840. Symmetry and the Properties of Crystals
Winter. 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 piezo-electricity, elasticity, transport properties and heat conductivity.

850. Modern Ceramic Materials I
Fall. 3(3-0) CEM 462; PHY 540; 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) 850.
Properties of ceramic materials with specific reference to mechanical, optical, electrical, magnetic and thermal properties.

852. Modern Ceramic Materials III
Spring. 3(3-0) 851.
Applications of ceramic materials Glass-ceramics, nuclear fuel elements, hot-pressed translucent 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) 860.
Introduction to quantum theory of metals, physical properties of metals and alloys.

862. Theoretical Metallurgy III
Spring. 3(3-0) 861.
Imperfection in crystalline solids, dislocation theory and mechanical properties of metals and alloys.

875. Ferrous Metallurgy
Fall. 3(3-0) 493.
Stress-strain material and heat balance calculations of the blast furnace, open hearth and electric furnace processes.

876. Nonferrous Process Metallurgy
Winter. 3(3-0) 462.
Stress-strain material and heat balance calculations 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 880, but with reference to nonferrous alloys.

882. Metals and Alloys III
Spring. 3(3-0) 372.
Similar to 880, but with reference to cast alloys.

885. Seminar
Fall, Winter, Spring. 1 credit. 999 concurrently.
Descriptions — Microbiology and Public Health of Courses

301. Introductory Microbiology  
Fall, Winter, Spring. 3(3-0) CEM 242, 244 or BCH 200.  
Fundamentals of microbiology. Ranges of cell structure and activities, nutrition, growth, and importance of major microbial groups.

302. Introductory Microbiology Laboratory  
Fall, Winter, Spring. 2(0-4) 301 or concurrently.  
Methodology of microbiology including microscopy, staining, asepsis, cultural media and quantification.

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 Research  
Fall, Winter, Spring, Summer. 2 credits. May re-enroll for a maximum of 8 credits. Approval of department.  
A four-term research project with thesis.

406. Medical Mycology  
Fall, Spring. 4(3-3) BOT 405 or approval of department. Interdepartmental with and administered by the Department of Botany and Plant Pathology.  
Characteristics, habits, and laboratory identification of fungal diseases infecting humans. Emphasis on laboratory techniques and morphological characteristics of the various mycetes.

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

414. General Virology Laboratory  
Winter. 1(0-4) 413 or concurrently.  
Laboratory procedures employed for cultivation and identification of viruses.

416. General Parasitology  
Fall. 3(3-0) B S 210, 211, 212 or LBC 141.  
Life history, host-parasite relationships (including physiology, immunology, immunopathology and pathology) and epidemiology of selected groups and species of protozoan, trematode, cestode and nematode parasites.

417. General Parasitology Laboratory  
Fall. 2(0-4) 416 or concurrently or approval of department.  
Identification and life histories of representative species of major groups of animal parasites. Selected concepts of host-parasite associations will be tested experimentally.

420. Ecology of Animal Parasites  
(420) Summer. 6 credits. B S 212 or approval of department. Given at W. K. Kellogg Biological Station. Interdepartmental with the departments of Fisheries and Wildlife, and Zoology.  
Parasitism of animals by protozoa, helminths and arthropods with emphasis on the interrelationships of host-parasite associations with the natural environments.

421. Microbiological Physiology and Genetics  
Winter. 4(4-0) 301, 302; BCH 401 or 452 or concurrently.  
Cell structure and function, macromolecular synthesis and control, genetic capabilities of microorganisms.

422. Microbial Physiology Laboratory  
Winter. 2(0-6) 421 or concurrently.  
Laboratory work based upon the subject matter in 421.

424. Microbial Genetics Laboratory  
Spring. 2(0-6)  
Laboratory work in microbial genetics.

425. Microbial Ecology  
Spring. 5(4-3) 301 or approval of department.  
Fundamental concepts of microbial ecology. Emphasis will be placed on aquatic and soil habitats.

427. Immunobiology  
Winter. 3(3-0) B S 212; BCH 200 or 401.  
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  
Spring. 5(3-3) 301, 427.  
Bacteriology, immunology, pathogenicity, and medical aspects of microorganisms associated with infectious diseases of man. Methods of isolation and identification are emphasized in the laboratory.

437. Introductory Medical Parasitology Laboratory  
Fall, Winter. 2(1-4) 416 or concurrently or approval of department. Primarily for Medical Technology students.  
Laboratory diagnosis of protozoan, helminth, and arthropod infections of man.

