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Course Descriptions - Applied Biology and Biomedical Engineering

Applied Biology and Biomedical Engineering Faculty ♦ Ahmed, Anthony, Buckley, Coppinger, Dee, Ingram, Livesay, O'Connor, Rogge, Waite, Weiner, Xu

Applied Biology

AB 101 Essential Biology 4R-OL-4C F,W,S Pre: None

Surveys basic concepts in the biological sciences and describes how new advances related to these concepts affect contemporary society. **Students who have completed AB110, AB120 or AB130 cannot receive credit for taking AB101.**

AB 110 Biology I ♦ Cell Structure and Function 3R-3L-4C F,S Pre: None

Introduces structures, mechanisms, and laboratory techniques in cellular and molecular biology. Discusses biomolecules, bioenergetics, biosynthesis, enzymatic function, genetics, and cellular regulatory systems.

AB 120 Biology II ♦ Comparative Anatomy & Physiology 3R-3L-4C W Pre: AB 110 or instructor consent

The structural and functional relationships between tissues and organ systems are discussed using a comparative approach. The lecture is combined with laboratory exercises and observations, which may require dissection of biological specimens.

AB 130 Biology III ♦ Evolution and Diversity 3R-3L-4C S Pre: AB 120 or instructor consent

Introduces fundamental principles, important applications, and field and laboratory techniques in organismal biology. Discusses mechanisms of evolution, the history of life on earth, biological diversity, and ecology.

AB191 Special Topics in Applied Biology XR-OL-XC Arranged Pre: Consent of instructor

Covers material of mutual interest to students and instructors which cannot be acquired in any other listed AB course.

AB 210 Mendelian and Molecular Genetics 3R-3L-4C F Pre: AB 110 or instructor consent

A discussion of Mendelian genetics including the molecular mechanisms of nuclear and cytoplasmic inheritance. Information flow and control of gene expression are addressed at the molecular level. Basic genetic techniques are covered in both lecture and laboratory.

AB 220 Prokaryotic Cell and Molecular Biology 3R-3L-4C W Pre: AB 110 or instructor consent

Discusses the essential properties of eubacteria and archaea. Bacterial nutrition, growth, genetics and structural and metabolic diversity are discussed in detail. The basics of virology are also addressed. Fundamental laboratory methodologies are also covered.

AB 230 Eukaryotic Cell and Molecular Biology 3R-3L-4C S Pre: AB 110 or instructor consent

Examines the structure and function of various eukaryotic cells. Biomembranes, organelles, the cytoskeleton, energetics, protein sorting, signal transduction and cell interactions are discussed in detail. Essential methods in cell biology are addressed in both lectures and laboratories.

AB 264 Introduction to Environmental Science 4R-OL-4C W Pre: CHEM 111 or CHEM 201 or consent of instructor

This course will introduce students to the broad field of environmental science by examining the biological, chemical, and physical processes that regulate the earth's ecosystems and the effect that anthropogenic activity has in disrupting these components on the local and global scale. A final aspect of the course will discuss sustainable human utilization of natural resources. Cross-listed with CHEM 264.

AB 301, 302 Biology Colloquium 1R-OL-1C F, W Pre: Junior standing

A discussion of selected timely topics and preparation for senior research.

AB 310 Plant Structure & Function 3R-3L-4C S Pre: AB 130 or instructor consent

Surveys the structure, physiology, diversity, evolution, and ecological importance of plants and related groups of organisms.

AB 320 Ecology 3R-3L-4C F Pre: AB 130 or instructor consent

Surveys adaptations of organisms, population dynamics, species interactions, and the structure and function of natural communities and ecosystems.

AB 330 Evolutionary Biology 4R-0L-4C W Pre: AB 130 or instructor consent

Surveys three major themes of evolutionary biology: adaptation, diversity of life, and the shared characteristics of life. Mechanisms of evolution, speciation, phylogeny, and macroevolutionary processes are discussed.

AB 340 Introduction to Biomedical Research: Clinical Methodology 1R-1L-1C Pre: AB120, and Jr/Sr standing or consent of instructor

Designed to introduce applied biology/bioengineering students to the basics of biomedical research using the clinical methodology typical of patient sample analysis. Students will learn to relate testing procedures with specific diseases and to use data obtained from laboratory testing to understand more about specific patient health problems.

AB 401 Biology Colloquium 2R-0L-2C W Pre: Senior standing

Oral presentations and discussion of selected timely topics.

