Biomedically-Oriented Courses for
Undergraduate Engineering Students at VT

Engineering undergraduate students interested in Biomedical Engineering are encouraged to use the following list as a guideline for choosing courses which may be applicable to their future interests in the Biomedical area. These courses are useful whether you are considering graduate study in BME or simply wanting to fulfill a general interest in the area. Please note that many of these courses carry pre-requisites which may limit eligibility to enroll in them. Students with questions about any of these classes should inquire with the individual departments offering the courses.

Please note that SBES degrees are degrees in engineering, therefore it is expected that students entering the program will have a strong background in the particular engineering major chosen for the undergraduate degree. It is also assumed that all undergraduate engineering programs include sufficient coursework in mathematics. For that reason, math courses are not included in this list. (Non-engineering undergrads should refer to the SBES website for a listing of math background expectations.)

ENGINEERING COURSEWORK

The following is a list of BME-related courses that you may want to consider if you are an undergraduate engineering student. In some cases your department may allow you to take these as technical electives. You may want to see your undergraduate advisor to get help in making appropriate choices.

Chemical Engineering:

CHE 4544 (BSE 4544): PROTEIN SEPARATION ENGINEERING
Concepts, principles and applications of various unit operations used in protein separations. Properties of biological materials, such as cells and proteins, and their influences on process design. Design of processes for protein purification based on the impurities to be eliminated. Concepts and principles of scale-up of unit operations. Case studies in practical protein recovery and purification issues, with a focus on enhanced protein purification by genetic engineering. Protein purification process simulation and optimization using process simulation software. Pre: BSE 3504 or CHE 3144. (3H,3C)

Engineering Science & Mechanics:

ESM 4105-4106: ENGINEERING ANALYSIS OF PHYSIOLOGIC SYSTEMS
Engineering analysis of human physiology. Physiologic systems are treated as engineering systems with emphasis input-output considerations, system interrelationships and engineering analogs. 4105 - Mass and electrolyte transfer, nerves, muscles, renal system. 4106 - cardiovascular mechanics, respiratory system, digestive systems, senses. Pre: 2304, MATH 2214. (3H,3C) 4105: I,II; 4106: digestive systems, senses.

ESM 4204: MUSCULOSKELETAL BIOMECHANICS

ESM 4224: BIODYNAMICS AND CONTROL
Study of human movement dynamics and neuromuscular control of multi-degree-of-freedom systems. Computational simulation of forward-dynamics and state-space linear control of human movement to investigate functional performance and neuromuscular pathology. Pre: 3124, 4204. (3H,3C)
ESM 4234:  MECHANICS OF BIOLOGICAL MATERIALS AND STRUCTURES
Anatomy and physiology of connective tissue. Techniques for determining the mechanical response of biological soft and hard tissues. Includes static, viscoelastic, creep, fatigue, and fracture. Simplified models of biological structures. Creation of geometric models from medical imaging and computational modeling. Specific topics may include bone, cartilage, ligaments, tendon, teeth, and skin. Pre: 3054, (2074 or ME 2004). (3H,3C)

ESM 4304:  HEMODYNAMICS

Industrial Systems Engineering:

ISE 3614:  INTRODUCTION TO HUMAN FACTORS ENGINEERING
Survey of human factors engineering emphasizing the systems approach to workplace and machine design. Discussion of basic human factors research and design methods, visual processes and design methods, selection of statistical techniques for application to human factors data, visual and auditory processes, display and control design and effects of environmental stressors on humans. Pre: STAT 4105. (2H,3L,3C) I,IV.