440. Food Microbiology  
Fall. Dietetics majors only. Spring. 5(3-4) 290 or 301 or approval of department. 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.

442. Soil Microbiology  
Spring. 3(2-4) 290 or 301. Interdepartmental with the Department of Crop and Soil Sciences.  
Major groups of microorganisms of importance in soils are studied with emphasis on ecological, biochemical, and physical aspects.

444. Environmental Microbiology  
Spring. 3(2-4) 300 or 301.  
Flora, methods of testing, and purification of environmental air and water. Treatment and disposal of sewage.

4DC. Biological Membranes  
For course description, see Interdisciplinary Courses.

490. Special Problems in Microbiology  
Fall, Winter, Spring, Summer. 1 to 6 credits. May re-enroll for a maximum of 12 credits. Approval of department.  
Tutorial instruction in laboratory or library research for advanced undergraduates.

511. Medical Microbiology and Immunology  
Spring. 1 to 6 credits. May re-enroll for a maximum of 6 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. 4(3-3) 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 credits. 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  
(531L) 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 immunochemistry) and their relation to disease in animals.

531B. Medical Microbiology: Bacteriology and Mycology  
Winter. 3(2-4) A course in biochemistry and admission to the veterinary professional program, or approval of department.  
Basic principles of bacteriology and mycology and their relation to disease in animals.

531C. Medical Microbiology: Virology  
Spring. 3(2-2) A course in biochemistry and admission to the veterinary professional program, or approval of department.  
Basic principles of virology and their relation to disease in animals.

531D. Medical Microbiology: Parasitology  
Spring. 3(3-4) Admission to the veterinary professional program, or approval of department.  
Basic principles of parasitology (protozoology, helminthology, and entomology) and their relations to disease in animals.

618. Infectious Disease Clerkship  
Fall, Winter, Spring, Summer. 1 to 17 credits. May re-enroll for a maximum of 34 credits. H M 402 and MED 408 or H D 608. Interdepartmental with and administered by the Department of Medicine.  
The clerkship emphasizes acquisition in depth of knowledge and skills essential in solutions of clinical problems in infectious and immunologic diseases. Integrated basic science input is afforded through relevant seminars.

A-136
800. Seminar
Fall, Winter, Spring, Summer. 1(1-0)
May re-enroll for a maximum of 6 credits. Approval of department.

513. Molecular Virology
Fall. 4(4-0) Basic in biochemistry, and approval of department. Molecular nature and biochemistry of replication of bacterial and animal viruses. Emphasis is on current advances, research concepts, and the role of viruses in molecular biology research.

526. Ecology of Animal Parasites
Summer. 3 credits. 416, approval of department. Given at W. E. Kellogg Biological Station. Interaction of parasite animals (protozoa, helminths, and arthropods) with their natural environment, including host, biotic, and physical aspects.

827. Immunohemistry
Spring. 3(3-0) 427; BCH 452, or ZOL 441, and CEM 383 recommended. Structure and activity of antigens and antibodies; synthesis of immunoglobulins. Emphasis is on current advances and research concepts.

828. Immunohemistry Laboratory
Spring. 2(0-6) 427; 827 or concurrently. Laboratory based partially on subject matter of 827. Experimental techniques used in immunological assays and immune systems.

980. Special Problems in Microbiology
Fall, Winter, Spring, Summer. 2 to 6 credits. May re-enroll for a maximum of 12 credits. Approval of department.

989. Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

990. Topics in Microbiology
Fall, Winter, Spring, Summer. 2(2-0) May re-enroll if different topic is taken. Approval of department. Topics will be selected from taxonomic substances such as bacteriology, virology, protozoology, mycology, algalogy, and helminthology; and from transacting disciplines such as microbial genetics, immunology, physiology, and ecology.

991. Experimental Microbiology
Fall, Winter, Spring, Summer. 3(0-9) May re-enroll for a maximum of 9 credits. Approval of department. Experiments, demonstrations, and discussions of current research programs in various areas of microbiology.

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

MILITARY SCIENCE M S

All University

041. General Military Science
Application of leadership techniques, the decision making process and staff planning. Military customs and traditions. Students will concurrently enroll in a selected non-Military Science course to fulfill military professional requirements.