AB 410 Infection and Immunity 4R-0L-4C Arranged Pre: AB 110 or consent of instructor

Discussion of various pathogens, how they cause disease, and how they elicit the innate and adaptive immune responses employed to combat them. Cellular and molecular mechanisms of immunity are addressed, as is the epidemiology of various human diseases.

AB 411 Genetic Engineering 4R-0L-4C Arranged Pre: AB 210 or consent of instructor

Discusses the basics of molecular biology and the genetic and molecular techniques used to engineer prokaryotic and eukaryotic cells, plants, and animals for the production of useful traits or compounds. The application of DNA technology to the diagnosis and treatment of disease is also addressed.

AB 421 Applied Microbiology 4R-0L-4C Arranged Pre: AB110 or consent of instructor

Discusses the fundamental biology of microprobes and the processes underlying their use in the production of chemicals, therapeutics and foods. The basics of microbial ecology and the environmental applications of microbial biotechnology are also discussed.

AB 431 Genomics and Proteomics 4R-0L-4C S Pre: AB210 or consent of instructor

Exploration of the methodologies used to generate systems-level sets of genetic and protein data, and the tools used to access and analyze the prodigious amounts of data emerging from such projects. The application of these technologies to investigate biological questions and model complex biological systems is also discussed.

AB 441 ♦ Virology 3R-3L-4C Pre: AB110, or consent of instructor

Virology focuses on the study of viruses as well as non-viral entities such as prions and viroids. In this course, students will learn about the structures, genomes, replication strategies, and pathogenic mechanisms of various viruses. Viruses causing diseases of medical and economic importance will be emphasized. In addition, the techniques used to study viruses and the uses of viruses in the treatment of disease will be addressed.

AB 451 ♦ Cancer Biology 4R-0L-4C Pre: AB210, or consent of instructor

This course focuses on cancer at the molecular and cellular level. Specific cellular molecules and the changes to these cellular molecules that contribute to transformational and immortalization of cells and tumor progression will be studied. The mechanisms behind these molecular changes, cancer promotion and initiation events, and cancer molecule-specific treatment options will be addressed. In addition, students will study a variety of specific cancer types.

AB 491 Special Topics in Applied Biology XR-0L-XC Arranged Pre: Consent of instructor

Covers upper level material of mutual interest to student and instructor which cannot be acquired in any other listed AB course.

AB492 Directed Study in Applied Biology XR-XL-XC Arranged Pre: Consent of instructor

Covers applied biology material of mutual interest to the student and instructor which

cannot be experienced in any other listed AB course. A student may take between 1-4 credits in any given term, and a maximum of 8 credits of this course are permitted.

AB 499 Senior Thesis Research 0R-12L-4C F, W, S Pre: Senior standing

Laboratory research under the direction of a faculty mentor. Culminates in an oral research presentation and publication of a Senior Thesis.

Biomedical Engineering

BE 100 ♦ Problem Solving in the Biological Sciences and Engineering 3R-3L-4C W Pre: None

This course introduces students to computational tools for solving problems in biology and biomedical engineering. The primary thrust of the course is structured programming in MatLab. In addition, we will explore data description, the proper presentation of data, effective use of spreadsheet tools in data analysis, structured programming, and an introduction to bioinformatics and Working Model.

BE 200 Introduction to Biomedical Engineering 3R-3L-4C S Pre: BE 100 or consent of instructor

An introductory course for biomedical engineering. Includes lectures, demonstrations, hands-on experimentation, and scientific literature readings in the major branches of biomedical engineering. Laboratory experiments are utilized to complement key concepts covered in lecture.

BE 310 Analysis of Physiological Systems I: 3R-3L-4C F Pre: AB120

An analysis of neural, muscular, endocrine, reproductive and digestive physiology from a quantitative, systems-based approach.

BE 317 Design for Biomedical Manufacturing 1R-0L-1C W Pre: EM 104

This BE course is taught in conjunction with ME317, an introductory course that examines the interactions between design and manufacturing from the designer's point of view. Common manufacturing processes will be introduced and design guidelines will be developed for each process. The successful student will leave this class with an appreciation that a designer must consider the method of manufacture during the design process to ensure that a product is functional, economically viable, and safe. Taking ME317 and BE317 will count as a 4 credit BE track elective.

