BIOMEDICAL ENGINEERING (BME)

BME 1310 - Introduction to Biomedical Engineering (3 Credits)
Crosslisted with ENGRI 1310
An introduction to the field of biomedical engineering with emphasis on application. Specific applications include biomechanics, bioimaging, bioinstrumentation, biotechnology/nanofabrication, artificial organs, cancer therapy and vaccines.
Enrollment Information: Enrollment limited to: first-year or sophomore Engineering students, or permission of instructor.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Learning Outcomes:

- To understand the underlying molecular, cellular, physiological and engineering that govern the field of biomedical engineering.

Schedule of Classes (https://classes.cornell.edu/)

BME 2000 - Biomedical Transport Phenomena (3 Credits)
Crosslisted with ENGRD 2202
Quantitative analysis of transport phenomena in physiological systems, including fluid mechanics and mass transfer. Fluid statics, mass and momentum conservation, laminar and turbulent flow, microscale and macroscale analytical methods, mass transport with biochemical reactions, applications to transport in tissue and organs.
Corequisites: MATH 2930 or equivalent.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

BME 2010 - Physiology of Human Health and Disease (3 Credits)
Covers essentials of human physiology, with an overview of complementary mechanisms of homeostasis and disease pathogenesis. Topics presented in a modular format incorporating an overview of basic physiological mechanisms and key diseases of specific organ systems susceptible to alterations in that physiological mechanism. Topics include: filtration and renal function, electrophysiology and cardiac arrhythmia, neural transmission and muscular dystrophy, mineral balance and osteoporosis, and lipid transport and atherosclerosis. Course utilizes best pedagogical strategies including engaged learning practices, small group discussion, and lectures by clinicians working in these areas.
Enrollment Information: Enrollment preference given to: BME majors.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BME 2080 - Experiential Learning Seminar (1 Credit)
This seminar focuses on building professional skills while activating curricular content within the context of experiential learning activities. Students will pursue individual and team-based exercises, with reflective discussions.
Enrollment Information: Enrollment limited to: BME majors.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BME 2110 - Biomolecular Thermodynamics (3 Credits)
Crosslisted with ENGRD 2111
This course serves as an introduction to thermodynamics and physical chemistry focused on the application to biomolecular systems. Topics include the role of entropy and free energy in determining biological reactions and processes such as enzymatic reactions or molecular interactions, protein folding/unfolding, single molecule mechanics, energy states, and equilibrium distribution of biomolecular and other systems. This course serves as the foundation for the Molecular, Cellular, and Systems Engineering (MCSE) concentration as well as the molecular principles of biomedical engineering course.
Prerequisites: CHEM 2090, MATH 1920, and BIOG 1350 or BIOG 1440.
Enrollment Information: Enrollment preference given to: BME majors.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BME 2210 - Biomaterials: Foundations and Application in Medicine (3 Credits)
This course focuses on the fundamental understanding of implantable materials with respect to their design, analysis and use in human health. The course content includes the fundamentals of materials synthesis/fabrication, interactions between materials with tissues, quantitative analysis of material properties and how materials are used to impact human health.
Enrollment Information: Enrollment preference given to: BME majors.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

BME 3010 - Cellular Principles of Biomedical Engineering (3 Credits)
This course will provide students a fundamental understanding of cellular systems essential for engineering effective biomedical applications. The course comprises of three modules. Module 1 will discuss the principles of cellular biology and mathematics that govern cell signaling, growth, and propagation. In the laboratory students will create and analyze mammalian cell growth curves. Biomedical applications such as bioreactors will be discussed. Module 2 will discuss how cells organize into tissue and organs within the human body. Characteristics of different cell types found within human body will be mathematically analyzed, with special emphasis on stem cells and their application in tissue engineering. Module 3 will discuss how immune cells react to infection and injury. In the laboratory students will explore stimulus driven immune cell migration.
Prerequisites: BIOMG 1350; MATH 2930; BME 2010, or BIOG 1440 or BIOG 1445.
Enrollment Information: Recommended prerequisite: BIOMG 3300.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

BME 3020 - Molecular Principles of Biomedical Engineering (3 Credits)
Crosslisted with CHEME 4020
Genomic and proteomic thinking and tools have revolutionized the way scientists study biology and medicine. We are now beginning to understand the molecular level mechanisms that underlie normal and pathologic cellular functions. As a consequence, novel molecular level approaches provide the basis for better diagnostic and therapeutic strategies to effectively treat or prevent human diseases. This course aims to present a broad overview of molecular level techniques that are relevant in many aspects of biomedical engineering. We will discuss the underlying principles, how to interpret representative data, limitations of current approaches, and engineering challenges for the development of new and improved techniques.The lectures will cover existing and emerging technologies and instrumentation critical to molecular - level analysis in biomedical engineering. These will include DNA recombinant technology, design of primers, vectors and gene-modified organisms, gene therapy approaches, DNA sequencing, quantification of RNA expression, fundamentals of protein biochemistry and biophysics, protein structure determination, mass spectrometry, protein purification, thermodynamic principles of biomolecular interactions, enzyme kinetics and modes of inhibition, and design and application of nano- and microtechnologies for diagnosis and therapeutic applications.The laboratory work consists of three modules: DNA isolation and sequencing, surface plasmon resonance technique, and design of microfluidic systems for molecular biology applications.
Prerequisites: BIOMG 1350 or other coursework that covers basics of DNA, RNA, and proteins or permission of instructor.
Enrollment Information: Enrollment preference given to: Biomedical Engineering majors.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BME 3030 - Biomedical Circuits, Signals and Systems (5 Credits)
This course will cover the mathematical foundation to analyze signals and model the behavior of biomedical systems in the time and frequency domains, and help students develop the mindset and skills necessary to produce high-quality measurements of a physiological or biological variable. Labs involving the design and construction of biomedical circuits to quantify a physiological or biological function will foster a broad perspective on biological and biomedical measurement, and provide practical application of linear systems theory and measurement principles covered in lectures.
Prerequisites: MATH 2930 and PHYS 2213 or equivalent. Corequisite: MATH 2940
Enrollment Information: Enrollment preference given to: BME majors.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Learning Outcomes:

- Identify variables that could be measured to quantify a physiological function, then design and defend an approach to measure those variables.
- Design and analyze the behavior of circuits with appropriate sensors, filters, and amplifiers for measuring those variables.
- Construct and empirically optimize circuits from these designs so that they are operational with minimal noise and meet experimental needs.
- Acquire high quality data on the variable with appropriate controls and calibrations, while identifying and minimizing systematic bias and random noise.
- Design and implement appropriate signal and image processing approaches for the measured variables and analyze these data to characterize the physiological function.
- Conceive of and conduct an experimental plan to test a hypothesis about the physiological function using the measurement and analysis tools developed.
- Analyze data acquired in a thoughtful and statistically relevant way to test the hypothesis.
- Produce high quality oral presentations and writing that present experimental approach and findings.
- Develop strategies to acquire, consolidate, and use new information to meet challenges.

