

**Descriptions — Fisheries and Wildlife of Courses**

**484. Environmental Education**  
*Spring, 3(3-0)*  
*P: AEE 101 or PRR 320 or RD 201 or TE 150. R: Not open to freshmen and sophomores.*  
 Methods, materials and theory for teaching environmental education in formal and nonformal educational settings.

**490. Independent Studies of Fisheries and Wildlife Problems**  
*Fall, Spring, Summer. 1 to 5 credits. A student may earn a maximum of 5 credits in all enrollments for this course.*  
*P: BS 110. R: Not open to freshmen and sophomores. Approval of department and application required.*  
 Special topics in fisheries and wildlife.

**810. Human Dimensions Research in Fisheries and Wildlife**  
*Fall of even-numbered years. 3(3-0)*  
 Methods of surveying, educating and involving the public to achieve fish and wildlife management goals. Review of human dimensions research and current case studies.

**814. Environmental Chemodynamics**  
*Spring of even-numbered years. 4(4-0)*  
 Chemical and environmental factors controlling the distribution of organic and inorganic chemicals in air, water and soil. Monitoring.

**817. Ecology and Evolution in Aquatic Systems**  
*Summer. 4 credits. Given only at W.K. Kellogg Biological Station. Interdepartmental with Zoology, and Botany and Plant Pathology. Administered by Zoology.*  
*P: ZOL 250 or ZOL 431.*  
 Experimental field studies of population and community ecology of freshwater lakes and streams. Emphasis on interactions among species and between biotic and abiotic factors.

**824. Analysis of Wildlife Populations**  
*Spring of even-numbered years. 3(2-3)*  
 Statistical and ecological concepts, methods and computer techniques needed to analyze and interpret demographic data from fish and wildlife studies.

**826. Ecology and Management of Waterfowl**  
*Fall of even-numbered years. 3(2-3)*  
*P: FW 412, FW 424.*  
 Physiological, behavioral, and population characteristics of waterfowl. Current issues and management.

**828. Conservation and Genetics**  
*Fall of odd-numbered years. 3(3-0)*  
*P: ZOL 341 or CSS 350 or ANS 314.*  
 Population genetic principles applied to ecology and management of fish and wildlife.

**831. Aquatic Toxicology**  
*Spring of odd-numbered years. 4(3-2)*  
*R: Open only to graduate students in the Colleges of Agriculture and Natural Resources, Engineering, Human Medicine, Natural Science, Osteopathic Medicine, and Veterinary Medicine.*  
 Techniques for assessing acute and chronic effects of toxicants on biochemical, physiological, organismal, population, community and ecosystem levels of organization.

**860. Wildlife Nutrition**  
*Fall of odd-numbered years. 3(2-2)*  
*R: Open only to graduate students in the Colleges of Agriculture and Natural Resources, and Natural Science.*  
 Nutritional ecology of wild species. Techniques for analyzing and improving nutritional qualities.

**872. Fishery Habitat Analysis and Management**  
*Spring of odd-numbered years. 3(3-0)*  
*R: Open only to graduate students in the Colleges of Agriculture and Natural Resources, Engineering, and Natural Science.*  
 Fish habitat use. Analysis and manipulation of habitats to enhance fish production in freshwater ecosystems.

**875. Advanced Aquaculture**  
*Fall of odd-numbered years. 3(3-0)*  
*P: FW 475. R: Open only to seniors and graduate students.*  
 Adaptations and responses of aquatic organisms to environmental change in aquaculture systems. Research methods and applications for aquaculture planning and management decisions.

**876. Applied Limnology**  
*Spring of even-numbered years. 3(3-0)*  
*R: Open only to graduate students in the Colleges of Agriculture and Natural Resources, Engineering, and Natural Science.*  
 Applied aquatic ecology. Quantitative relationships between physical, chemical, and biological parameters in polluted and unpolluted lakes.