ISE 3624:  INDUSTRIAL ERGONOMICS
Introduction to ergonomics with an emphasis on people at work. Discussion of ergonomic methods for measurement, assessment, and evaluation, with major topics including manual materials handling, cumulative trauma disorders, environmental stresses, safety, and legal issues. A grade of C- or better required in ISE prerequisite 3014. I,II. Pre: 3014, ESM 2104. (3H,3C)

ISE 4624:  WORK PHYSIOLOGY
Anthropometry, skeletal system, biomechanics, sensorimotor control, muscles, respiration, circulation, metabolism, climate. Ergonomic design of task, equipment, and environment. A grade of C- or better required in prerequisite ISE 3614. Pre: 3614. (3H,3C)

Materials Science & Engineering:

MSE 4574 (ESM 4574):  BIOMATERIALS
Lectures and problems dealing with materials used to mimic/ replace body functions. Topics include basic material types and possible functions, tissue response mechanisms, and considerations for long term usage. Integrated design issues of multicomponent materials design in prosthetic devices for hard and soft tissues are discussed. Must meet prerequisite or have graduate standing in the College of Veterinary Medicine. Pre: 3054. (3H,3C)

Mechanical Engineering:

ME 4754:  IMPACT BIOMECHANICS
Introduction to impact biomechanics. Covers in-depth background of human tolerance to impact loading. Emphasis on the interdisciplinary nature of impact biomechanics. Use of fundamental engineering principles and advanced medical technologies to develop injury prevention measures. Real world examples from automobile safety, military applications, and sport biomechanics. Pre: ESM 2204, ESM 2304. (3H,3C)

LIFE-SCIENCE COURSEWORK

Success in Biomedical Engineering requires a strong background in the life sciences. If you decide to pursue a graduate degree, you will be required to take a number of life science courses. The following list presents some possibilities for choices that would offer a good head-start in this area at the undergraduate level. Again, please see your undergraduate student advisor about using these types of courses as electives for your particular program.
**Biology:**

**BIOL 2405-2406: HUMAN ANATOMY AND PHYSIOLOGY**
Structure and function of the human body for students preparing for professions in the health fields. 2405: cell structure and function, integument, skeleton, muscles, nervous, endocrine, and cardiovascular systems. 2406: immunity, respiratory system, digestive system, metabolism, excretion, reproduction, and development. It is recommended that students take freshman biology before taking this course. Does not count as Biology elective for biology majors/minors. 2405: (3H,3C) 2406: (2H,2C) I,II.

**BIOL 2414: HUMAN ANATOMY AND PHYSIOLOGY LABORATORY**
Structure and function of human body approached through the use of dissectible models, CD ROM dissections, computer simulations, and physiological experiments. Does not count as Biology elective for biology majors/minors. Co: 2406. (3L,1C) II.

**BIOL 2104: CELL AND MOLECULAR BIOLOGY**
Fundamental molecular mechanisms essential for the function of prokaryotic and eukaryotic cells. Topics will include: organization and maintenance of cellular structure, energy production, transcripational regulation, protein synthesis, regulatory pathways, cell-cell interactions and reproduction. Pre: (1005, 1006) or (1105, 1106), (CHEM 1036). (3H,3C) I,II.

**BIOL 3124: CELL PHYSIOLOGY**
Cell structure and metabolism, including enzymes, energy production, photosynthesis, membranes, nerve conduction, muscle contraction, and regulation of cellular activity. Pre: 2104, CHEM 2536. (3H,3C) I,II.

**BIOL 3774: MOLECULAR BIOLOGY**
Advanced study of the molecular biology of prokaryotic and eukaryotic cells, including mechanisms of gene expression and regulation, relative merits of experimental model systems, and practical applications in agriculture and medicine. Pre: 2104 or ALS 3104. (3H,3C) II.

**Biology:**

**BCHM 2024: CONCEPTS OF BIOCHEMISTRY**
Short course in fundamentals of the chemistry of living systems. Introduction to major categories of biochemical substances, metabolic pathways, and principles of biochemical information transfer. (No credit for majors). Pre: CHEM 2514 or CHEM 2535. (3H,3C) II.

**BCHM 3114: BIOCHEMISTRY FOR BIOTECHNOLOGY AND THE LIFE SCIENCES**
Survey presentation of the basic principles of biochemistry as they apply to biotechnology. Topics covered include protein structure, enzymology, cellular organization, and biochemical regulation. Special emphasis will be given to gene structure, transcription, and translation, cellular organization, and cloning, sequencing, modification and expression of recombinant DNA. Examples will be given of agricultural/medical/industrial applications of cellular and molecular biochemical knowledge. Non-majors only. Pre: 3174 or BCHM 4116. (3H,3C) II.