Schedule of Classes (https://classes.cornell.edu/)

BME 3080 - BME Clinical Immersion Program I (0.5 Credits)
This course will help students prepare for participation in the Clinical Immersion Program. BME undergraduates will be able to fully grasp the role engineers play in the medical ecosystem and the important contributions they make to medicine. Through a range of exposures to real-world practices and professionals, immersion scholars will take away a deeper understanding of the relationship between medicine and engineering. This experience will directly inform their final semesters and senior design project at Cornell and affect their future education and careers.
Enrollment Information: Enrollment limited to: BME Juniors.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Spring 2015
Schedule of Classes (https://classes.cornell.edu/)

BME 3081 - BME Clinical Immersion Program II (0.5 Credits)
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023
Schedule of Classes (https://classes.cornell.edu/)

BME 3110 - Cellular Systems Biology (3 Credits)
The behaviors of cells are increasing appreciated to be governed by a system of regulatory pathways, which processes information often in a multivariate, dynamic and non-linear fashion. The ability to reduce this complexity to predictable models is useful for designing new cancer therapies and genetically engineering cellular machines. The course will cover: (1) analysis of dynamic control processes in cell biology, from intracellular pathways to networks to multicellular systems; (2) principles of computational systems biology, including genomic, proteomic, and transcriptomic algorithms; and (3) principles of synthetic biology, including gene circuit design and modeling. Students will learn to solve problems using computationally implemented algorithms and models, involving statistical methods, differential equation systems, multivariate regression, and logic-based approaches. This course is designed for upper-level undergraduate and Master's students in the biomedical, biological and/or engineering sciences.
Prerequisites: BME 3010, MATH 2930, MATH 2940, CS 1112 or equivalents or permission of instructor. Corequisite: BME 3020 or equivalent.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BME 3210 - Multiscale Biomaterial Analysis (3 Credits)
The course in advanced biomaterials leads the class through the process of material design and characterization for their development as products in the medical device or pharmaceutical fields. Student teams will apply their fundamental knowledge of chemistry and biology to open-ended design challenges focused on biomaterial mechanics, processability, biocompatibility and federal regulatory requirements. Hands-on technical work in materials characterization will be combined with key knowledge of biomaterials to give the class an integrated understanding of biomaterials design and development. Specific topics to be covered are classes of biomaterials, methods of characterization, the interface of biomaterials and biology, the foreign body response, inflammation, wound healing, biofilms, sterilization methods, FDA-approval guidelines and EU-approval guidelines.
Prerequisites: BME 2210 or equivalent.
Enrollment Information: Enrollment preference given to: BME majors.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BME 3300 - Introduction to Computational Neuroscience (3-4 Credits)
Crosslisted with BIONB 3300, PSYCH 3300, COGST 3300
Covers the basic ideas and techniques involved in computational neuroscience. Surveys diverse topics, including neural dynamics of small networks of cells, neural coding, learning in neural networks and in brain structures, memory models of the hippocampus, sensory coding, and others.
Prerequisites: BIONB 2220 or permission of instructor.
Distribution Requirements: (BIO-AS, SDS-AS), (OPHLS-AG)
Last Four Terms Offered: Fall 2024, Fall 2022, Fall 2018, Fall 2016
Learning Outcomes:

- Basic understanding of current theories of brain function.
- How to construct representations from tuning curves.
- Plasticity and how it relates to memory.
- Models of human memory.

Schedule of Classes (https://classes.cornell.edu/)

BME 3310 - Medical and Preclinical Imaging (3 Credits)
This course teaches the fundamentals and applications of medical imaging techniques, including x-ray imaging and computed tomography, nuclear medicine, magnetic resonance imaging, ultrasound, and optical imaging. Through lecture and demonstration labs, the class provides a rigorous introduction to medical imaging, beginning with the basic physical principles of image formation on to image reconstruction and descriptions and demonstrations of the hardware used in clinical applications. Concepts covered include resolution, point-spread-functions, modulation transfer functions, signal-to-noise, multi-dimensional Fourier transformation, image filtering in spatial domain and the structure and function of the human visual system.
Prerequisites: engineering core or permission of instructor.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BME 3410 - Systems Mechanobiology (3 Credits)
This course analyzes how mechanical forces affect biological responses across biological scales, including molecular, cellular, tissue, organ, and organism level. Theoretical and empirical foundations and engineering approaches to applying, quantifying, and elucidating mechanobiological mechanisms across each scale will be presented. Applications in human health and disease pathogenesis will be emphasized.
Prerequisites: ENGRD 2020, MATH 2930, BME 3010 or equivalent or permission of instructor.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BME 4010 - Biomedical Engineering Analysis of Metabolic and Structural Systems (3 Credits)
Crosslisted with MAE 4660
This course focuses on applying techniques of engineering analysis to quantify function and dysfunction of human physiologic systems. Thematic areas include the cardiovascular, respiratory, musculoskeletal, and renal systems. Emphasis will be placed on developing mathematical models to understand function and dysfunction across tissue scales, and implementing these with experimental data to make biomedical engineering judgments.
Prerequisites: ENGRD 2020, MATH 2930, BIOMG 1350 and BME 2010 or BIOG 1440.
Enrollment Information: Enrollment preference given to: Biomedical Engineering majors.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

BME 4020 - Electrical and Chemical Physiology (3 Credits)
Focuses on understanding how circulating agents and bioelectric activity comprises interorgan and central nervous system communication, and control of the human body. Additional emphasis includes examining medical devices involved in the treatment of human disease.
Prerequisites: MATH 2930, PHYS 2213, BME 2000 or equivalent, BME 2010 or equivalent or permission of instructor.
Enrollment Information: Enrollment preference given to: Biomedical Engineering majors.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BME 4080 - Biomedical Engineering Design I (3 Credits)
This course articulates fundamental engineering design theory and practice for biomedical engineering applications. Design specification establishment, tolerance/robustness, validation, and documentation strategies are presented. Product archaeology, human factors, FDA/Insurance regulatory concepts, and product lifecycle/iteration are also pursued through lectures and case studies.
Prerequisites: BME 3030, BME 4190 or BME 4390 or BME 4490.
Enrollment Information: Enrollment limited to: BME seniors or permission of instructors.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

BME 4090 - Biomedical Engineering Design II (3 Credits)
Substantial design experience based on the knowledge and skills acquired in earlier course work combined with the fundamental design theory articulated in BME 4080.
Prerequisites: BME 4080.
Exploratory Studies: (CU-UG)

Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BME 4190 - Laboratory Techniques for Molecular, Cellular, and Systems Engineering (3 Credits)
This class will provide students with the skills needed for the design, fabrication, and characterization of experimental approaches relevant to Molecular, Cellular, and Systems engineering. Lectures will integrate three modules: the first module will focus on stem cell biology, differentiation, and characterization. The second module will provide a thorough understanding of polymeric scaffold design and characterization for tissue engineering applications. The third module will focus on analytic techniques suitable to analyze molecular, cellular, and systems-level signaling changes of cells in response to varied microenvironmental context. All three modules will be taught in a manner that will enable students to design and implement experimental approaches for cell manufacturing, tissue regeneration, and drug testing.
Prerequisites: BME 3010, BME 3020, BME 3110 or BME 3210.
Enrollment Information: Enrollment limited to: BME majors. Permission of instructor required if additional seats are available.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

