460. **Principles of Biochemical Methods**
Spring, 3(3-0) One year of physical chemistry or CEM 354 concurrently, BCH 453 or concurrently, or BCH 451.
Principles of biochemical methods with emphasis on electrophoresis, chromatography, immunological techniques, sedimentation, diffusion, viscometry, radiochemistry, and absorption and emission spectroscopy.

470. **Biological Membranes**
(IDC 470) Spring, 3(3-0) BCH 401. Interdepartmental with the departments of Microbiology and Public Health, and Physiology. Administered by the Department of Physiology.
The chemistry, physics and mathematics of the permeability, energy transductions and surface functions of differentiated cell membranes and membranous organelles are compared. A brief discussion of theoretical and experimental models is included.

499. **Research**
Fall, Winter, Spring, Summer, 1 to 4 credits. May reenroll for a maximum of 12 credits. Undergraduate; approval of department. Participation in research projects.

501. **Medical Biochemistry**
Fall, 3(3-0) Open only to students in the professional programs in the College of Human Medicine and the College of Osteopathic Medicine.
Basic biochemical principles and terminology of importance in medical biology.

502. **Medical Biochemistry**
Winter, 3(3-0) BCH 501 or approval of department.
A continuation of BCH 501.

511. **Medical Biochemistry I**
Winter, 4(4-0) One year of organic chemistry, one year of physical chemistry, and one year of basic biochemistry or BCH 453; or approval of department. A course in fundamental genetics is strongly recommended. Limited to graduate students in biochemistry or other students needing a similar professional preparation.
Organization and expression of procaroytic and eucaryotic genes, including gene structure, regulation of gene expression, replication, and recombination. Molecular cloning, DNA sequencing, and gene transfer techniques.

512. **Medical Biochemistry II**
Spring, 4(4-0) BCH 511.
Basic biochemical principles and processes pertinent to specific areas of human pathophysiology.

513. **Metabolism and Its Regulation**
Spring, 4(4-0) One year of organic chemistry, one year of physical chemistry, and one year of basic biochemistry; or approval of department. Limited to graduate students in biochemistry or other students needing a similar professional preparation.
Molecular basis of metabolic regulation, compartmentation and interrelationships of metabolic cycles involving carbohydrates, proteins and lipids.

810. **Biochemical Mechanisms and Structures**
Fall, 4(4-0) One year of organic chemistry; introductory biochemistry; and physical chemistry concurrently. Structures, methods of structural analysis, synthesis, and reaction mechanisms of biological substances including proteins, carbohydrates, lipids, porphyrins, phospholipid esters, enzymes and coenzymes.

812. **Selected Topics in Biochemistry**
Fall, Winter, Spring, 1 to 3 credits. May reenroll for a maximum of 10 credits if different topics are taken. Approval of department. Topics will be selected from the areas of biochemical genetics, biochemistry of development, biochemical evolution, complex proteins, lipid metabolism, immunobiology, hormones, control mechanisms and structure of biological macromolecules.

815. **Cell Structure and Function**
Winter, 4(4-0) BCH 451 or BCH 401 or approval of instructor. Interdepartmental with the departments of Microbiology and Public Health, and Physiology.
Molecular basis of structure and function of cells. Fundamental properties of cells: reproduction, dynamic organization, integration, programmed and interactive information transfer considered through original investigations in all five kingdoms.

831. **Physiological Biochemistry I**
Winter, 3(3-0) BCH 401.
Physiological biochemistry, with emphasis on metabolic interpretation of normal and altered physiological states of the human organism and appropriate animal models.

832. **Physiological Biochemistry II**
Spring, 3(3-0) BCH 831.
Continuation of BCH 831.

855. **Special Problems**
Fall, Winter, Spring, Summer, 1 to 6 credits. May reenroll for a maximum of 12 credits. Approval of department. Consideration of current problems.

856. **Plant Genetics and Molecular Biology**
Spring of even-numbered years, 3(3-0) Approval of department and a course in introductory genetics. Interdepartmental with Genetics and the Department of Botany and Plant Pathology. Administered by the Department of Botany and Plant Pathology. Recent advances in genetics and molecular biology of higher plants.

864. **Plant Biochemistry**
Spring, 4(4-0) BCH 401, BOT 301 or approval of department. Interdepartmental with the Department of Botany and Plant Pathology.
Metabolism of nitrogen-compounds, carbohydrates, and lipids unique to plants; organelles; photosynthesis; photosynthesis; dark respiration; cell walls; lectins; nitrogen cycle including nitrogen fixation; sulfur cycle.

888. **Laboratory Rotation**
Fall, Winter, Spring, Summer, 1 to 8 credits. May reenroll for a maximum of 18 credits. Graduate students only; approval of department.
Participation in research laboratories to learn experimental techniques and research approaches, broaden research experiences, and assess research interests prior to selecting a thesis adviser.

900. **Master's Thesis Research**
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

960. **Selected Topics in Biochemistry**
Fall, Winter, Spring, 1 to 3 credits. May reenroll for a maximum of 10 credits if different topics are taken. Approval of department. Topics will be selected from the areas of biochemical genetics, biochemistry of development, biochemical evolution, complex proteins, lipid metabolism, immunobiology, hormones, control mechanisms and structure of biological macromolecules.

982. **Seminar in Biochemistry**
Fall, Winter, Spring, 1(1-0). May reenroll for a maximum of 8 credits. Approval of department.

999. **Doctoral Dissertation Research**
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

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**BIOLOGICAL SCIENCE**

**BS College of Natural Science**

The content of courses 400, 405, and 420, as well as the research and problems courses 499, 800 and 899, may vary from term to term. Brochures giving detailed information about individual courses are available in the Office of the Assistant Dean for Lifelong Education in the College of Natural Science. These courses are primarily designed for in-service teachers and interested adults and are offered in off-campus locations.

