953. Plasma Dynamics (Magnetogas Dynamics)
Winter. 3(3-0) 439; PHY 491.
Fundamental equations of hydrodynamics; Maxwell equations; continuum; channel flow; boundary layer; shocks; Alfvén wave propagation; one and two fluid theories; discrete particle approach; plasma oscillations; flow around bodies and in nozzles; space propulsion systems.

954. Ion Flow Dynamics
Spring. 3(3-0) 853.
Continuation of 953 as applied to the ion flow; extension of the neutral flow turbulence into electromagnetic turbulence, and method of characteristics applied to the ion flow dynamics.

999. Research
(EGR 999.) Fall, Winter, Spring, Summer. Variable credit. Approval of department.

MEDICAL TECHNOLOGY M T

College of Human Medicine

College of Osteopathic Medicine

College of Veterinary Medicine

201. Medical Technology
Fall. 1(1-0) Approval of school.
Relationship of medical technology to medicine and research, and the necessary interaction with other paramedical sciences.

401. Seminar in Medical Technology
Fall. 1 credit. Seniors. Acquaints students with the operation and administration of a hospital, the philosophy and understanding of the entire profession of medical technology.

495. Independent Study
Fall, Winter, Spring, Summer. 1 to 3 credits. May re-enroll for a maximum of 6 credits. Approval of department. Independent study including assigned reading and reviews of appropriate scientific periodicals.

MEDICINE MED

College of Human Medicine

512. Infectious Diseases
Fall. 3(3-0) MPH 511, or approval of department. Interdepartmental with and administered by the Microbiology and Public Health Department.
Infectious diseases of man, including biology of the causative microorganism, epidemiology, pathogenesis, host-parasite relationships, clinical and laboratory diagnosis, and clinical management.

590. Special Problems in Medicine
Fall, Winter, Spring. Summer. 1 to 6 credits. May re-enroll for a maximum of 12 credits. Human Medicine students. Each student will work under direction of a staff member on an experimental, theoretical or applied problem.

608. Senior Medical Clerkship
Fall, Winter, Spring, Summer. 1 to 17 credits. May re-enroll for a maximum of 43 credits. Primary clerkship, third year Human Medicine students.

Based in community hospitals, this clerkship will stress interviewing skills, history, physical examination, laboratory, problem solving and therapy, and care of the whole patient leading to independence in patient management.

609. Hematology Clerkship
Fall, Winter, Spring, Summer. 1 to 17 credits. May re-enroll for a maximum of 34 credits. H M 603. Development of skills in data collection, problem solving and management related to common hematologic disorders of children and adults.

610. Oncology Clerkship
Fall, Winter, Spring, Summer. 1 to 17 credits. May re-enroll for a maximum of 34 credits. H M 603. Development of skills in data collection, problem solving and management of the more prevalent cancers in children and adults.

611. Cardiology Clerkship
Fall, Winter, Spring, Summer. 1 to 17 credits. May re-enroll for a maximum of 34 credits. H M 603. A clinical clerkship in which students evaluate in depth patients with cardiac diseases. This includes non-invasive and invasive diagnostic procedures including cardiac catheterisation, photoangiography, echocardiography and electrocardiography.

613. Dermatology Clerkship
Fall, Winter, Spring, Summer. 1 to 17 credits. May re-enroll for a maximum of 34 credits. H M 602. Integrated concepts of renal physiology and pathophysiology of renal disease. Clinical experience.

614. Medical Chest Clerkship
Fall, Winter, Spring, Summer. 1 to 17 credits. May re-enroll for a maximum of 34 credits. H M 602. A clerkship covering four aspects of chest diseases: tuberculosis, diagnosis, pulmonary function, and physiology. The student works with medical residents, utilizing outpatient and hospital facilities.

615. Gastroenterology Clerkship
Fall, Winter, Spring, Summer. 1 to 17 credits. May re-enroll for a maximum of 34 credits. H M 602. Refers patients with gastrointestinal problems are seen as either in- or out-patients. Many long term problems are followed. Patients with psychosomatic problems are seen conjointly with Social Services.

616. Allergy Clerkship
Fall, Winter, Spring, Summer. 1 to 17 credits. May re-enroll for a maximum of 34 credits. H M 602. Office based experience with a dermatologist to learn clinical skills in dermatology and develop observational and diagnostic skills in skin disease.