**877. Fish Population Dynamics**  
*Fall of even-numbered years. 3(3-0)*  
*R: Open only to graduate students in the Colleges of Agriculture and Natural Resources, and Natural Science.*  
 Quantitative analysis of fish populations. Evaluation, causes, and impacts of the rates of change in survival, growth, reproduction, and recruitment for fish populations and their yield.

**878. Dynamics of Trace Contaminants in Aquatic Systems**  
*Spring of even-numbered years. 3(3-0)*  
*R: Open only to graduate students in the Colleges of Agriculture and Natural Resources, Engineering, Human Medicine, Natural Science, Osteopathic Medicine, and Veterinary Medicine.*  
 Chemical and environmental parameters controlling movement and disposition of trace contaminants in aquatic environments. Fate models.

**879. Advanced Limnology**  
*Spring of odd-numbered years. 3(3-0)*  
*R: Open only to graduate students in the Colleges of Agriculture and Natural Resources, Engineering, and Natural Science.*  
 Physical, chemical, and biological processes affecting productivity of aquatic ecosystems.

**891. Advanced Topics**  
*Fall, Spring, Summer. 2 to 4 credits. A student may earn a maximum of 10 credits in all enrollments for this course.*  
 In depth study of advanced topics in fisheries and wildlife.

**892. Biodiversity**  
*Spring. 2(2-0) A student may earn a maximum of 4 credits in all enrollments for this course. Interdepartmental with Zoology. Administered by Zoology.*  
*P: ZOL 250.*  
 Status of world biota and factors in the decline and extinction of major groups of plants and animals. Theory and design of natural reserves. Assessment and ecological meaning of diversity. Management for global and local diversity.

**893. Seminar in Fisheries and Wildlife**  
*Fall, Spring. 1(1-0) A student may earn a maximum of 7 credits in all enrollments for this course.*  
 Study and research in advanced problems and current development in fisheries and wildlife.

**897. Community and Ecosystem Ecology**  
*Spring. 4(4-0) Interdepartmental with Zoology, and Botany and Plant Pathology. Administered by Zoology.*  
*R: Open only to students in Interdepartmental Graduate Specializations in Ecology and Evolutionary Biology.*  
 Structure and function of natural communities and ecosystems. Community analysis along environmental gradients. Succession, food web analysis, energy flow, nutrient cycling, and effects of human activities on ecosystems.

**898. Master's Research**  
*Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 10 credits in all enrollments for this course.*  
*R: Open only to graduate students in Fisheries and Wildlife.*  
 Master's degree Plan B research paper.

**899. Master's Thesis Research**  
*Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 99 credits in all enrollments for this course.*  
*R: Open only to graduate students in Fisheries and Wildlife.*

**943. Techniques of Analyzing Unbalanced Research Data**  
*Spring. 4(4-0) Interdepartmental with Animal Science, Forestry, Crop and Soil Sciences, and Horticulture. Administered by Animal Science.*  
*P: STT 464. R: Open only to graduate students in the College of Agriculture and Natural Resources.*  
 Linear model techniques to analyze research data characterized by missing and unequal number of observations in classes. Simultaneous consideration of multiple factors. Estimable comparisons. Hypothesis testing. Computational strategies. Variance and covariance components. Breeding values.

**976. Multivariate Methods in Agriculture and Natural Resources**  
*Spring. 4(4-0) Interdepartmental with Forestry and Animal Science. Administered by Forestry.*  
*P: STT 422, MTH 314. R: Open only to graduate students in the College of Agriculture and Natural Resources and in the Interdepartmental Graduate Specializations in Ecology and Evolutionary Biology.*  
 Application of multivariate methods to research problems. Hotelling's T-test, profile analysis, discriminant analysis, canonical correlation, principal components, principal coordinates, correspondence analysis, and cluster analysis.

**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 level graduate students in Fisheries and Wildlife.*

**FOOD ENGINEERING FE**  
**Department of Agricultural Engineering**  
**College of Agriculture and Natural Resources**  
**College of Engineering**

**329. Fundamentals of Food Engineering**  
*Spring. 3(3-0) Interdepartmental with Food Science.*  
*P: FSC 211, MTH 124, PHY 231. R: Not open to freshmen and sophomores.*  
 Unit operations in food industry: fluid mechanics, heat transfer, rate processes, refrigeration, freezing, and dehydration. Thermal process calculations.