202. **Introductory Biology for Non-Science Majors**
Fall, Winter, Spring, 4(3-3) 12 credits in general education natural science courses.

210. **General Biology**
Fall, Spring, 4(4-2) Not open to students with credit in LBS 141.
Principles of biological organization: scientific method, biochemistry, cell biology, and evolution.

211. **General Biology**
Fall, Winter, Summer, 4(4-2) CEM 140 or high school chemistry. Not open to students with credit in LBS 492.
Principles of biological regulation and integration: genetics, development, and selected physiological topics.
212. General Biology
Winter, Spring, Summer. 4(4-2) Not open to students with credit in LBS 140.
Principles of biological diversity: taxonomy and systematic, comparative physiology, and ecol-
ygy.

400. Biological Science for Teachers
Fall, Winter, Spring, Summer. 1 to 6 credits. May reenroll for a maximum of 12 credits.
Teacher certification with science major or minor.
A course for in-service teachers, topics will be selected from actual classroom problems of the
participates. Stress will be placed on field, laboratory and inquiry teaching.

405. Topics in Biological Science
Fall, Winter, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 8 credits.
if different topic is taken. Approval of department.
Presentation of single topics from the biological sciences by senior faculty and guest lecturers.
Topics are selected to facilitate development of strong biological science programs in schools.

410. Seminar in Recent Advances in Biological Science
Fall, Winter, Spring, Summer. 1 to 3 credits. May reenroll for a maximum of 6 credits.
if different topic is taken. Approval of department.
A series of lectures by senior faculty on topics on the history, development, the most recent
advances and the possible future and limits of the Biological Sciences.

415. Field Biology for Teachers
Fall, Winter, Spring, Summer. 4 credits. Biology course or approval of department.
Field investigation and interpretation of prairie, dune, forest and wetland communities. An eco-
system approach to ecological concepts. Natural history and identification of key species. Field
trips required.

420. Directed Studies
Fall, Winter, Spring, Summer. 1 to 6 credits. May reenroll for a maximum of 12 credits.
Approval of department.
Individual or group work on special problems related to biomechanics, neuromusculoskeletal
system primarily.

500. Basic Concepts in Biomechanics
Fall, Winter, Spring, Summer. 1 to 8 credits. May reenroll for a maximum of 16 credits.
Approval of department.
Basic concepts of biomechanics and their rela-
tionship to functional anatomy and osteopathic manipulative therapy.

505. Advanced Biomechanics
Fall, Winter, Spring, Summer. 1 to 6 credits. May reenroll for a maximum of 12 credits.
Approval of department.
Advanced study in the diagnosis of muscu-
lósketal dysfunctions and application of osteo-
pathic manipulative techniques in patient care.

590. Special Problems in Biomechanics
Fall, Winter, Spring, Summer. 1 to 8 credits. May reenroll for a maximum of 16 credits.
Approval of department.
Each student will work under direction of a fac-
ulty member on an experimental, theoretical or
applied problem.

595. Special Topos in Biomechanics
Fall, Winter, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 8 credits.
Approval of department.
Independent study in topics of biomechanics.

800. Problems in Biological Science
Fall, Winter, Spring, Summer. 1 to 6 credits. May reenroll for a maximum of 12 credits.
B.S. degree in biological science.

805. Outdoor Environmental Studies
Fall, Winter, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 8 credits.
if different topics are taken. B.S 415 or ZOL 490 or approval of department.
Emphasis on environmental understanding. Development of educational materials through
team research and testing. Trials of materials with elementary, middle, secondary school or
college students.

890. Independent Study
Fall, Winter, Spring, Summer. 1 to 8 credits. May reenroll for a maximum of 16 credits.
Approval of department.
Individual or group work related to biome-
chanics and/or neuromusculoskeletal system.

895. Master's Thesis Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

BIOMEDICAL ENGINEERING

BME 410. Electronic Instrumentation in
Biology and Medicine
Fall. 4(4-0) MTH 112, PHY 238 or
approval of instructor.
Electronic components and circuits. Physiologi-
cal measurements. Transduction of physiological
events to electrical signals. Detection of physiological events by electrical impedance
measurements. Ultrasonic techniques in bio-
medical systems. Biomedical applications of
lasers.

411. Electric Theory of Nerves
Winter of odd-numbered years. 4(4-0)
MTH 310; PHY 285.
Neurophysiology: basic organization, function and electrical activity of neurons. Sub-
threshold membrane phenomena: Nernst-
Planck equations, constant field membrane
model, electromotors. Membrane action po-
tenials: voltage clamp experiments, Hodgkin-Hux-
ley equations, computer simulation.

414. Clinical Instrumentation
Winter of even-numbered years. 3(3-0)
BME 410.
Ultrasound theory and applications in medicine. Photoelectric, piezoelectric and tempera-
ture transducers. Detection of physiological events by impedance measurements. Radiology and x-
ray techniques. Isotopes and nuclear medicine.
Lasers in medicine. Field trips required.

424. Materials in Biomedical
Engineering
Winter. 3(3-0) PSL 240 or PSL 431 or
approval of department.
Basic materials science. Biocompatibility of
metals, polymers and ceramics. Infernal and
external prosthetic materials.

431. Biological Transport Mechanisms
Spring. 3(3-0) MTH 215.
Mechanisms which govern transport or momentum, heat and mass. Application to mathemat-
cal description of transport processes in biological systems and to solution of biomedical
problems.

481. Tissue Biomechanics
Fall. 3(3-0) ANT 316 or approval of
department.
Fundamentals of continuum mechanics in rela-
tion to morphological classification of tissue.
Mechanical properties of connective and muscle
tissue.