A. Military Traditions—M S I
Winter. 0(0-1) Approval of department.

B. Evolution of Military Leadership—M S II
Fall, Winter. 0(0-1) Approval of department or M S II standing. HST 255 concurrently.

C. Military Career Preparation—M S III
Spring, Summer. 0(0-1) Approval of department or M S III standing.

D. Advanced Camp Preparation—M S IV
Fall, Winter. 0(0-1) Approval of department or M S IV standing.

E. Military Staff Organization—M S IV
Fall. 0(0-1) Approval of department or M S IV standing.

121. Preview of Military Science
Fall, Winter, Spring, Summer. 1(1-0) Approval of department. Role of the ROTC officer in the Army. Assists the student in planning a curriculum to satisfy requirements for a commission.

122. Marksmanship and Hunter Safety
Fall, Spring. 1(0-1) 121 or approval of department. Small arms marksmanship and safety. Practical exercises on local firing ranges. Individual basic military marksmanship and the skills necessary to participate in a competitive or recreational shooting program.

223. Terrain Analysis and Land Navigation
Winter, Spring. 3(3-0) 121 and approval of department. Military maps, map construction, specifications and uses. Includes both a study of aerial photographs and an introduction to remote energy sensors employed by defense agencies as they relate to tactical operations.

224. Military Teaching
Fall, Winter, 4(2-4) Basic course, approval of department. Methods of teaching manipulative skills to groups with varying educational backgrounds. Emphasis on determination of entry behavior, progress analysis, testing and test construction, Introduction to current teaching aids. Practical experience in simulated field situations is stressed during laboratory.

225. Military Management
Spring. 4(3-2) 324 or approval of department. Task analysis approach to missions. The subject of tactics is used as a teaching vehicle for the managerial approach to the preparation and execution phases of military operations. Emphasis is placed on physical and moral leadership during the laboratory sections.

426. Military Law
Winter. 4(4-0) Approval of department. Jurisdiction and responsibility of the Army commander; and junior leader in the application of military justice. Implications of Army operations as related to the rules of land warfare.

427. Seminar
Spring. 1(1-0) Approval of department. Precommissioning orientation stressing current military policies, procedures, customs and tenets.

499. Independent Study in Military Science
Fall, Winter, Spring, Summer. 1 to 3 credits. May re-enroll for a maximum of 6 credits. Approval of department and Juniors. Individual research and study in an area related to military science as approved and directed by the Department of Military Science.

MUSIC MUS

College of Arts and Letters

100. Theory Review
Fall, Summer. 2(2-1) For majors who need Theory review. Basic course in fundamentals and ear training.

112. Chamber Music
Fall, Winter, Spring, Summer. 1(1-0) May re-enroll for a maximum of 8 credits. Approval of department. Performance of works for small ensembles.

118. Band
A. Marching Band
Fall. 1 credit. May re-enroll for credit. Membership determined by audition. The Marching Band participates at football games.

B. Spartan Brass
Winter. 1 credit. May re-enroll for credit. Membership determined by audition. The Spartan Brass participates at basketball games.

C. Concert Band
Fall, Winter, Spring. 1 credit. May re-enroll for credit. Membership determined by audition. Public appearances are scheduled on campus each term.

D. Symphonic Band
Fall, Winter, Spring, 1 credit. May re-enroll for credit. Membership determined by audition. A high level of achievement in performing ability is required. Concerts are scheduled both on and off campus.

E. Wind Ensemble
Fall, Winter, Spring, 1 credit. May re-enroll for a maximum of 12 credits. Membership determined by audition. The highest level of performance is required. Full range of wind literature is performed. Public concerts are presented both on and off campus.

133. Orchestra
Fall, Winter, Spring, 1(0-5) May re-enroll for a maximum of 12 credits. Membership determined by audition. Standard overtures and symphonies studied and publicly performed. Attendance at all rehearsals and public concerts obligatory.

135. Music in Elementary Education
Fall, Winter, Spring, Summer. 4(3-2) Elementary education majors. Basic scope and sequence of music instruction in the elementary schools with an introduction to basic knowledge and skills used in elementary school music.

141. Class Instruments and Voice
Fall, 3(0-3) Knowledge of notation. Music majors, or approval of department. Class instruction in piano, voice, violin, cello, clarinet, and cornet.

142. Class Instruments and Voice
Winter. 1(0-8) 141. Continuation of 141.

143. Class Instruments and Voice
Spring. 1(0-9) 142. Continuation of 142.