**338. Machinery Systems for Food Processing**  
Spring, 3(3-0)  
P: MTH 235.  
Principles of design, operation, and performance of equipment for processing raw materials into finished or intermediate products.  
SA: AE 338

**460. Postharvest Engineering**  
Fall, 3(3-0)  
P: BE 350 or CHE 311 or ME 410. R: Open only to majors in College of Agriculture and Natural Resources or College of Engineering.  
Engineering principles involved with the storage and handling of grains and horticultural crops between harvest and processing.

**465. Thermal Processing of Foods**  
Spring, 3(3-0)  
P: BE 350 or CHE 311 or ME 410. R: Open only to majors in College of Agriculture and Natural Resources or College of Engineering. Not open to students with credit in FE 483 or FE 433.  
Engineering principles involved in the freezing, heating, cooling, drying and aseptic processing of food products.

**490. Directed Study**  
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course.  
P: FSC 211 or MSM 221 or MTH 235. R: Open only to Engineering majors. Approval of department; application required.  
Supervised individual student research and study in food engineering.

**491. Special Topics in Food Engineering**  
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course.  
P: FSC 211 or MSM 221 or MTH 235. R: Open only to Engineering majors. Approval of department.  
Special topics in food engineering.

## FOOD SCIENCE

## FSC

### Department of Food Science College of Agriculture and Natural Resources

**150. Introduction to Nutrition and Food Science**  
Fall, Spring, Summer. 3(3-0) Interdepartmental with Human Nutrition and Foods. Administered by Human Nutrition and Foods.  
Nutrition needs in life stages from a human ecological perspective. Domestic and international factors affecting the availability of a safe, nutritious food supply. Relationships of food choices to health and disease.

**211. Principles of Food Science**  
Fall, 3(3-0)  
P: CEM 141.  
Scientific principles, historical perspective and current status of technology related to food composition, safety, toxicology, processing, preservation and distribution.

**329. Fundamentals of Food Engineering**  
Spring, 3(4-0) Interdepartmental with Food Engineering. Administered by Food Engineering.  
P: FSC 211, MTH 124, PHY 231. R: Not open to freshmen and sophomores.  
Unit operations in food industry: fluid mechanics, heat transfer, rate processes, refrigeration, freezing, and dehydration. Thermal process calculations.

**330. Food Processing: Fruits and Vegetables**  
Fall, 2(3-3)  
P: MTH 116, FSC 211. R: Not open to freshmen.  
Fruit and vegetable composition and quality indices. Harvest and post harvest technology. Preservation systems: canning, freezing and specialized techniques. Offered first half of semester.

**331. Food Processing: Cereals**  
Fall, 2(3-3)  
P: MTH 116, FSC 211. R: Not open to freshmen.  
Classification and composition of cereals. Milling processes. Cereal product manufacture. Offered second half of semester.

**332. Food Processing: Dairy Foods**  
Spring, 2(1-3)  
P: MTH 116, FSC 211. R: Not open to freshmen.  
Fluid milk. Principles and technology in manufacturing dairy products. Marketing, distribution and regulations of dairy foods. Offered first half of semester.

**333. Food Processing: Meat, Poultry and Fishery Products**  
Spring, 2(1-3)  
P: FSC 211, MTH 116. R: Not open to freshmen.  
Manufacturing practices and principles of fresh, frozen, and cured meats, eggs, and processed products. Product formulation and quality control. Offered second half of semester.

**401. Food Chemistry**  
Fall, 3(3-0)  
P: FSC 211, CEM 251. R: Not open to freshmen and sophomores. Not open to students with credit in HNF 300.  
Organic and biological reactions of food constituents. Chemical changes in foods during processing and storage affecting texture, color, flavor, stability and nutritive qualities.