BE 320 Analysis of Physiological Systems II: 3R-3L-4C W Pre: BE310

An analysis of cardiovascular, pulmonary, immune and renal physiology from a quantitative, systems-based approach.

BE 325 Biomedical Fluid Mechanics 3R-3L-4C Pre: EM 301 or CHE 301 or ES 202 or consent of instructor

Includes cardiovascular physiology, Poiseuille flow, pulsatile flow in rigid tubes, pulsatile flow in large arteries, blood flow in the microcirculation, flow and pressure measurement, prosthetic heart valves, prosthetic arteries, dimensional analysis and modeling.

BE 330 ♦ Biomechanics 3R-3L-4C W Pre: ES201, EM203, and BE 200, or consent of instructor

This course introduces students to the various interdisciplinary fields in biomechanics - such as orthopaedic biomechanics, biofluid mechanics, soft tissue mechanics, and the biomechanics of human movement. Specific topics include: statics/dynamics of the human body, kinematics during activity; the analysis of forces and stresses/strains in biological structures under loading; constitutive models for biological materials (e.g. bone, cartilage, tendon/ligament); and the relationship between structure and function in tissues and organs.

BE 340 Biomedical Instrumentation 3R-3L-4C F Pre: BE 200 and ES 203 or consent of instructor

Topics include Circuit analysis, frequency analysis, biomedical transducers, design of biomedical devices, and introduction to imaging techniques.

BE 350 Biocontrol Systems 4R-0L-4C W Pre: ES 205

Systems representation and analysis in the frequency and time domain. Topics include Laplace transforms, modeling of electrical and mechanical systems, stability, steady-state error analysis, root locus design, frequency response analysis, and applications in physiology and medicine.

BE 360 Biomaterials 4R-0L-4C W Pre: BE 200 or consent of instructor

Structure-property relationships for metallic, polymeric, and ceramic biomaterials. Study of the interactions of these materials with the body and factors affecting the selection and design of materials for medical implants and devices.

BE 390 ♦ Principles of Biomedical Engineering Design 1R-3L-2C S**Pre: BE 200**

In this course, junior BE majors are introduced to the engineering design methodology as utilized in biomedical engineering. Students will learn engineering design through completion of a team design project with realistic constraints. This course serves as the entry point for the four-quarter sequence in which students undertake and complete their capstone design project.

BE 410 ♦ Biomedical Engineering Design I 3R-3L-4C F Pre: BE390

This course begins the year-long capstone design project and continues to investigate the process of design in biomedical engineering by having student teams initiate the design process for a relevant problem in biomedical engineering. This includes developing the design problem from a set of client needs, establishing specifications, planning the project, scheduling, efficient use of resources, examining ethics and safety in engineering design, and working within explicit (or implicit) constraints such as social, fiscal, manufacturing, etc. The course culminates with the presentation of the preliminary proposal for the capstone design project in biomedical engineering.

BE 420 ♦ Biomedical Engineering Design II 2R-6L-4C W Pre: BE410

This course is a continuation of BE410 by having student teams implement their design plan. This will include development of a test plan, modifications to the design project as needed, and assessment of design performance relative to initial specifications. This course culminates in the submission of the final design document.

BE 430 ♦ Biomedical Engineering Design III 1R-3L-2C S Pre: BE420

This course is a continuation of BE420 and introduces students to the skills necessary for professional practice in biomedical engineering including project management, review of critical design decisions, mentoring design teams, etc. The biomedical engineering design sequence culminates in the formal oral presentation of the capstone design report.

BE 435 Biomedical Optics 4R-0L-4C W Pre: PH 113, MA 222, and SR/GR standing

Optical techniques for biomedical applications and health care; laser fundamentals, laser interaction with tissues, laser diagnostics and therapy, laser surgery, endoscopy and applications; fiber optics; fiber optic biosensors; microscopes; optics- based clinical applications. Same as OE 435. Students taking BE435/OE435 may not receive credit for BE535/OE535.

BE 482 Bioengineering Statistics 4R-0L-4C Pre: MA 223 or MA 382 and consent of instructor (cross listed with MA 482)

Hypothesis testing and confidence intervals for two means, two proportions, and two variances. Introduction to analysis of variance to include one factor and two factors (with interaction) designs. Presentation of simple linear and multiple linear regression modeling; development of analysis of contingency table to include logistic regression. Presentation of Log odds ratio as well as several non-parametric techniques of hypothesis testing and construction of non-parametric confidence intervals and correlation coefficients. Review of fundamental prerequisite statistics will be included as necessary.