**BCHM 3124: BIOCHEMICAL TECHNIQUES FOR BIOTECHNOLOGY AND THE LIFE SCIENCES**
Survey of basic biochemical laboratory techniques for students interested in biotechnology, genetic engineering, and the modern life sciences. Topics include the use of buffers, spectroscopy, enzyme assays, chromatography, electrophoresis, and immunoassays in the analysis of biological macromolecules. (Non-majors only). Co: 3114. (2H,3L,3C) I.

**BCHM 4115-4116: GENERAL BIOCHEMISTRY**
Metabolism and chemistry of carbohydrates, proteins, lipids, and nucleic acids with emphasis on interactions and comparative aspects of microbial, plant, and animal forms. For students in the biochemistry curriculum and other students interested in a foundation course. (Students are required to have at least a C- in both CHEM 2535 and 2536 to be admitted to BCHM 4115). Pre: CHEM 2536. 4115: (4H,4C) 4116: (3H,3C) I,II.

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Biomedical & Veterinary Sciences:

BMVS 4064: INTRODUCTION TO MEDICAL PHYSIOLOGY
An introductory course to the principles of medical physiology, designed primarily for -- but not limited to -- undergraduate and graduate students majoring in biomedical engineering, and other related engineering and physical sciences majors with little or no formal background in biological sciences. The focus is on basic principles and concepts of physiology with a special emphasis on the interactions of human systems biology in their entirety rather than individual genes and pathways. Not intended for students expecting to major in biology or planning to enter health professional fields. (3H,3C)

BMVS 4054: LABORATORY ANIMAL MANAGEMENT
This course involves a study of the principles of laboratory animal science, providing the student with a basic understanding of the laws and regulations governing the care and use of animals, husbandry and surgery of a variety of lab animal species, and variables which can adversely affect animal research. Through formal lectures, discussions, and laboratory sessions, the course is designed to complement graduate studies in biological, biomedical, and life sciences which involve the use of animals in research. (2H,3L,3C) (approved for graduate credit)

BMVS 4074: PHARMACOLOGY
A basic course in the science of pharmacology, intended to provide an understanding of the mechanisms of action and physiological systemic effects of major classes of drugs of biological, agricultural, social, and medical importance. Must have prerequisites or equivalent. Pre: CHEM 2514 or CHEM 2535 or ALS 2304 or BIOL 2406. (3H,3C) (approved for graduate credit)

BMVS 4084 (VM 9204): MEDICAL TOXICOLOGY
Adverse health effects of exposure to drugs or substances of abuse. Covers principles of toxicodynamics, toxicokinetics, biotransformation, diagnosis and treatment. Emphasis will be placed on mechanism(s) of action of the various drug classes, body system(s) affected, clinical manifestations of problems and the resulting adverse effects on human health and society. Methods of treatment and client education will also be addressed. Laws controlling and governing the use of these drugs/substances and the agencies responsible for them will also be covered. Pre: third year standing in DVM curriculum. Pre: (CHEM 2514 or CHEM 2535), (BIOL 2406 or ALS 2304), (MATH 1015). (2H,2C) (approved for graduate credit)

Human Food, Nutrition & Exercise:

HNFE 3804: EXERCISE PHYSIOLOGY
Effects of exercise on physiology: neuromuscular, metabolic, cardiopulmonary. Scientific basis of physical training. Pre: BIOL 2405, BIOL 2406. (3H,3C) I.

HNFE 3824: KINESIOLOGY
The anatomical and biomechanical basis of human motion, with applications for motor skill acquisition, and development and rehabilitative exercises. Pre: BIOL 2406, PHYS 2205. (3H,3C) I.

HNFE 4844: EXERCISE AND NEUROMUSCULAR PERFORMANCE
Functional properties of the neuromuscular system. Emphasis placed on the acute and chronic responses of muscle in exercise, rehabilitation and the factors which determine human performance. Special emphasis on the molecular biological factors responsible for skeletal muscle development and differentiation, as well as adaptation to training and disease states, including activation of signal cascades responsible for the changes in muscle performance. Pre: 3804. (3H,3C) II.

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