**402. Food Chemistry Laboratory**  
Fall, 1(0-3)  
P: FSC 401 or concurrently. R: Open only to majors in Food Science, Foods: Technology and Management, and Food Engineering.  
Chemical changes in food constituents which affect stability of food products and properties such as color, flavor and texture.

**405. Application of Biotechnology to Food Science**  
Fall of odd-numbered years. 3(3-0)  
P: MIC 205 or MIC 301.  
Advances in biotechnology and their application to food safety and quality. Scientific basis and methods used in genetic engineering of plant and animal cells. Use of molecular probes in detection of toxins and bacterial pathogens. Ethical concerns related to biotechnology.

**407. Food and Animal Toxicology**  
Fall, 3(3-0) Interdepartmental with Animal Science. Administered by Animal Science.  
P: BCH 200 or BCH 401. R: Not open to freshmen and sophomores.  
Fate and effects of chemicals in the food chain. Impact on animal production. Residues in food products. Food safety assessment. Control methods.

**407L. Toxicology Methods Laboratory**  
Fall, 2(0-4) Interdepartmental with Animal Science. Administered by Animal Science.  
P: ANS 407 or concurrently. R: Not open to freshmen and sophomores.  
Laboratory techniques for evaluating potential toxicity of chemicals to living systems. Field trip to industrial toxicology laboratory required.

**417. Topics in Toxicology**  
Spring, 1(1-0) Interdepartmental with Animal Science. Administered by Animal Science.  
P: ANS 407. R: Not open to freshmen and sophomores.  
Selected topics including regulatory toxicology, risk assessment, environmental toxicology, food safety, and safe handling of toxic substances.

**420. Quality Assurance**  
Fall, 2(2-0)  
P: STT 201; FSC 330 or FSC 331 or FSC 332 or FSC 333. R: Not open to freshmen and sophomores.  
Theory and application of quality assurance programs for food processing industries.

**421. Food Laws and Regulations**  
Spring, 3(3-0)  
P: HNF 150 or HNF 311 or FSC 211. R: Not open to freshmen and sophomores.  
Adoption, interpretation and enforcement of laws and regulations governing food processing and foodservice systems. Impact of regulation on food production, availability, marketing and safety.

**432. Advanced Food Processing: Dairy Foods**  
Fall of odd-numbered years. 3(2-3)  
P: FSC 332. R: Not open to freshmen and sophomores.  
Theoretical and practical principles of the manufacture of cheese, frozen desserts, butter and powders. Concentration and fractionation techniques for producing dairy based ingredients for food systems.

**433. Advanced Food Processing: Meat, Poultry and Fish**  
Fall of even-numbered years. 3(2-3)  
P: FSC 333. R: Not open to freshmen and sophomores.  
Scientific principles of processing animal tissues for food. Field trips required.

**440. Food Microbiology**  
Spring, 3(3-0) Interdepartmental with Microbiology.  
P: MIC 205. R: Not open to freshmen and sophomores.  
Major groups of microorganisms of importance to the food industry. Emphasis on ecological, physiological, and public health aspects.

**441. Food Microbiology Laboratory**  
Spring, 1(0-3) Interdepartmental with Microbiology.  
P: FSC 440 or concurrently; MIC 206. R: Not open to freshmen and sophomores. Open only to majors in Food Engineering, Food Science, Foods: Technology and Management, or Microbiology and Public Health.  
Methods for studying major groups of microorganisms important to food industry. Isolation, enumeration, characterization, identification and use of microorganisms.

**455. Food Analysis**  
Fall, 3(2-3)  
P: BCH 200, CEM 262, FSC 401. R: Not open to freshmen and sophomores.  
Principles and application of analytical techniques. Analysis for fats, proteins, carbohydrates, minerals, vitamins and additives. Techniques include spectroscopy, fluorimetry, chromatography, electrophoresis, proximate composition.

**490. Special Problems in Food Science**  
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course.  
R: Not open to freshmen and sophomores. Approval of department; application required.  
Individual study of selected topics in food science. Supervised independent study.