

**831 Physiological Biochemistry**  
Spring & even years. 4(4-0) P:NM: BMB 401 or BMB 462. SA: BCH 831

Mammalian physiological biochemistry. Metabolic interpretation of normal and altered physiological states of humans and other mammals.

**855 Special Problems**

Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. R: Approval of department. SA: BCH 855

Laboratory or library research on special problems in biochemistry.

**856 Plant Molecular Biology**

Spring. 3(3-0) Interdepartmental with Botany and Plant Pathology. Administered by Department of Botany and Plant Pathology. P:NM: (ZOL 341)

Recent advances in genetics and molecular biology of higher plants.

**864 Plant Biochemistry**

Spring. 3(3-0) Interdepartmental with Botany and Plant Pathology. P:NM: BMB 401 or BMB 462. SA: BCH 864

Biochemistry unique to photosynthetic organisms. Photosynthetic and respiratory electron transport, nitrogen fixation, carbon dioxide fixation, lipid metabolism, carbon partitioning, cell walls, biosynthesis of plant hormones.

**888 Laboratory Rotation**

Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 12 credits in all enrollments for this course. R: Open only to graduate students in Biochemistry. SA: BCH 888

Participation in research laboratories to learn experimental techniques and approaches, broaden research experience, and assess research interests prior to selecting a thesis or dissertation adviser.

**899 Master's Thesis Research**

Fall, Spring, Summer. 1 to 12 credits. A student may earn a maximum of 24 credits in all enrollments for this course. R: Open only to master's students in Biochemistry. SA: BCH 899

Master's thesis research.

**960 Selected Topics in Biochemistry I**

Fall, Spring. 1 to 2 credits. A student may earn a maximum of 7 credits in all enrollments for this course. R: Open only to graduate students in Biochemistry or approval of department. SA: BCH 960

Contemporary biochemical research topics in such areas as biochemical genetics, biochemistry of development, biochemical evolution, complex proteins, or lipid metabolism.

**961 Selected Topics in Biochemistry II**

Fall, Spring. 1 to 3 credits. A student may earn a maximum of 7 credits in all enrollments for this course. R: Open only to graduate students in the Department of Biochemistry. SA: BCH 961

Contemporary biochemical research topics in such areas as bioenergetics, bioinstrumentation, complex carbohydrates, mass spectrometry, biomolecular spectroscopy or computer-based modeling and analysis of DNA and protein sequences and structures.

**978 Seminar in Biochemistry**

Fall, Spring. 1(1-0) A student may earn a maximum of 8 credits in all enrollments for this course. R: Open only to graduate students in Biochemistry. SA: BCH 978

Seminars on biochemistry research mainly with visiting scientists.

**999 Doctoral Dissertation Research**

Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 99 credits in all enrollments for this course. R: Open only to doctoral students in Biochemistry. SA: BCH 999

Doctoral dissertation research.

## BIOLOGICAL SCIENCE

BS

### College of Natural Science

**110 Organisms and Populations**

Fall, Spring. 4(3-3) Not open to students with credit in LBS 144 or LBS 148H.

Biological diversity and organismal biology. Principles of evolution, population biology, and community structure.

**111 Cells and Molecules**

Fall, Spring, Summer. 3(3-0) P:M: (CEM 141 or CEM 151 or LBS 171 or CEM 181H) Not open to students with credit in LBS 145 or LBS 149H.

Macromolecular synthesis; energy metabolism; molecular aspects of development; principles of genetics.

**111L Cell and Molecular Biology Laboratory**

Fall, Spring, Summer. 2(1-3) Interdepartmental with Microbiology and Molecular Genetics; Botany and Plant Pathology; Zoology. P:M: (BS111 or concurrently) Not open to students with credit in LBS 159H.

Principles and applications of common techniques used in cell and molecular biology.

**148H Honors Organismal Biology**

Fall. 3(3-0) Interdepartmental with Lyman Briggs School. Administered by Lyman Briggs School. R: Honors College student or approval of school. Not open to students with credit in BS 110 or LBS 144.

Diversity and basic properties of organisms, with emphasis on genetic principles, ecological interactions, and the evolutionary process. Historical approach to knowledge discovery.

**149H Honors Cell and Molecular Biology**

Spring. 3(3-0) Interdepartmental with Lyman Briggs School. Administered by Lyman Briggs School. P:M: (CEM 141 or concurrently or CEM 151 or concurrently or CEM 181H or concurrently or LBS 171 or concurrently) R: Honors College student or approval of school. Not open to students with credit in BS 111 or LBS 145.

Exploration of the physicochemical and molecular organization of cells as the unifying framework for genetics, evolution, and the social relevance of biology.