617. Neurology Clerkship
Fall, Winter, Spring, Summer. 1 to 17 credits. May re-enroll for a maximum of 34 credits. H M 602. A combined office and in-patient experience that will provide the student with an opportunity to learn the concepts of evaluation and management of neurological disease.

METALLURGY, MECHANICS AND MATERIALS SCIENCE MMM

College of Engineering

205. Mechanics I
Fall, Winter, Spring. Summer. 4(4-0) MTH 214 or concurrently. Vector description of forces and moments. Two and three dimensional equilibrium problems, Statics of frames and machines. Friction. Shear and moments in beams and shafts.

206. Mechanics II
Fall, Winter, Spring. Summer. 4(4-0) MTH 215, or concurrently. Dynamics of particles and particle systems. Energy and momentum principles. Two and three dimensional rigid body dynamics.

211. Mechanics of Deformable Solids
Fall, Winter, Spring. Summer. 4(4-0) or 5(4-0) MTH 515. Deformable solids, stress and strain, principal axes, material behavior, static, plastic, visco-elastic, temperature dependent. Boundary value problems, torsion, beams. Instability, columns.

215. Materials Testing Laboratory
Fall, Winter, Spring. 1(0-0) 340. Physical properties of engineering materials, resistance to primary types of static loading.

230. Introduction to Materials Science
Fall. 4(4-0) Sophomores. A qualitative survey of metals, ceramics, and polymers, and the relationship of electronic, molecular, and crystal structure to the physical, mechanical, thermal, electrical and magnetic properties.

320. Analytical Mechanics I
Fall. 3(3-0) MTH 215; PHY 289. Measures of point motion, indicial notation, vector space and time transformations, Newton's, Lagrange's and Hamilton's equations. Motions of point objects; limiting wave forms.

321. Analytical Mechanics II
Fall, Winter. 3(3-0) 320. Schooling's equation. Particle motions in various potentials; hydrogen-like atoms and molecules. Continuum models of particle systems; tensor properties, rigid and elastic solids, transfer of heat and electricity, flow relations.

322. Analytical Mechanics III
Spring. 3(3-0) 321. Quantum and statistical models of particle systems; the Maxwell-Boltzmann, Einstein-Bose and Fermi-Dirac distributions; analysis of ideal atomic, electron and photon gases; properties of dense gases and liquids; thermal, elastic and electrical properties of crystals.

340. Materials Chemistry I
Fall. 4(4-0) CEM 153. An integrated treatment of the physical chemistry of metals and other engineering materials is presented by 340, 341 and 342. Physicochemical systems; thermodynamics and thermodynamics and thermodynamics and equilibrium; solutions and phase equilibrium; electrochemistry; corrosion; reaction kinetics in condensed phases; diffusion; surface phenomena.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Offered</th>
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<tr>
<td>341</td>
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<td>4-4-0</td>
<td>Winter, 340 or approval of department</td>
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<td>Materials Chemistry III</td>
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<td>Fall, 153 or approval of department</td>
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<td>Spring, 360, 361</td>
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<td>370</td>
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<td>Fall, Winter, 4-3-3</td>
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<td>3-3-0</td>
<td>Spring, 371</td>
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<td>400</td>
<td>Special Problems</td>
<td>3-3-0</td>
<td>Fall, Winter, Spring, 1 to 3 credits</td>
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<td>404</td>
<td>Dynamics of Mechanical Systems</td>
<td>3-3-0</td>
<td>Fall, 346</td>
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<td>411</td>
<td>Mechanics of Deformable Solids II</td>
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<td>413</td>
<td>Applied Solid Mechanics</td>
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<td>Winter, 311</td>
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<td>414</td>
<td>Principles and Techniques of Experimental Solid Mechanics</td>
<td>3-3-0</td>
<td>Spring, 211</td>
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<td>430</td>
<td>X-Ray Crystallography</td>
<td>4-2-3</td>
<td>Fall, 342 or approval of department</td>
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<tr>
<td>440</td>
<td>Color and Appearance of Materials</td>
<td>3-3-0</td>
<td>Winter, 346</td>
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<td>455</td>
<td>Advanced Physical Metallurgy I</td>
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<td>Winter, 346</td>
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<td>Advanced Physical Metallurgy II</td>
<td>3-3-0</td>
<td>Spring, 346</td>
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<td>460</td>
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<td>4-3-2</td>
<td>Fall, 342 or approval of department</td>
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<td>Metallurgical Engineering II</td>
<td>4-3-2</td>
<td>Fall, 346</td>
</tr>
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<td>480</td>
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<td>3-3-0</td>
<td>Spring, 346</td>
</tr>
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<td>482</td>
<td>Optical Strain Measurement</td>
<td>3-3-0</td>
<td>Winter, 346</td>
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<tr>
<td>493</td>
<td>Introduction to the Mechanics of a Continuous Medium</td>
<td>3-3-0</td>
<td>Fall, Summer, 4-4-0</td>
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<tr>
<td>513</td>
<td>Theory of Elasticity</td>
<td>4-4-0</td>
<td>Winter, 346</td>
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</table>