BME 4390 - Circuits, Signals and Sensors: Instrumentation Laboratory (3 Credits)
This class provides students with the basic skills needed to design and fabricate biomedical and bioanalytical instrumentation. Lectures cover analog and digital electronics, microcontrollers, microcontroller interfacing and firmware programming (in C). Circuit simulation (using CircuitLab) is covered as is an instruction to schematic capture and printed circuit board layout software (Eagle). Emphasis is on designing and building analog circuitry for sensors, analog to digital conversion and microcontroller/device and microcontroller/PC interfacing. Lab exercises involve the design and construction of a number of biomedically related circuits.
Prerequisites: engineering common math/physics and CS 1112.
Enrollment Information: Enrollment limited to: BME seniors, or permission of instructor.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Learning Outcomes:

- Become proficient with analog electronics and analog circuit design at the level required to design and build a various biomedical devices. (ABET a,k)
- Become proficient with digital electronics and digital circuit design at the level required to digitize signals and collect data from a biomedical device. (ABET a,k)
- Become proficient at programming of microcontrollers in C to implement microcontroller/peripheral device interfacing and microcontroller/PC communications and data transfer. (ABET a,k)

Schedule of Classes (https://classes.cornell.edu/)

BME 4410 - Biofluid Mechanics (3 Credits)
Crosslisted with MAE 4650
Prerequisites: ENGRD 2020 and ENGRD 2202 or MAE 3230 or equivalents, or permission of instructor.
Last Four Terms Offered: Fall 2024, Fall 2022, Fall 2021, Spring 2020
Schedule of Classes (https://classes.cornell.edu/)

BME 4440 - Science Policy Bootcamp: Concept to Conclusion (3 Credits)
Science Policy Bootcamp: Concept to Conclusion, is an interdisciplinary service-learning course where students will explore the trends that shape science and innovation policy, understand core science policy concepts and engage in active policymaking work. This three-credit course will comprise of a three-hour long session that will meet every week. The first hour of each session will be devoted to broadening student's perspective on science policy. The following two hours will be spent working in groups on the primary activity of the course - a science policy advocacy project that builds over the full semester. Working in small groups, students will identify a key science policy issue. Together, they will thoroughly research the issue and contact key stakeholders, formulate a detailed plan to address the issue, and unique to this course - implement their plan for solving the problem toward the end of the semester. Examples may include drafting legislation, commenting on Federal or State rulemaking procedures, launching public outreach campaigns, or raising press awareness of an issue. This aspect of the course will include both mentored work in developing the idea and advocacy plan, as well as activities to build the skills necessary to be an effective policy advocate. Examples of such activities include mock press interviews and lobbying visits. As a result of the final project - students will have the unique opportunity to address a bona fide policy issue and create a working solution.
Exploratory Studies: (CU-CEL)

Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2021
Schedule of Classes (https://classes.cornell.edu/)

BME 4490 - Biomechanics Laboratory (3 Credits)
Crosslisted with MAE 4480
This course focuses on mastering experimental techniques related to measuring the mechanical behavior of biomedical materials and biological tissues. Students will learn techniques for measuring mechanical properties of cardiovascular and musculoskeletal tissues in tension, compression, shear, and bending. Students will learn to apply non-linear models to describe the behavior of elastic, viscoelastic, poroelastic, and hyperelastic materials.
Prerequisites: BME 3410 or BME 3210 or permission of instructor.
Enrollment Information: Enrollment preference given to: Biomedical Engineering majors.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BME 4640 - Orthopaedic Tissue Mechanics (3 Credits)
Crosslisted with MAE 4640
Application of mechanics and materials principles to orthopaedic tissues. Physiology of bone, cartilage, ligament, and tendon and the relationship of these properties to their mechanical function. Mechanical behavior of skeletal tissues. Functional adaptation of these tissues to their mechanical environment. Tissue engineering of replacement structures.
Prerequisites: ENGRD 2020 and MAE 3270.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2021, Spring 2019
Learning Outcomes:

- Students will be able to know and understand the function and physiology of bone, cartilage, tendon and ligament as organs and tissue.
- Students will be able to apply strength of materials concepts to the mechanical behavior of musculoskeletal tissues and organs.
- Students will be able to understand the unique adaptive capacity of musculoskeletal tissues to their mechanical environment.
- Students will be able to integrate and interpret biological data and mechanical engineering concepts.

Schedule of Classes (https://classes.cornell.edu/)

BME 4790 - Modern Applications of Machine Learning and Artificial Intelligence for Biomedical Applications (3 Credits)
This one semester course will be focused on exposing students to basic strategies in machine learning using neural networks and other machine learning techniques within the context of biomedical engineering. This includes early uses (classical fitting), and basic to concepts such as loss functions, models, backpropagation and training, as well as current layer (dense, convolutional networks and x-formers), and model architectures (e.g. autoencoders, U-Nets, adversarial networks, and large language models) and how these are applied towards current biomedical engineering tasks (medical image recognition, bioinformatics, etc.). This will be geared towards students who are interested in learning to design, code and understand common neural network strategies. Course materials will be primarily implemented in Python, using common packages, such as NumPy, SciPy, Pandas, and TensorFlow, in addition to open-source databases. Students are expected to have a basic familiarity with python programming and some experience with applying statistical methods.
Prerequisites: CS 1110, or equivalent and ENGRD 2020, BTRY 3010, BTRY 3020, or ILRST 2110, or equivalent.
Learning Outcomes:

- Demonstrate the ability to distinguish between different types of modern machine learning architectures and the kinds of physical problems they can be applied to.
- Explain the fundamental strengths and weaknesses of current neural network models, and how they contribute to their function and limitations (e.g. For instance, how are LLM trained, how does this limit them or contribute to the type of information they can provide).
- Demonstrate the ability to implement and train a basic neural network model as applied towards a biomedical application.