**158H Honors Organismal Biology Laboratory**

Fall. 2(1-3) Interdepartmental with Lyman Briggs School. Administered by Lyman Briggs School. Not open to students with credit in BS 110 or LBS 144. C: LBS 148H concurrently.

Basic procedures used by organismal biologists, including experimental design and statistical methods. Development and implementation of research projects to test hypotheses in genetics, ecology, and evolution.

**159H Honors Cell and Molecular Biology Laboratory**

Spring. 2(1-3) Interdepartmental with Lyman Briggs School. Administered by Lyman Briggs School. Not open to students with credit in BS 111L or LBS 145. C: LBS 149H concurrently.

Basic techniques of cellular and molecular biology including experimental design and hypothesis formulation. Student-initiated projects to test hypothesis-driven projects in biochemistry, molecular biology or genetics.

## BIOMEDICAL ENGINEERING

BME

### Department of Materials Science and Mechanics College of Engineering

**424 Biomaterials and Biocompatibility**

Spring of even years. 3(3-0) Interdepartmental with Materials Science and Mechanics. Administered by Department of Materials Science and Mechanics. P:M: (PSL 250 and MSM 250)

Materials science of human implants. Design requirements imposed by the body's milieu and the need to protect the body.

**441 Tissue Mechanics**

Spring of odd years. 3(3-0) Interdepartmental with Materials Science and Mechanics. Administered by Department of Materials Science and Mechanics. P:M: (MSM 211)

Application of solid mechanics to understanding mechanical responses of biological tissues. Microstructure and biological function for soft and hard connective tissues and muscle.

**442 Biodynamics**

Fall. 3(2-2) Interdepartmental with Materials Science and Mechanics. Administered by Department of Materials Science and Mechanics. P:M: (MSM 306) R: Open only to students in the Engineering Mechanics major.

Fundamentals of motion analysis of human movement and its application to the study of function and dysfunction of the musculoskeletal system. Solution methods of the inverse dynamics problem.

## Biomedical Engineering–BME

- 445 Biomechanical Design**  
Spring. 3(3-0) Interdepartmental with Materials Science and Mechanics. Administered by Department of Materials Science and Mechanics. R: Open only to juniors or seniors in the College of Engineering. SA: BME 491A

Biomechanical product design with application to people or animals. Synthesis, prototyping, and analysis of designs. Project management. Market research.

- 490 Independent Study (MTC)**  
Fall, Spring. 3 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course. R: Approval of department.

Individualized reading and research in biomedical engineering or bioengineering such as clinical biomechanics, biomaterials, tissue biomechanics, etc.

- 491 Special Topics (MTC)**  
Fall, Spring. 3 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course.

Special topics in biomedical engineering or bioengineering such as biochemical design, occupational biomechanics, biological surface science, or low temperature biotechnology.

- 331 Machinery Principles in Biosystems Engineering**  
Fall. 3(3-0) P:M: (MTH 235 or MTH 255H or LBS 220) and (MSM 206 or MSM 211 or concurrently) and (CE 321) RB: Upper division standing in the College of Engineering

Functional processes of machines used in biosystems engineering, including pumping, blowing, conveying, mixing separation, atomization, size reduction and mobility. Power requirements, efficiency and failure modes

- 333 Biosystems Engineering Laboratory**  
Fall. 1(0-3) P:M: (BS 110 or BS 111 or BOT 105 or ENT 205 or MIC 205 or MIC 301 or PSL 250 or ZOL141) R: Open only to students in the Biosystems Engineering major.

Measurement of physical, chemical and biological parameters and properties that characterize engineered biosystems. Data collection and analysis. Experiment design.

- 337 Machinery Systems for Food Processing**  
Spring. 3(3-0) P:M: (BE 230) and (LBS 220 or concurrently or MTH 235 or concurrently or MTH 255H or concurrently) SA: AE 338, FE 338

Principles of design, operation, and performance of equipment for processing raw materials into finished or intermediate products.

- 350 Heat and Mass Transfer in Biosystems**  
Spring. 3(3-0) P:M: (MTH 235 or MTH 255H or LBS 220) and (CSE 131 or LBS 127) and (CE 321 or concurrently or CHE 311 or concurrently or ME 332 or concurrently) P:NM: (CEM 143) Not open to students with credit in ME 410.

Steady state and transient heat conduction. Radiation and convection heat transfer. Heat exchangers. Mass transfer application problems in biosystems engineering.

- 351 Environmental Thermodynamics**  
Fall. 3(3-0) P:M: (MTH 235 or MTH 255H or LBS 220) Not open to students with credit in CHE 321 or ME 201.