**Courses: 361, 413, and 414**

- Theoretical study of solution of problems in elasticity, plasticity, and viscoelasticity. Emphasis on the important heterogeneous systems, cold work, recrystallization, and grain growth. Emphasis on the important commercial metals and alloys.

- Continuation of 381. Physical Metallurgy Laboratory. A broad study of the physical metallurgy of alloys. Emphasis on the important heterogeneous systems, cold work, recrystallization, and grain growth. Emphasis on the important commercial metals and alloys.

- Continuation of 381. Physical Metallurgy Laboratory II. Continuation of the study of physical metallurgy. Emphasis on the important heterogeneous systems, cold work, recrystallization, and grain growth. Emphasis on the important commercial metals and alloys.


- Principles and Techniques of Experimental Solid Mechanics. Continuation of the study of physical metallurgy. Emphasis on the important heterogeneous systems, cold work, recrystallization, and grain growth. Emphasis on the important commercial metals and alloys.

- X-Ray Crystallography. Continuation of the study of physical metallurgy. Emphasis on the important heterogeneous systems, cold work, recrystallization, and grain growth. Emphasis on the important commercial metals and alloys.

- Color and Appearance of Materials. Continuation of the study of physical metallurgy. Emphasis on the important heterogeneous systems, cold work, recrystallization, and grain growth. Emphasis on the important commercial metals and alloys.

- Advanced Physical Metallurgy I. Continuation of the study of physical metallurgy. Emphasis on the important heterogeneous systems, cold work, recrystallization, and grain growth. Emphasis on the important commercial metals and alloys.

- Advanced Physical Metallurgy II. Continuation of the study of physical metallurgy. Emphasis on the important heterogeneous systems, cold work, recrystallization, and grain growth. Emphasis on the important commercial metals and alloys.

- Metallurgical Engineering I. Continuation of the study of physical metallurgy. Emphasis on the important heterogeneous systems, cold work, recrystallization, and grain growth. Emphasis on the important commercial metals and alloys.

- Metallurgical Engineering II. Continuation of the study of physical metallurgy. Emphasis on the important heterogeneous systems, cold work, recrystallization, and grain growth. Emphasis on the important commercial metals and alloys.

- Strain and Motion Measurement. Continuation of the study of physical metallurgy. Emphasis on the important heterogeneous systems, cold work, recrystallization, and grain growth. Emphasis on the important commercial metals and alloys.

- Optical Strain Measurement. Continuation of the study of physical metallurgy. Emphasis on the important heterogeneous systems, cold work, recrystallization, and grain growth. Emphasis on the important commercial metals and alloys.

- Introduction to the Mechanics of a Continuous Medium. Continuation of the study of physical metallurgy. Emphasis on the important heterogeneous systems, cold work, recrystallization, and grain growth. Emphasis on the important commercial metals and alloys.

- Theory of Elasticity. Continuation of the study of physical metallurgy. Emphasis on the important heterogeneous systems, cold work, recrystallization, and grain growth. Emphasis on the important commercial metals and alloys.
815. Advanced Strength of Materials I
Fall, Winter, 3(3-0) 211.
Elasticity, energy methods, general bending of straight bars, curved beams, shear center, torsion.

816. Advanced Strength of Materials II
Winter, 3(3-0) 315; MTH 215.
Beams on elastic support, beam columns, axially symmetric stress distribution, symmetrical bending of circular plates, introduction to theory of elasticity.