Schedule of Classes (https://classes.cornell.edu/)

BME 4900 - Independent Undergraduate Project in Biomedical Engineering (1-6 Credits)
Research or projects by an individual or a small group of undergraduates.
Exploratory Studies: (CU-UG)

Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

BME 4901 - Honors Thesis (3 Credits)
Intended for students pursuing the research honors program in BME. This course is the culmination of the program's honors project requirement. Students enrolled in the BME Honors program will prepare an honors thesis based on the subject matter of a BME 4900 project from the previous semester, under the supervision of their research mentor.
Prerequisites: BME 4900 and acceptance in the BME honors program.
Exploratory Studies: (CU-UG)

Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

BME 4910 - Principles of Neurophysiology (4 Credits)
Crosslisted with BIONB 4910, ECE 4910
Laboratory-oriented course designed to teach the concepts and tools of cellular neurophysiology through hands-on experience with extracellular and intracellular electrophysiological techniques, and computer acquisition and analysis of laboratory results. Students explore signal transmission in the nervous system by examining the cellular basis of resting and action potentials, and synaptic transmission and optogenetic control of behavior and physiology. Lecture time is used to review nervous system physiology, introduce laboratory exercises, discuss lab results and primary research papers, and for presentation of additional experimental preparations and methods. Invertebrate preparations are used as model systems.
Prerequisites: one of the following courses: general biology, BIONB 2220, physiology covering neuronal excitability and synaptic transmission, or permission of instructor.
Distribution Requirements: (BIO-AS), (BSC-AG, OPHLS-AG)
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Learning Outcomes:

- Students should understand the contemporary experimental paradigms in modern neurophysiology and become technically competent with the extracellular and intracellular recording techniques used to explore nervous system physiology.
- Students should deepen their understanding of the ionic mechanisms underlying neuronal excitability and synaptic communication in the nervous system.
- Students should develop their skills in communicating scientific results effectively through written lab reports and oral presentations.
- Students should refine their critical reading skills of primary scientific literature.
- Students should refine their ability to develop testable hypotheses, and develop independent scientific thinking.

Schedule of Classes (https://classes.cornell.edu/)

BME 4960 - Microbial Genomics Hackathon: Microbiomes, Probiotics and Antibiotics (1 Credit)
The Microbial Genomics Hackathon is meant to bring together Cornell students in a weekend of experiential learning around the topic of Microbiomes, Probiotics and Antibiotics. The hackathon will include lectures given by innovators and leaders in genomics, data science and microbiome-based companies. Students will form diverse teams with business students, engineers, and computational biologists, among others, to create solutions, products, or services around the topic. Students will generate solutions to real-world problems, such as stopping the spread of antibiotic resistant bacteria and creating self-monitoring microbiome technologies. A major goal of the program is for students to gain exposure to computational genomics and the diversity of problems that these methods can be applied to. Prior to the event, students will be required to complete preparatory reading and reflection and will attend several introductory lectures and brainstorming sessions. These will include skill-building sessions on scientific communication. This will prepare students for effective teamwork and the ability to utilize key genomic resources. Students will be exposed to and utilize computational tools and programming languages such as Python and R. Students will learn about genomics databases and tools (such as BLAST, RAST, NCBI, IMG, PATRIC and KEGG) used across industry and academia. The event will also consist of career building opportunities to hone skills and interface with industry partners. Students will receive feedback from faculty, industry and student mentors and participate in a project showcase where they will present their proposals. After the event, students will synthesize their efforts into a final team report about their product, initiative, service or technique where they will hone their scientific communication through problem statements and business plan development. They will also reflect upon various aspects of the material knowledge gained (improvements in computational proficiency and exposure to microbial genomics and microbiome solutions, communication across disciplines, and market evaluation) and how this can translate into career opportunities. The course will meet weekly until the hackathon, which takes place on a weekend in March (exact dates TBD). More info at http://www.microbiomehack.org.
Last Four Terms Offered: Spring 2020, Spring 2019, Spring 2018
Schedule of Classes (https://classes.cornell.edu/)

BME 4970 - Undergraduate Teaching in Biomedical Engineering (1-3 Credits)
The student assists in teaching a biomedical engineering course appropriate to their previous training. The student may meet with a discussion or laboratory section, prepare course materials, grade assignments, and regularly discuss objectives and techniques with the faculty member in charge of the course.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

BME 5010 - BME MEng Professional Engagement Seminar (1 Credit)
Students must attend and report on 10 self-selected seminars to fulfill the requirements of the course.Self-selected seminars may include topics related to bioengineering, engineering and biology or life science. Seminars offered at other universities or at national scientific meetings may be used as long as the topic is relevant.
Enrollment Information: Enrollment limited to: BME M.Eng. students.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

BME 5100 - Clinical Preceptorship for Biomedical Engineers (1 Credit)
Preceptorship, is a well-known process in healthcare education and described as a short term relationship between a student as novice and an experienced health care professional, who provides individual attention to the student's learning needs within a clinical environment. The BME 5100 leverages this methodology and enable our students to experience the dynamics of a clinical environment, observe the routine practice of a clinician, identify potential needs, and through a formal process evaluate the merits and provide ideas on how to address these perceived needs. The instructor will educate the students about the clinical environment, dress and behavior code, interaction with hospital staff and patients, as well as monitor and manage each student-preceptor team. The instructor and other engineering faculty will also review the student's experiences and assist in any assignments the preceptor may have given to the student. The preceptor will guide the student with in depth knowledge of the related anatomy, physiology and pathology associated with his specialty. The preceptor will also provide the student the ability to participate and observe as well as generate weekly assignments. The sponsoring institution and the preceptors are very interested in the identified problems, the ideas resultant of the process, and how these ideas could be addressed by applying principles of engineering. The student will provide feedback in the form of a final report as well as an on-site poster presentation at the end of the academic year. The merited ideas will be placed in the pipeline for the sponsored design projects (BME 5910, BME 5920).
Enrollment Information: Enrollment limited to: BME M.Eng. students.
Exploratory Studies: (CU-CEL)

Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

BME 5110 - Stem Cell Bioengineering (3 Credits)
This course explores the interface of stem cell biology and bioengineering and biotechnology and will examine the how quantitative modeling and analysis approaches inform stem cell-based biotechnologies and medical therapies. The course will cover embryonic and adult stem cell biology fundamentals, cell and molecular bioengineering concepts and techniques, biomolecular and genetic therapies to regulate stem cell function, and design of biomimetic and bioreactor environments for stem cell differentiation and derivation. These concepts will be conveyed in a mixture of assigned readings; interactive lectures; quantitative, descriptive, and computational problem sets; primary literature discussions and reviews; quizzes; and a small-team final grant proposal project.
Prerequisites: BME 3010 and BME 3020, or equivalent.
Last Four Terms Offered: Fall 2024, Fall 2021
Learning Outcomes:

- To identify key features of adult and pluripotent stem cell systems.
- To summarize molecular and cell engineering techniques to modulate stem cell functions.
- To design bioengineering strategies for enhancing stem cell-based regenerative medicine therapies.
- To analyze scientific publications for critical assessment of research methods, experimental design, and statistical/quantitative outcomes.
- To produce teaching modules on stem cell biology and revise/refine them for real-world dissemination.