First and Second Laws of Thermodynamics with applications in food, biosystems, and environmental engineering. Refrigeration cycles. Entropy. Thermodynamic aspects of fluid flow. Psychrometrics.

- 402 Agricultural Climatology**  
Fall of even years. 3(3-0) Interdepartmental with Geography. Administered by Department of Geography. P:M: (MTH 104 or MTH 110 or MTH 116) R: Not open to freshmen or sophomores. SA: AE 402

Relationships between climate and agriculture in resource assessment, water budget analysis, meteorological hazards, pests, crop-yield modeling, and impacts of global climate change.

- 403 Microclimate and Its Measurement**  
Fall of odd years. 4(3-3) Interdepartmental with Geography. P:M: (MTH 116 or MTH 124 or MTH 132 or LBS 118)

Climate near the earth's surface. Energy balance, thermal radiation exchange, heat fluxes, temperature sensors, wind speed and direction, humidity and evapotranspiration and their measurement.

- 418 Comprehensive Nutrient Management Planning**  
Fall. 3(2-2) Interdepartmental with Animal Science. Administered by Department of Animal Science. P:M: (ANS 110 or BE 230)

Comprehensive nutrient management plans (CNMP) for animal feeding operations. Trends in animal production, environmental issues, and diet formulation and their impact on manure production. Development of CNMP for a specific animal feeding operation.

- 419 Applications of Geographic Information Systems to Natural Resources Management**

Spring. 4(2-4) Interdepartmental with Fisheries and Wildlife; Forestry; Geography; Park, Recreation and Tourism Resources; Resource Development. Administered by Department of Fisheries and Wildlife. P:NM: (GEO 221)

The application of geographic information systems, remote sensing, and global positioning systems to integrated planning and management for fish, wildlife, and related resources.

- 430 Power and Control Hydraulics**  
Fall. 3(2-2) P:M: (CE 321 or CHE 311 or ME 332) SA: AE 430

Hydraulic fluid properties. Pump and motor performance parameters. Control valves and hydraulic circuitry components. Analysis and design of hydraulic systems.

- 431 Resource Optimization**  
Spring. 3(2-2) P:M: (BE 230) and (MTH 235 or MTH 255H or LBS 220) Not open to students with credit in BE 831.

Optimal solutions to problems with multiple and conflicting objectives and constraints. Applications to natural and manufactured biological systems.

- 438 Design of Machinery Structures**  
Fall. 3(3-0) P:M: (MSM 211) SA: AE 438 Not open to students with credit in ME 471.

Design of structural components and systems in machines. Tension, compression, torsion, bending and combined loadings. Joint connections.

- 443 Restoration Ecology**  
Spring. 3(2-2) Interdepartmental with Fisheries and Wildlife; Zoology. Administered by Department of Fisheries and Wildlife. P:NM: (CSS 210 or BE 230) and (FOR 404 or FW 364 or ZOL 355)

Principles of ecological restoration of disturbed or damaged ecosystems. Design, implementation, and presentation of restoration plans. Field trips required.

- 452 Watershed Concepts**  
Fall, Spring, Summer. 3(3-0) Interdepartmental with Resource Development; Crop and Soil Sciences; Forestry; Fisheries and Wildlife. Administered by Department of Resource Development. P:M: (RD 324 and ZOL 355) RB: organic chemistry

Watershed hydrology and management. The hydrologic cycle, water quality, aquatic ecosystems and social systems. Laws and institutions for managing water resources.

## BIOSYSTEMS ENGINEERING

BE

### Department of Agricultural Engineering College of Agriculture and Natural Resources

- 130 Engineering Design Fundamentals for Biological Systems**  
Fall. 2(1-2) P:M: (MTH 132 or concurrently or MTH 114 or concurrently or MTH 116 or concurrently or LBS 117 or concurrently or LBS 118 or concurrently or MTH 152H)

Professional and fundamental methods of biosystems engineering. Basic engineering methods. Analysis and design. Interdisciplinary design.

- 230 Principles of Biosystems Engineering**  
Fall. 3(3-0) P:M: (MTH 132 or MTH 152H or LBS 118)

Concepts of biosystems. Hard and soft systems. Conceptual and computer modeling of components of biosystems.

- 232 Food Production and Processing Systems**  
Fall. 1(0-2)

Crop and animal production systems. Food processing systems. Field trips required.

- 329 Fundamentals of Food Engineering**  
Spring. 3(3-0) Interdepartmental with Food Science. P:M: (FSC 229) and (MTH 126 or LBS 118) and (PHY 231 or LBS 164) P:NM: (FSC 211) SA: FE 329

Unit operations in food industry: fluid mechanics, heat transfer, rate processes, refrigeration, freezing, and dehydration. Thermal process calculations.