817. Plasticity
Spring, 4(4-0) 810; MTH 422 or approval of department.
Yield conditions, stress-strain relations, plastic under internal pressure; plane strain of perfectly plastic material.

823. Theory of Vibrations I
Fall, 4(4-0) M E 455. Interdepartmental with Civil Engineering Department.
Discrete and continuous system parameters with linear and non-linear characteristics. Variational principles; equations of motion. Matrices, quadratic forms; self-adjoint operators; eigenvalues. Transient and random excitations. Theory developed through physical problems.

831. Advanced X-Ray Metallurgy
Winter, 2(3-0) Approval of department.
Development of crystallographic space groups, treatment of the intensity of diffracted X-rays; Weissenberg method, crystal structure analysis.

832. Electron Microscopy
Spring, 4(3-0) 831 or approval of department.
Theory of image formation in electron microscopy and intensity of electron diffraction. Transmission and replica microscopy.

835. Orthopedic Biomechanics
Fall, 3(3-0) Approval of department.
Basic theories of mechanics with application to orthopedics. Elastic and viscoelastic materials will be considered and experimental demonstrations of tissue response.

840. Symmetry and the Properties of Crystals
Spring, 3(3-0)
Point-group theory and symmetry in tensor properties of crystals; systematic treatment of properties, e.g., electrical polarization, magnetic induction, pyro- and piezoelectricity, elasticity, transport properties and rheology.

850. Modern Ceramic Materials I
Fall, 3(3-0) CEM 463, PHY 440, or approval of department.
Crystalline microstructure and microstructure of ceramics and glasses; dependence of microstructure on amounts, size, shape, and distribution of phases; modification of microstructure by control of nucleation and growth; composite materials.

851. Modern Ceramic Materials II
Winter, 3(3-0) 390.
Properties of ceramic materials with specific reference to mechanical, optical, electrical, magnetic and thermal properties.

852. Modern Ceramic Materials III
Spring, 3(3-0) 391.
Applications of ceramic materials. Glasses, ceramic, nuclear fuel elements, hot-pressed transparent oxides, pre-stressed ceramics, ceramic coatings, pyrolytic materials.

860. Theoretical Metallurgy I
Fall, 3(3-0) 342.
Metallurgical thermodynamics, introduction to statistical thermodynamics, kinetics of metallurgical processes.

861. Theoretical Metallurgy II
Winter, 3(3-0) 360.
Introduction to quantum theory of metals, physical properties of metals and alloys.

862. Theoretical Metallurgy III
Spring, 3(3-0) 361.
Imperfection in crystalline solids, dislocation theory and mechanical properties of metals and alloys.

870. Ferrous Physical Metallurgy
Fall, 3(3-0) 342, 362.
Theory of steel hardening and hardenability from nucleation, growth, and shear considerations.

871. Nonferrous Physical Metallurgy
Winter, 3(3-0) 342, 361.
Binary, ternary and complex alloy systems, shear mechanism, recrystallization and grain growth, age hardening, and other diffusion mechanisms.

872. Physical Metallurgy of Alloy Steels
Spring, 3(3-0) 870, 871.
Steel for extreme service conditions.

875. Ferrous Metallurgy
Fall, 3(3-0) 462.
Stechiometric material and heat balance calculations of the blast furnace, open hearth and electric furnace processes.

876. Nonferrous Process Metallurgy
Winter, 3(3-0) 462.
Stechiometric material and heat balance calculation in nonferrous extractive metallurgy.

880. Metals and Alloys I
Fall, 3(3-0) 372.
Topics in engineering properties and application of wrought steels for engineers other than metallurgical.

881. Metals and Alloys II
Winter, 3(3-0) 372.
Similar to 845, but with reference to nonferrous alloys.

882. Metals and Alloys III
Spring, 3(3-0) 372.
Similar to 845, but with reference to cast alloys.

885. Seminar
Fall, Winter, Spring, 1 credit. 889 concurrently.

890. Selected Topics
Fall, Winter, Spring, Summer, 3(3-0) May re-enroll for a maximum of 16 credits if a different topic is taken. Approval of department.
A newly developing area in metallurgy, mechanics, or materials science selected by the department for offering each term. Information on the specific topic to be covered should be obtained from the department office before registration.