Schedule of Classes (https://classes.cornell.edu/)

BME 5130 - Introduction to Microbiome Engineering (3 Credits)
The human microbiome impacts human health in a multitude of ways. To achieve a specific health outcome, we can modify the compositions of the microbiome, the molecules microbes produce, how they interact or how our body interacts with them. Yet, our current toolbox is fairly limited. In this course, we will examine current methods for intervening in the microbiome but focus primarily on cutting-edge technologies for microbiome-related therapeutics. This will include synthetic biology and genetic engineering approaches. Topics will include probiotics, antibiotics, drug discovery, live bacterial therapeutics, biosensors, phage therapies, bacterial evolution and engineering immune responses.
We will touch on the safety implications of using different biological technologies. This course is designed for Masters-level students and advanced undergraduate students. There will be a computational component to this course, although no prior computational experience is required. Students will learn generalizable skills such as how to navigate the server, distinguish between the formats of genomics files, and employ command-line tools used in common genomic pipelines.
Last Four Terms Offered: Fall 2021
Learning Outcomes:

- Understand how to modulate microbiome composition and function.
- Demonstrate knowledge in leveraging the microbiome for the development of therapeutics or diagnostics.
- Navigate a server handling sequence files for genomic analyses.

Schedule of Classes (https://classes.cornell.edu/)

BME 5310 - Medical and Preclinical Imaging (3 Credits)
Last Four Terms Offered: Spring 2025, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

BME 5320 - Principles of Neurophysiology (4 Credits)
Crosslisted with BIONB 5910, ECE 5090
Laboratory-oriented course designed to teach the concepts and tools of cellular neurophysiology through hands-on experience with extracellular and intracellular electrophysiological techniques, and computer acquisition and analysis of laboratory results. Students explore signal transmission in the nervous system by examining the cellular basis of resting and action potentials, and synaptic transmission. Lecture time is used to review nervous system physiology, introduce laboratory exercises, discuss lab results and primary research papers, and for presentation of additional experimental preparations and methods. Invertebrate preparations are used as model systems. Students must complete and additional semester-long project. The project includes exploration of experimental neuroscience questions not covered in the undergraduate laboratory class, novel, low cost instrumentation design, computational approaches to nervous system function and development of active learning activities. It will require a project proposal early in the semester, and a final project presentation and research journal style paper at the end of the semester.
Prerequisites: one of the following courses: general biology, BIONB 2220, physiology covering neuronal excitability and synaptic transmission, or permission of instructor.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Learning Outcomes:

- Students should understand the contemporary experimental paradigms in modern neurophysiology and become technically competent with the extracellular and intracellular recording techniques used to explore nervous system physiology.
- Students should deepen their understanding of the ionic mechanisms underlying neuronal excitability and synaptic communication in the nervous system.
- Students should develop their skills in communicating scientific results effectively through written lab reports and oral presentations.
- Students should refine their critical reading skills of primary scientific literature.
- Students should refine their ability to develop testable hypotheses, and develop independent scientific thinking.
- Graduate students will be able to prioritize, rate, evaluate, compare and contrast, and summarize Neuroscience research literature.
- Graduate students will be able to lead discussion of scientific literature, and justify, construct a scientific argument, and investigate reliability of research findings.
- Graduate students will be able to analyze and interpret research methods and data, design experiments to test hypotheses, and teach active learning activities.

Schedule of Classes (https://classes.cornell.edu/)

BME 5390 - Circuits, Signals and Sensors: Instrumentation Laboratory (3 Credits)
This class provides students with the basic skills needed to design and fabricate biomedical and bioanalytical instrumentation. Lectures cover analog and digital electronics, microcontrollers, microcontroller interfacing and firmware programming (in C). Circuit simulation (using CircuitLab) is covered as is an instruction to schematic capture and printed circuit board layout software (Eagle). Emphasis is on designing and building analog circuitry for sensors, analog to digital conversion and microcontroller/device and microcontroller/PC interfacing. Lab exercises involve the design and construction of a number of biomedically related circuits. This course serves as an introduction to the skills needed by biomedical engineers who chose to focus on instrument design and imaging.
Enrollment Information: Enrollment limited to: BME MEng students, or permission of instructor.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Learning Outcomes:

- Become proficient with analog electronics and analog circuit design at the level required to design and build a various biomedical devices. (ABET a,k)
- Become proficient with digital electronics and digital circuit design at the level required to digitize signals and collect data from a biomedical device. (ABET a,k)
- Become proficient with hardware programming of microcontrollers in C to implement microcontroller/peripheral device interfacing and microcontroller -PC communications and data transfer. (ABET a,k)

Schedule of Classes (https://classes.cornell.edu/)

BME 5410 - Biofluid Mechanics (4 Credits)
Crosslisted with MAE 5650
Prerequisites: ENGRD 2020 and ENGRD 2202 or MAE 3230 or equivalents, or permission of instructor.
Last Four Terms Offered: Fall 2024, Fall 2022, Fall 2021, Spring 2020
Schedule of Classes (https://classes.cornell.edu/)

BME 5420 - Systems Mechanobiology (3 Credits)
Last Four Terms Offered: Spring 2025
Schedule of Classes (https://classes.cornell.edu/)

BME 5500 - Innovation and Design of Biomedical Technologies (3 Credits)
This course was designed to addresses the business, regulatory, and technical challenges throughout the many design phases of a biomedical technology product life cycle. It is a required and essential course for the BME Masters of Engineering program and it lays the foundation to the also required BME 5910 (Design Project) and BME 5920 (Performance of Design Project).
Enrollment Information: Enrollment limited to: BME M.Eng. students.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

BME 5510 - Medical Device Regulatory Affairs for Biomedical Engineers (2 Credits)
This course is designed to provide a working knowledge of Medical Device Regulatory Affairs specifically for Biomedical Engineers. It is geared for both experienced biomedical engineering professionals as well as those new to the industry and is intended for non-regulatory professionals who need a better understanding of the regulatory requirements necessary to bring medical devices to market. This course demonstrates important regulatory requirements and concepts using case study discussions of real products from a variety of clinical specialties. Strategies for using regulation as a competitive advantage will also be discussed. Instructor will be lecturing virtually (on-line) but in real-time.
Enrollment Information: Enrollment limited to: M.Eng students.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BME 5610 - Advanced Cellular Systems Biology (3 Credits)
Last Four Terms Offered: Spring 2025, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

BME 5620 - Biomineralization: The Formation and Properties of Inorganic Biomaterials (3 Credits)
Crosslisted with MSE 5620
This course will examine the wide variety of mineralized materials made by biological organisms including mollusk shells, sea urchins, mammalian bone and teeth, siliaceous sponges and diatoms, and magnetotactic bacteria. The focus will be on the molecular and biological mechanisms that lead to the formation of these materials as well as their unique mechanical, optical and optical properties.
Prerequisites: MSE 3010 or CHEM 1570 or CHEM 3570-CHEM 3580 or equivalent, or permission of instructor.
Last Four Terms Offered: Spring 2025, Spring 2022, Spring 2018, Spring 2017
Schedule of Classes (https://classes.cornell.edu/)

BME 5630 - Fundamentals of Artificial Intelligence and Machine Learning for BME Applications (3 Credits)
Last Four Terms Offered: Spring 2025
Schedule of Classes (https://classes.cornell.edu/)

