analysis and statistics including uncertainty analysis, and image analysis.

ME 250C, Special Topics in Mechanical Engineering Specialized courses dealing with advanced topics and recent developments in-one or more of the following areas: dynamic systems, control and robotics, fluid mechanics, materials science and engineering, ocean engineering, solid mechanics and structures, thermal sciences.

ME 258, Mechanobiology Methods Cell mechanobiology topics including cell structure, mechanical models, and chemo-mechanical signaling. Review and apply methods for controlling and analyzing the biomechanics of cells using traction force microscopy, AFM, micropatterning and cell stimulation. Design and application of methods for quantitative cell mechanobiology.

ME 292, Design Transducer Design issues associated with microscale transduction. Electrodynamics, linear and nonlinear mechanical behavior, sensing methods, MEMS-specific fabrication rules, and layout are all covered. Modeling techniques for electromechanical systems are also discussed.

PHYS 238, Soft Matter Physics A physics-based approach to study the structure, assembly and dynamical properties of a variety of soft materials, such as simple and complex fluids, colloidal systems, liquid crystals, polymers, granular matter and gels, including biological examples. Topics covered include elasticity, viscosity and viscoelasticity, capillarity and wetting, phases and phase diagrams of soft materials, entropy-driven phase transitions, Brownian motion and active matter.

PHYS 239, Physical Biology of the Cell The role of physics in biology through quantitative measurements and modeling, the organization of a cell, and exemplary quantitative results of biological model systems. The physics of biologically relevant macromolecules, including DNA, RNA and mechanisms of transcription and translation; introduction to protein folding and the role of electrostatics in biology. The physics of the cytoskeleton including beam theory, persistence length, molecular motors, instrumentation used to characterize motor properties, as well as the role of active stresses in cell biology. If time permits, a brief introduction to cell motility and the structure of epithelial tissue.

PSTAT 215A, Bayesian Inference Fundamentals of the Bayesian inference, including the likelihood principle, the discrete version of Bayes theorem, prior and posterior distributions, Bayesian point and interval estimations, and predictions. Bayesian computational methods such as Laplacian approximations and Markov Chain Monte Carlo (MCMC) simulation.

PSTAT 231, Introduction Introduction to data mining techniques. Model assessment and performance evaluation. Data preparation.

Programming techniques for transforming raw data into a form suitable for predictive modeling. Extracting data to a form that predictive models can utilize. Incorporating non-numeric data in predictive models. Techniques for managing exceptional and extreme data. Building predictive models using SAS Enterprise Miner 5 in SAS 9, including Decision Trees, Neural Networks, and Bayesian Networks.

PSTAT 274, Time Series Stationary and non-stationary models, seasonal time series, ARMA models: calculation of ACF, PACF, mean and ACF estimation. Barlett's formula, model estimation: Yule-Walker estimates, ML method. Identification techniques, diagnostic checking, forecasting, spectral analysis, the periodogram. Current software and applications.

PSY 211, Basic Concepts in Behavioral Neuroscience Intended to provide fundamental understanding of neuroscience and behavior for graduate students at the beginning of their studies. Provides a broad overview of brain function with focus on the molecular, cellular, system, and behavioral level of analysis in order to instill a comprehensive appreciation of the biological mechanisms important to behavior.

PSY 221A, Design and Measurement Experimental design and statistical analysis in psy- chological research. Includes basic probability, sampling and distribution theory, hypothesis testing, and estimation.

PSY 221C, Multivariate Analysis in Psychology and Related Social Sciences The use in psychology of the general linear model, multiple regression, discriminant function analysis, factor-analysis, and prinicipal components analysis.

PSY 221F, Computational Neuroscience Survey of methods in computational neuroscience; single cell methods including Hodgkin-Huxley models, occupation theory, integrate-and-fire models; neural network modeling including linear system theory, nonlinear dynamics, connectionism, Hodgkin-Huxley-like network models, models of synaptic plasticity, methods for generating predicted BOLD signals.

PSY 231, Cognitive Neuroscience Examination of the neurological basis of cognition with material drawn fromresearch in psychology, neurology and the neurosciences with brain injured and healthy human and non-human subjects. Topics include memory, language, and perception.

PSY 265, Computational Neuroscience Survey of methods in computational neuroscience; single cell methods including Hodgkin-Huxley models, occupation theory, integrate-and-fire models; neural network modeling including linear system theory, nonlinear dynamics, connectionish, Hodgkin-Huxley-like network models, models of synaptic plasticity, methods for generating predicted BOLD signlas.

PSY 268, Brain Development An examination of the major developmental events producing the organizationand connectivity of the nervous system. offered concurrently with Psychology 168, but graduate students will be required to complete additional reading and writing assignments.

PSY 269, Neuroanatomy An examination of the organization of the vertebrate nervous system. Topicsinclude neurohistological techniques; neurology and neuropsychology; comparative neuroanatomy; neural degeneration; developmental neuroscience.