899. Research
(EGR 899.) Fall, Winter, Spring, Summer. Variable credit. Approval of department.

900. Special Problems
Fall, Winter, Spring, Summer. 1 to 6 credits. May re-enroll for a maximum of 6 credits. Approval of department.
Individualized reading and research compatible with the student's interest and ability.

901. Modern Mathematical Mechanics
Winter of odd-numbered years. 3(3-0) Approval of department.
Application of functional analysis and tensor theory to classical and contemporary problems in dynamics and material properties.

909. Elastic Thin Shells
Spring, 4(4-0) 815 or C E 804 or approval of department; MTH 421. Interdepartmental with and administered by Civil Engineering Department.
Elements of differential geometry, membrane theory of shells; Pucker's stress function, deformation and buckling of shells of revolution and shallow shells.

910. Nonlinear Continua
Winter of even-numbered years. 4(4-0) 810.
Modern nonlinear theories of continua. Equations of balance and constitutive equations. Topics selected from finite elasticity, nonlinear viscoelasticity, and viscoelasticity. General tensors are introduced and used throughout.

911. Theory of Elastic Stability
Fall of odd-numbered years. 4(4-0) 815 or approval of department.
Theory and methods of determining buckling strength and post-buckling behavior of bar, plate and shell elements and of elastic systems.

912. Theory of Plates
Winter, 4(4-0) 815 or C E 804 or approval of department; MTH 422. Interdepartmental with Civil Engineering Department.
Bending of thin elastic plates with various shapes and boundary conditions; application of energy principles and approximate methods of solution; thick plates; large deflection theory; sandwich plates.

915. Theory of Elasticity II
(913.) Spring, 3(3-0) 813 or approval of department.
Saint-Venant bending and torsion. Problems in three-dimensional linear elasticity using the Galerkin vector and Neuber-Pappovich functions.

918. Theory of Viscoelasticity
Fall of even-numbered years. 3(3-0) 810; MTH 423 or approval of department.

920. Theory of Vibrations II
(904.) Winter of odd-numbered years. 4(4-0) MTH 422; M E 823 or approval of department. Interdepartmental with the Mechanical Engineering Department.

921. Theory of Vibrations III
(903.) Spring of odd-numbered years, Summer, 4(4-0) 920 or approval of department.

933. Advanced Elasticity
Spring of even-numbered years 3(3-0)
May re-enroll for a maximum of 9 credits. Selected topics in non-linear elasticity.

941. Advanced Topics in Mechanical Metallurgy
Fall of odd-numbered years; Winter and Spring of odd-numbered years. 3(3-0)
Various aspects of dislocation theory and applications to the mechanical and physical properties of solids.

942. Advanced Topics in the Kinetics of Phase Transformation
Fall of odd-numbered years; Winter and Spring of even-numbered years. 3(3-0)
May re-enroll for a maximum of 8 credits.

999. Research
(ECR 999) Fall, Winter, Spring. Variable credit. Approval of department.

MICROBIOLOGY AND PUBLIC HEALTH MPH
College of Human Medicine
College of Natural Science
College of Osteopathic Medicine
College of Veterinary Medicine

100. Preview of Microbiology
Winter. 2(2-0) Freshmen and Sophomores only. Science and scientists of microbiology, presented in historical perspective and carried to the forefront of current research. A rigorous preview for students seriously curious about microbiology.

200. Elementary Microbiology
Fall, Winter. 4(3-3) Three terms of Natural Science. Primarily for majors outside the College of Natural Science. Description of bacteria and related forms of microorganisms, their growth and nature, their application in industry, and their control in public health.

234. Elementary Medical Microbiology
Fall. 5(4-4) Three terms of Natural Science. Primarily for Nursing students. Survey of immunology and microbiology with emphasis on pathogenic microorganisms, antimicrobial agents, and laboratory diagnosis.

301. Introductory Microbiology
Fall. Spring. 3(3-0) B S 212; BCH 200
Fundamentals of microbiology with emphasis on the comparative nature of the various groups of microorganisms, their distribution and activities.

302. Introductory Microbiology Laboratory
Fall, Spring. 1(0-4) 301 or concurrently. Laboratory based on the subject matter of 301.

400. Bacteriology for High School Science
Summer. 4(4-4) Bachelor's degree and teaching certificate. Fundamental concepts, experiments, and projects useful in secondary school science courses.