BME 5710 - Analytical Techniques for Material Science (3 Credits)
Crosslisted with MSE 5710
Covers techniques used to determine the composition and structure of materials, both synthetic and biological. The aim is a level of understanding that allows students to choose suitable methods, to appreciate the physical basis of techniques so as to recognize their limitations, and to be able to interpret literature in specialty journals of the field. Modern approaches to determine composition, chemical structure and microstructure will be emphasized. It is not the intent of this course to train students as hands on users of particular instruments.
Prerequisites: MSE 2060.
Last Four Terms Offered: Spring 2020, Fall 2016, Fall 2014, Spring 2013
Schedule of Classes (https://classes.cornell.edu/)

BME 5750 - Biomaterials and Drug Delivery in the Immune System (3 Credits)
The objectives of this class are to introduce basic concepts, update the latest developments, identify critical bottlenecks, analyze complex problems, and demonstrate effective solutions relating to biomaterials and drug delivery in the immune system. The course will begin by introducing modern biomaterials and drug delivery systems. Then, basic concepts in immunology will be covered. Finally, several applications will be illustrated about how immunology impacts the design of next-generation biomaterials and drug delivery systems and how biomaterials and drug delivery systems impact the development of immunotherapies, vaccines and implants.
Last Four Terms Offered: Fall 2024
Schedule of Classes (https://classes.cornell.edu/)

BME 5760 - Engineering the Human Body: From Artificial Joints to Living Organs (3 Credits)
Last Four Terms Offered: Spring 2025
Schedule of Classes (https://classes.cornell.edu/)

BME 5780 - Computer Analysis of Biomed Images (3 Credits)
Crosslisted with ECE 6690
Powerful imaging modalities with attending computer image processing methods are evolving for the evaluation of health and the detection of disease. This course focuses on the quantitative analysis of such images and Computer Aided Diagnosis (CAD), i.e., the automatic identification and classification of abnormalities by the computer.
Prerequisites: ECE 5470 or equivalent.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2022, Spring 2021
Schedule of Classes (https://classes.cornell.edu/)

BME 5810 - Soft Tissue Biomechanics (3 Credits)
Crosslisted with MAE 5680
Introduces concepts of biomechanics applied to understanding the material behavior of soft tissues. Topics include finite strain, nonlinearities, constitutive frameworks, and experimental methodologies. Tissues to be modeled include tendons, blood vessels, heart valves, cartilage, and engineered tissues.
Prerequisites: ENGRD 2020, BME 3410 or MAE 3270.
Enrollment Information: Enrollment limited to: graduate students; seniors by permission of instructor.
Last Four Terms Offered: Spring 2024, Fall 2019, Fall 2017, Fall 2016
Schedule of Classes (https://classes.cornell.edu/)

BME 5830 - Cell-Biomaterials Interactions (3 Credits)
Biological principles underlying biomaterial design and cellular adhesive behavior, incorporating biomechanical analysis across the molecular, cellular and tissue length scales. We will take an in-depth look at design considerations and biomaterials analysis, incorporating reading from the primary literature as well as the text.
Prerequisites: BME 3010 and BME 2210 or equivalent, or permission of instructor.
Enrollment Information: Enrollment preference given to: BME M.Eng students.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BME 5850 - Current Practice in Tissue Engineering (3 Credits)
Covers fundamental biological principles and engineering concepts underlying the field of tissue engineering and describes specific strategies to engineer tissues for clinical use along with examples.
Corequisites: BME 3010 or BME 3020 or BME 4010.
Enrollment Information: Enrollment limited to: seniors and graduate students.
Last Four Terms Offered: Fall 2024, Spring 2024, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

BME 5910 - Master of Engineering Research Project - Phase I (2-3 Credits)
Design and economic evaluation of a biomedical engineering device or therapeutic strategy. Team projects are encouraged.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

BME 5911 - BME MEng Design Project Phase I (2 Credits)
The first of two required design courses for the biomedical engineering Master of Engineering program. Teams starting a new project will focus on the identification and ideation phases of a design process. The teams will identify and/or verify unmet healthcare need(s), roughly explore potential concepts, devise the requirements of the technology to be engineered, and implement the first interaction of a conceptual prototype.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

BME 5920 - Master of Engineering Research Project - Phase II (3-4 Credits)
Once a proposal for the project has been approved by the Sponsor or Faculty member, the student must (deliver on time and under budget) produce a tangible work product. Scheduling activities, ordering supplies, assembling, testing the device or procedure, and documenting the work and outcomes are the key expectation for the project.
Prerequisites: BME 5910.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

BME 5921 - Master of Engineering Design Project - Phase II (4 Credits)
This course is the execution phase of your design project. From BME 5500 and BME 5911 your team should have applied Yock's Biodesign process and devised the product requirements of the solution to be engineered during this semester. The objective of the course is the engineering of a fully functional proof-of-concept prototype (product) based on the previously defined and proposed set of requirements.
Prerequisites: BME 5911. Corequisite: BME 5500.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

BME 5930 - Independent Design Project (1-6 Credits)
Graduate-level, non-thesis research or studies on special projects in biomedical engineering.
Corequisites: BME 5910.
Enrollment Information: Enrollment limited to: graduate students.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

BME 5940 - Biomedical Engineering Internship (1 Credit)
Off-campus internship with industry in which a student gains knowledge and experience in the field of biomedical engineering.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

BME 5950 - Special Topics in Biomedical Engineering (1-6 Credits)
Study of topics in biomedical engineering that are more specialized or different from other courses. Special topics depend on staff and student interests.
Last Four Terms Offered: Spring 2025, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

BME 6110 - Stem Cell Bioengineering (3 Credits)
This course explores the interface of stem cell biology and bioengineering and biotechnology and will examine the how quantitative modeling and analysis approaches inform stem cell-based biotechnologies and medical therapies. The course will cover embryonic and adult stem cell biology fundamentals, cell and molecular bioengineering concepts and techniques, biomolecular and genetic therapies to regulate stem cell function, and design of biomimetic and bioreactor environments for stem cell differentiation and derivation. These concepts will be conveyed in a mixture of assigned readings; interactive lectures; quantitative, descriptive, and computational problem sets; primary literature discussions and reviews; quizzes; and a small-team final grant proposal project.
Prerequisites: BME 3010 and BME 3020, or equivalents.
Last Four Terms Offered: Fall 2024, Fall 2021, Fall 2020, Fall 2019
Learning Outcomes:

- To identify key features of adult and pluripotent stem cell systems.
- To summarize molecular and cell engineering techniques to modulate stem cell functions.
- To design bioengineering strategies for enhancing stem cell-based regenerative medicine therapies.
- To analyze scientific publications for critical assessment of research methods, experimental design, and statistical/quantitative outcomes.
- To produce teaching modules on stem cell biology and revise/refine them for real-world dissemination.