BE 491 Special Topics in Biomedical Engineering XR-0L-XC Arranged Pre: Consent of instructor

Covers upper-level, undergraduate material of mutual interest to student and instructor which cannot be acquired in any other listed undergraduate BE course.

BE492 Directed Study in Biomedical Engineering XR-XL-XC Arranged Pre: Consent of instructor

Covers biomedical engineering material of mutual interest to the student and instructor which cannot be experienced in any other listed BE course. A student may take between 1-4 credits in any given term, and a maximum of 8 credits of this course are permitted.

BE 511 Human Physiology A 3R-3L-4C F Pre: Junior, Senior, Graduate standing or consent of instructor

An analysis of neural, muscular, endocrine, reproductive and digestive physiology from a quantitative, systems-based approach. Both recent and classical journal articles will be discussed in class.

BE 512 Human Physiology B 3R-3L-4C W Pre: Junior, Senior, Graduate standing or consent of instructor

An analysis of cardiovascular, pulmonary, immune and renal physiology from a quantitative, systems-based approach. Both recent and classical journal articles will be discussed in class. (Note: BE511 is not a prerequisite for BE512).

BE 516 Introduction to MEMS: Fabrication and Applications 3R-3L-4C S Pre: JR or SR standing

Properties of silicon wafers, wafer-level processes, surface and bulk micromachining,

thin-film deposition, dry and wet etching, photolithography, process integration, simple actuators. Introduction to microfluidic systems. MEMS application: capacitive accelerometer, cantilever and pressure sensor. Students enrolled in BE516 must do project work on a topic selected by the instructor.

BE 519 Advanced MEMS: Modeling and Packaging 3R-3L-4C F Pre: PH410 or equivalent course

Design process, modeling: analytical and numerical. Actuators; dynamics and thermal issues. Use of software for layout and simulation. Characterization and reliability of MEMS devices. Electrical interfacing and packaging of MEMS. Microsensors, microfluidic systems, applications in engineering, biology, chemistry, and physics. Students enrolled in BE519 must do project work on a topic selected by the instructor.

BE 525 Biomedical Fluid Mechanics 3R-3L-4C Pre: EM 301 or CHE 301 or ES202 or consent of instructor

Includes cardiovascular physiology, Poiseuille flow, pulsatile flow in rigid tubes, pulsatile flow in large arteries, blood flow in the microcirculation, flow and pressure measurement, prosthetic heart valves, prosthetic arteries, dimensional analysis and modeling.

BE 531 Biomechanics II 3R-3L-4C S Pre: BE330 or consent of instructor

Covers statics, dynamics and deformable body mechanics of biological systems. Topics include joint anatomy, muscle physiology, biomechanics of distance running, physiological response to acceleration, mechanics of bone, joint biomechanics and selected topics from current literature. The course includes a lab covering the use of a motion analysis system and force platforms.

BE 534 ♦ Soft Tissue Mechanics 3R-3L-4C S (Even years)

Pre: EM 203 and BE 330, or consent of instructor

This course provides an introduction to the various approaches used in modelling soft tissues, with particular attention paid to those of the musculoskeletal system (e.g. ligament, tendon, cartilage). Particular emphasis will be placed on the theoretical and experimental consequences of the large deformation behavior of these tissues. This course will serve as a ♦Biomechanics♦ track elective.

BE 535/OE 535 Biomedical Optics 4R-0L-4C W Pre: PH 113, MA 222, and SR/GR standing

Optical techniques for biomedical applications and health care; laser fundamentals, laser interaction with tissues, laser diagnostics and therapy, laser surgery, endoscopy and applications; fiber optics; fiber optic biosensors; microscopes; optics-based clinical applications. For graduate credit, students must do additional project work on a topic selected by the instructor. Students taking BE535/OE535 may not receive credit for BE435/OE435.

BE 539 ♦ Multiscale Biomechanics 3R-3L-4C S (Odd years)

Pre: EM 203 and BE 330, or consent of instructor

This course provides a comprehensive exploration/overview of the multiple approaches available for the analysis of multiscale media, beginning from classical approaches in composite theory and moving on to various structure-function and homogenization models. Specific attention will be placed on the application of these ideas to heterogeneous and finite deformation biological tissues (e.g. bone, cartilage, ligament, vessels, etc.). This course will serve as a ♦Biomechanics♦ track elective.