400H. Honors Work
Fall, Winter, Spring, Summer. 1 to 6 credits. May re-enroll for a maximum of 12 credits. Approval of department. Tutoring and experimentation.

401. General Microbiology
Fall. 5(3-0) B S 212; BCH 401 or concurrently. Comparative biology of microorganisms: viruses, rickettsiae, bacteria, fungi, algae, and protozoa.

402. General Microbiology Laboratory
Fall. 3(3-0) 401 or concurrently. Laboratory based on the subject matter of 401.

413. General Virology
(493) Winter. 3(3-0) 427 or concurrently. Physical, chemical, and biological properties of the viruses.

414. General Virology Laboratory
Winter. 10(4-4) 413 or concurrently. Laboratory procedures employed for cultivation and identification of viruses.

416. General Parasitology
(408) Winter. Summer at W. K. Kellogg Biological Station. 3(2-4) B S 212. Biology of parasitic animals.

421. Microbial Physiology
Winter. 3(3-0) 401, 402. Cell structure and function, growth and death, and metabolism of microorganisms.

422. Microbial Physiology Laboratory
Winter. 2(0-2) 421 or concurrently. Laboratory work based upon the subject matter in 421.

423. Microbial Genetics
(431) Spring. 3(3-0) BCH 401; ZOL 441 recommended. Fundamental genetic concepts as exemplified in microorganisms.

424. Microbial Genetics Laboratory
Spring. 3(0-6) 423 or concurrently. Laboratory work based upon the subject matter in 423.

425. Microbial Ecology
Summer. 6(3-9) 401. Given at W. K. Kellogg Biological Station. Lecture emphasizes biological and biochemical properties of diverse naturally occurring microorganisms. The laboratory stresses the analysis and description of natural metabolic activity. Methodology includes enrichment techniques but also qualitative and quantitative monitors of environmental changes.

427. Immunobiology
(460) Winter. 3(3-0) B S 212; BCH 200 or concurrently. Biological and biochemical mechanisms of the immune response. Emphasis is on concepts of immunity.

428. Immunobiology Laboratory
Winter. 2(0-6) 427 or concurrently. Basic laboratory techniques in immunobiology.

429. Microbiology of Infectious Diseases
(461) Spring. 3(2-8) 301 or 402 and 427. Biology, immunology, pathogenicity, and medical aspects of microorganisms associated with infectious diseases of man. Methods of isolation and identification are emphasized in the laboratory.

430. Introductory Medical Parasitology
(308) Fall, 4(2-8) 200 or 301 or 401. Interdepartmental with and administered by Food Science. Major groups of microorganisms of importance to the food industry are studied with emphasis on ecological, physiological, and public health aspects.

434. Soil Microbiology
(451) Spring. 4(3-4) 200 or 301 or 401. Interdepartmental with Soil Science. Major groups of microorganisms of importance in soils are studied with emphasis on ecological, biochemical, and physical aspects.

444. Environmental Microbiology
(351) Spring. 3(2-4) 200 or 401. Flora, methods of testing, and purification of environmental air and water. Treatment and disposal of sewage.

511. Medical Microbiology and Immunology
Spring. Variable credit. May re-enroll for a maximum of 7 credits. A biochemistry course. Enrollment in College of Human Medicine or approval of department. Basic principles of microbiology (bacteriology, virology, mycology and parasitology) and immunology. Selected type-infections relate these principles to disease in man.

512. Infectious Diseases
Fall. 3(2-2) 511, or approval of department. Interdepartmental with the Department of Medicine. Infectious diseases of man, including biology of the causative microorganism, epidemiology, pathogenesis, host-parasite relationships, clinical and laboratory diagnosis, and clinical management.

521. Medical Microbiology and Immunology
Winter. Variable credit. May re-enroll for a maximum of 6 credits. A biochemistry course. Enrollment in College of Osteopathic Medicine or approval of department. Basic principles of microbiology (bacteriology, virology, mycology and parasitology) and immunology. Selected type-infections relate these principles to disease in man.

531A. Medical Microbiology:
Immunology
(586, 531) Winter. 2(1-2) A course in biochemistry and admission to the veterinary professional program, or approval of department. Basic principles of immunology (immunobiology and immunochimistry) and their relation to disease in animals.