Schedule of Classes (https://classes.cornell.edu/)

BME 6120 - Precision and Genomic Medicine (3 Credits)
Genomic medicine is gaining momentum across the entire clinical continuum. This course will provide an introduction to the latest advances in genome research and their impact on medicine. This graduate level course focuses on quantitative engineering principles and precision measurements.The course has a modular structure and tackles a broad range of topics. Course modules will start with a discussion of molecular principles and basic concepts relevant to the module topic, will then proceed with a discussion of contemporary examples and applications, supported by a discussion of recent literature, and will incorporate discussion of relevant computational biology concepts. Topics will include:i) Foundational principles of precision medicine, with an introduction to the human genome, a discussion of modern DNA and RNA sequencing technologies, and basic principles of genome analyses;ii) A survey of cancer genomes, and an introduction to precision measurements of the genetic diversity within tumors;iii) Principles of precision diagnostics, a discussion of omics-enabled prenatal testing, organ transplant monitoring and cancer diagnostics. An in-depth discussion of the structure, function and diversity of the circulating genome.iv) Overview of the impact of genomics on Infectious disease. Measurements of viral sequence diversity and the implications for antiviral therapy. Discussion of the concept of viral quasi-species. Brief introduction to the human microbiome, with a focus on measurement principles;v) Gene expression in human tissues. Discussion of recent advances in single-cell genomics, with a focus on technologies and applications;vi) Principles of immune repertoire sequencing;vii) Omics-enabled analyses of the epigenome and the three dimensional structure of the genome.
Last Four Terms Offered: Fall 2024, Fall 2022, Fall 2021, Fall 2019
Schedule of Classes (https://classes.cornell.edu/)

BME 6130 - Advanced Microbiome Engineering (3 Credits)
The human microbiome touches upon every organ system and contributes to a wide range of disorders. Manipulating the human microbiome is becoming a new paradigm of treating disease. These efforts range from modifying the genomes of organisms or the composition of organisms in the gut, developing designer phage or personalized cocktails of organisms, engineering live bacterial biosensors, and bioprospecting within the gut microbiome for bioactive compounds. In this course, we will discuss new engineering tools and techniques for achieving new diagnostic or therapeutic outcomes. The course will be heavily based on reviewing recently published primary articles. Discussions will involve topics related to molecular and tissue engineering, and systems and synthetic biology.
Enrollment Information: Primarily for: Ph.D. students.
Last Four Terms Offered: Fall 2024, Fall 2022, Fall 2020, Fall 2019
Schedule of Classes (https://classes.cornell.edu/)

BME 6180 - Principles of Magnetic Resonance Imaging (3 Credits)
Crosslisted with VETCS 6180, ECE 6695
After a brief overview of all major medical modalities: x-ray, CT, MRI, SPECT/PET, and US, this course will focus on the formulations of spatial encoding and image contrasts as exemplified in MRI. The inverse problem between detected signal and image source will be discussed for biomedical applications. The concepts of image resolution, image contrast, SNR, and scan time will be illustrated quantitatively from an engineering point of view.
Prerequisites: functional knowledge and skills of linear algebra, calculus based physics, and knowledge of Fourier transformation.
Last Four Terms Offered: Fall 2023, Fall 2021, Fall 2020, Fall 2019
Schedule of Classes (https://classes.cornell.edu/)

BME 6210 - Engineering Principles for Drug Delivery (3 Credits)
Crosslisted with CHEME 6310
Application of engineering design principles to problems in drug formulation and delivery. Specific topics include traditional drug formulation, mechanisms and kinetics of pharmaceutical stability, stimuli-sensitive systems, controlled-release devices, prodrugs, targeted drug delivery, transdermal drug delivery, biomaterials, and gene therapy.
Prerequisites: background in organic and polymer chemistry or permission of instructor.
Enrollment Information: Enrollment limited to: graduate or professional students only.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

BME 6220 - Discussions on Current Topics in Biomaterials (3 Credits)
Last Four Terms Offered: Spring 2021
Schedule of Classes (https://classes.cornell.edu/)

BME 6230 - Cancer and Immuno-Engineering (3 Credits)
Cancer and immunology had been investigated separately for a long time. Recently, they have become connected to each other as we appreciated the roles of immunity in cancer formation, progression, and treatment. As cancer immunotherapies are emerging, understanding of cancer and immunity in deeper manners as a separate topic is required, but also, the abilities to combine both topics in physiologically relevant contexts and relevant knowledge in bioengineering approaches (biomaterials, drug delivery systems, tissue engineering) are needed to be able to solve the multifactorial disease. In this course, we will discuss the topics in Cancer Engineering (module 1); Immune Engineering (module 2); and Cancer Immunotherapy (module 3). In each module, critical biological concepts will be discussed, followed by engineering perspectives, and updated case studies from experts in the cancer and immune-engineering field.
Enrollment Information: Enrollment limited to: graduate students.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Learning Outcomes:
- Students will be able to recognize the importance of the key biological and engineering concepts in cancer, immunity, and cancer immunotherapy.
- Students will be able to explain molecular components and mechanisms by which cancer cells and immune cells respond to their environments.
- Students will be able to identify suitable engineering tools and approaches (biomaterials, drug delivery, tissue engineering) to investigate cancer immunotherapy and interpret representative experimental data.

Schedule of Classes (https://classes.cornell.edu/)

BME 6260 - Optical Microscopy and Fluorescence Methods for Research (3 Credits)
BME 6260 covers the fundamental optics, photophysics, spectroscopy and instrumentation required for understanding how to apply all modes of modern fluorescence microscopy, bioanalytical methods and single molecule fluorescence techniques for biomedical research and diagnostics. Material covered includes:(1) Theory and practical application of lenses, mirrors, dispersive elements, light sources, optical fibers, detectors, interference, nonlinear optical concepts and tissue optics.(2) Optical systems analysis concepts such as resolution, optical transfer functions, Fourier optics and convolution.(3) Photophysical analysis, such as photochemistry and photon statistics. (4) Both a lecture based and lab module based survey of the types of light microscopy and fluoresce methodologies used in modern biomedical research. The lab modules provide the students with hands-on experience with all forms of light microscopy now used in biological and biomedical research.
Prerequisites: physics, biology and calculus.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BME 6320 - Modern Biomedical Microscopy (3 Credits)
Current trends in the development of novel techniques for imaging cells and tissues. This course will emphasize both fundamentals as well as emerging applications to discovery-based biological studies or clinical disease diagnosis/management.
Prerequisites: PHYS 2213 or PHYS 2217, MATH 2930, CHEM 3880 or equivalents or permission of instructor.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BME 6330 - Optical Tools for Studying Living Systems (3 Credits)
Light is an ideal way to interrogate physiology because it is relatively non-invasive yet versatile. This course will cover optical methods used in the study of cells and in vivo animal imaging including twophoton microscopy, super-resolution microscopy, optogenetics, the use of indicators and labels, calcium and voltage-sensitive indicator imaging, and bioluminescence. These methods will be studied from an optical, technical perspective as well as in the context of biology and physiology studies. Students are expected to have a basic understanding of imaging as well as physiology. Some experience with Matlab or any programming language will be helpful.
Prerequisites: CS 1112 or equivalent.
Enrollment Information: Enrollment limited to: graduate students.
Last Four Terms Offered: Spring 2025, Spring 2024, Fall 2022, Fall 2020
Schedule of Classes (https://classes.cornell.edu/)