BE 540/PH 540 Biothermodynamics 4R-0L-4C Pre: PH 113, MA 222, and JR/SR/GR standing or consent of instructor

Heat transfer in biological tissue; determination of thermodynamic and transport properties of tissue; clinical applications of heat transfer for diagnosis and therapy. Calculation of the rate of heat production caused by direct absorption of laser light, calculation of thermal damage, and calculation of ablation.

BE 545 Orthopaedic Biomechanics 3R-3L-4C Pre: EM 203 and BE 330 or consent of instructor

This course covers current topics in orthopaedic biomechanics including the application of solid mechanics principles to musculoskeletal activities, orthopaedic implants, and fracture fixation devices. Topics include joint loading; composition and mechanical behavior of orthopaedic tissues; design/analysis of artificial joints and fracture fixation prostheses; osteoporosis and osteoarthritis; and finite element modeling.

BE 550 Research Methods in Biomechanics 3R-3L-4C W Pre: BE 330 or consent of instructor

> Focuses on the wide range of research methods used in the field of biomechanics. Current literature will be reviewed to analyze the advantages and disadvantages of various research methodologies. Topics will vary based on student interests and background, but may include topics such as motion/force analysis, soft tissue and bone mechanics, joint biomechanics, analysis of joint replacements, and

fracture fixation. Laboratory activities will reinforce the lecture topics and students will have the opportunity to investigate a biomechanics research topic in their area of interest.

BE 555 Electrophysiology 3R-3L-4C Pre: Junior, Senior, Graduate standing or consent of instructor

Introduces students to concepts of electrical activity in cells and organs of the body. Topics include: origin of membrane potential, membrane channels, synaptic signaling, recording techniques, gross electrical potentials (e.g. electrocardiogram, electroencephalogram, electromyogram, electroretinogram). Emphasis will be placed on how these signals are used to probe physiological function in the clinic and in the research laboratory.

BE 560: Tissue-Biomaterial Interactions F 4R-0L-4C Pre: BE 360, or consent of instructor

Addresses interactions between living cells/tissues and implant biomaterials, stressing the importance of molecular- and cellular-level phenomena in initiating and propagating clinically relevant tissue- and systemic- level results.

BE 570 Introduction to Tissue Engineering 4R-0L-4C S Pre: Junior, Senior, or Graduate standing or permission of instructor

This course provides a broad overview of the latest developments in the field of tissue engineering. Normal structure and function of tissues and organs such as bone, cartilage, nerve, skin, and liver are discussed. Methods of engineering these tissues, or encouraging healing or regeneration that would not otherwise occur, is the focus of the course. The course takes the format of a graduate seminar, with students taking an active role in presenting material to the class and leading discussions.

BE 590 Thesis Research F,W,S

Credits as assigned: however, not more than 12 credits will be applied toward the requirements of an M.S. degree.

BE 597 Selected Topics for Graduate Students Credits as assigned. Maximum 4 credits per term. F,W,S

The following courses are offered at the Terre Haute Center for Medical Education and may be taken for Rose-Hulman credit. To enroll in these courses RHIT students need permission from the Chairman of the Department of Applied Biology and Biomedical Engineering. BE 623 and BE 624 are typically offered in fall semester and BE 621 and BE 625 are typically offered in spring semester.

BE 621 Microbiology and Immunology (6 cr.)

Lectures, conferences and laboratories covering the immune response as a chemical and cellular Surveillance system; the consequences of activation of the immune system; and viruses, bacteria, fungi and protozoan and metazoan parasites as organisms and as agents of human disease.

BE 623 Gross Anatomy (8 cr.)

An intensive study of the gross structure of the human body accomplished through maximum student participation in the dissection of the human cadaver. Lectures are interpretive and correlative. Audiovisual supplementation is provided.

BE 624 Biochemistry (6 cr.)

The chemistry and reactions of constituents of living matter, including the carbohydrates, lipids, proteins, nucleic acids, vitamins, coenzymes and minerals; the chemistry and regulation of the reactions and processes of whole organisms; endocrinology; enzymology; nutrition; intermediary metabolism; and biochemical mechanisms in selected disease states.

BE 625 Physiology (8 cr.)

The course in human physiology covers, in lectures and laboratories, such topics as circulation, respiration, digestion, endocrinology, heat metabolism, renal physiology, muscle physiology, and neurophysiology.