BME 6350 - Introduction to Neurotechnology (3 Credits)
This course provides a survey of the latest technologies for recording and controlling brain activity. The class has three parts. Part I consists of lectures to introduce the relevant concepts in neurobiology. Part II, in seminar format, discusses approaches to read out neural signals, such as large-scale electrophysiology and optical imaging. Part III, in seminar format, focuses on approaches to modify neural dynamics, including electrical, optical, and viral strategies. Emphases will be placed on how the technologies may be integrated into brain machine interfaces, and what promise they have for treating brain disorders. The course assumes no background in neuroscience. It is intended for engineers who want to know more about neural engineering and neurobiologists who are interested in the latest methods.
Last Four Terms Offered: Fall 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

BME 6410 - Cell and Molecular Mechanobiology (3 Credits)
Mechanobiology describes how cells and tissues sense and respond to their physical environment. Examples range from muscle cells growing in response to exercise, bones adapting to mechanical load, and mechanical forces modulating immune cell function to the distribution of fluid shear stress determining the sites of atherosclerosis or tissue stiffness promoting the risk of cancer. This course will introduce examples of mechanobiology in physiology and disease, explain the cell and molecular components involved in mechanosensing and the cell/tissue response to mechanical stimuli, highlight experimental tools and approaches to study mechanobiology at the cell, molecular, and tissue level, analyze representative data of mechanobiology experiments, and discuss current limitations and engineering challenges to advance to field.
Prerequisites: BIOMG 1350 or equivalent, BME 3010 and BME 3020 or equivalents.
Last Four Terms Offered: Spring 2025, Spring 2022
Learning Outcomes:

- Students will be able to recognize the importance of the mechanical inputs on cellular function in physiological and pathological conditions.
- Students will be able to explain molecular components and mechanisms by which cells sense and respond to their mechanical environment.
- Students will be able to identify suitable experimental approaches to study mechanobiology and interpret representative experimental data.

Schedule of Classes (https://classes.cornell.edu/)

BME 6501 - Natural Engineering: Developmental Biology Paradigms for Regenerative Medicine (3 Credits)
Crosslisted with VTBMS 6501
This course is in two modules. The first module (1 credit) identifies fundamental biophysical mechanisms and systems engineering of early embryonic development (cleavage, gastrulation) and axis patterning. The second module (2 credits) extends these fundamentals to fetal maturation of several major organ systems, including lung, heart, vascular, and bone from an engineer's perspective (evolutionary conservation, major signaling pathways involved, etc). We further identify relationships between developmental biology and postnatal diseases, as well as explore developmental biology-based approaches for regenerative medicine (directed stem cell differentiation, mechanical conditioning, matrix based differentiation, etc.). Material is drawn largely from primary literature. Students have regular manuscript reviews, two midterms, and a final project analyzing the natural engineering of a different organ system.
Enrollment Information: Enrollment limited to: graduate students.
Last Four Terms Offered: Spring 2025, Spring 2023, Fall 2020, Fall 2018
Schedule of Classes (https://classes.cornell.edu/)

BME 6650 - Principles of Tissue Engineering (3 Credits)
Crosslisted with MSE 6650, MAE 6650
Covers introductory concepts in tissue engineering, including polymeric biomaterials used for scaffolds, mechanisms of cellbiomaterial interaction, biocompatibility and foreign body response, cell engineering, and tissue biomechanics. This knowledge is applied to engineering of several bodysystems, including the musculoskeletal system, cardiovascular tissues, the nervous system, and artificial organs. These topics are discussed in the context of scale-up, manufacturing, and regulatory issues.
Enrollment Information: Enrollment limited to: graduate students or permission of instructor.
Last Four Terms Offered: Spring 2025, Spring 2023, Spring 2017, Spring 2015
Schedule of Classes (https://classes.cornell.edu/)

BME 6680 - Cancer for Engineers and Physicists (3 Credits)
Crosslisted with MAE 6680
Introduction to clinical and biological aspects of cancer, organized primarily for a physical science and engineering audience that is interested in the topic but not necessarily steeped in biological training. Stress on description of current understanding and current clinical practice but not the history and process that has led to that understanding. In addition to the biological and medical aspects of cancer, engineering/chemistry/physics aspects of the process e.g., transport, reaction rates, tumor growth models will be discussed at a quantitative level when relevant to system-level understanding of cancer. Topics: Nature and hallmarks of cancer. Introductory human cell biology and modes of dysregulation by carcinogenesis. Cell cycle, aberrant mitogens, dysregulation of checkpoints. Framework and notation for describing reaction networks. Genetic foundations of cancer phenotype--germline and somatic. Tumorigenesis and metastasis. Clinical staging and medical management of the most common human cancers, including breast, prostate, lung, pancreas, colon, leukemia, lymphoma. Information on the course is summarized at blogs.cornell.edu/cancerforengineers.
Enrollment Information: Enrollment limited to: graduate students.
Last Four Terms Offered: Spring 2020, Spring 2018, Spring 2017, Spring 2015
Schedule of Classes (https://classes.cornell.edu/)

BME 7010 - Biomedical Engineering Ph.D Seminar (1 Credit)
An ongoing orientation and mentoring seminar for first-year Ph.D. students that includes research presentations by faculty and students as well as discussions and assignments on such topics as academic ethics, writing technical papers, and publishing.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

BME 7020 - Biomedical Engineering Research Seminar (1 Credit)
Designed to train graduate students in public presentation of scientific data. Students in their third year and beyond are required to give an annual seminar on their research; all students are required to attend the seminars and to provide constructive feedback to others on the quality of their presentation and data.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

BME 7030 - Graduate Student Teaching Experience (1-4 Credits)
Guided individual experience in laboratory instruction and/or lectures/recitation instruction. Provides a preparatory teaching experience for graduate students considering an academic career.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

BME 7130 - Core Concepts in Disease (3 Credits)
Most diseases emerge due to a relative small number of biological effects, including mechanisms like infection, inflammation, neoplasia, genetic mutation, protein misfolding, and metabolic disregulation. Students learn about disease-state biology by focusing on these broad disease pathways. The course consists of several modules, each focused on one broad class of disease mechanism, and includes both a discussion of the underlying biology of the disease pathway as well as examples of specific diseases that involve those mechanisms. This course complements the training in fundamental normal-state biology students are already receiving by providing a mechanism-centered view of disease development.
Prerequisites: introductory biology.
Enrollment Information: Enrollment limited to: BME Ph.D. students.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BME 7160 - Immersion Experience in Medical Research and Clinical Practice (6 Credits)
Summer immersion at Weill Medical College. Students participate in lectures, rounds, and seminars; observe surgeries; and solve medical problems presented by the staff.
Enrollment Information: Enrollment limited to: BME Ph.D. students.
Exploratory Studies: (CU-CEL)

Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

BME 7900 - Biomedical Engineering Graduate Colloquium (1 Credit)
Research-based seminars. May meet with other seminar series as appropriate.
Enrollment Information: Enrollment limited to: graduate students.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)