477. Limnological Methods
Winter. 3(0-4) 476 concurrently;
ZOL 481; ENT 301, 302 recommended.
Interdepartmental with the Zoology Department.
Methods and instruments of limnological field
investigation on lakes and streams.

484. Outdoor Environmental Education
Fall. 4(3-8) Juniors or approval of
department.
Using the outdoors as a teaching laboratory for
ecological studies of plant and animal communities.
Designed primarily for secondary teachers.

485. Environmental Conservation Program Design
Winter. 3(0-6) Seniors or approval of
department.
Materials and methods for integrating environ­
mental conservation into educational programs in
schools, nature centers, youth groups and
communities.

801. Seminar in Fisheries and Wildlife
Fall, Winter, Spring. 1(1-9)
Graduate problems and current developments of
importance.

802. Advanced Topics
Fall, Winter, Spring. Summer. 1 to 6
credits. May re-enroll for a maximum of 15
credits. Approval of department.
Study of selected advanced topics in detail and
depth.

821. Advanced Stream Ecology
Summer. 3 credits. ENT 421 or ap­
proval of instructor. Given with W. K. Kellogg
Biological Station. Interdepartmental with and
administered by the Entomology Department.
Stream ecosystem energy budget models with
emphasis on individual projects involving both
laboratory and field experiments. Particular use
will be made of artificial streams and locally
abundant species of aquatic insects.

830. Environmental Requirements of
Fish
Winter. 3(0-6) Approval of depart­
ment.
Adaptations and responses of fish to environ­
mental changes, research methods for evaluating
environmental limitations and effects of pol­
huants on fish growth, reproduction and
survival. Applications for developing water quality
criteria.

871. Ecology of Fishes
Summer. 6 credits. Approval of in­
structor or ZOL 389 or FW 473. Given with the
W. K. Kellogg Biological Station. Interdepartmental
with and administered by the Department of
Zoology.
Exploration of ecological problems with partic­
ular emphasis on growth, food and habitat
selection, population biology and niche relation.
Field and experimental investigations of fish
communities.

784. Advanced Biological Limnology
Fall. 3(4-0) 477, or approval of de­
partment.
Historical and current contributions to concepts
of community structure, energy flow and mate­
rials cycling in aquatic eco-systems.

785. Chemical Limnology
Winter. 4(3-3) 476, 477 or approval of
department.
Application of analytical chemistry concepts and
technologies to fundamental chemical mecha­
nisms in natural and polluted water systems.
Special consideration given to selected hetero­
genous equilibria.

899. Research
Fall, Winter, Spring. Summer. Varia­
tble credit. Approval of department.

940. Quantitative Wildlife Ecology
Spring. 3(3-0) Approval of depart­
ment.
Fundamentals of population demographics.
Rates of increase, dynamic and static life tables,
logistic theory, the Leslie matrix model,
age specific and time specific parameters.
Current hypotheses on mechanisms promoting pop­
ulation stability.

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

FOOD SCIENCE AND HUMAN NUTRITION

College of Agriculture and
Natural Resources

College of Human Ecology

Food Science

101. Food and Society
Fall, Winter. 3(3-0) Interdepartmental with Human Nutrition and Foods.
Analysis of the scientific, social and environ­
mental aspects of food in determining the
quality of man's life. Introduction into the
principles of food preservation and safety.

211. Introduction to Food Science
Spring. 3(3-0)
Modern food processing, world food problems,
and the basic characteristics of processed foods.

215. World Food Issues
Spring. 3(3-0) Interdepartmental
with and administered by the Department of
Geography.
Food resources as related to world distribu­
tions of population, soil, water, fuel and
minerals. Special attention to urbanization, irri­
tigation, and future food needs and global con­
straints.

223. Commercial Food Processing Systems
Fall. 3(3-0) Interdepartmental with
and administered by Physical Systems in Agri­
culture and Natural Resources.
Processes and systems used in handling, process­
ing and distribution of food; the need for
processing systems and their influence on food
quality.

242. Meats, Poultry and Fishery Products I
Fall. 3(3-0) Interdepartmental with
the Animal Husbandry Department.
Principles of evaluation and nutritive value.
Identification of grades and cuts of beef, pork,
lamb and poultry products.

300. Dairy Products
Spring. 3(3-2)
Composition, use, classification and market
grades, methods of storage and factors affecting
keeping quality of dairy products.

311. Food Processing and Preservation
Winter. Summer. 4(4-0) CEM 132
or HRI 245 or approval of department; not open
to freshmen in Food Science.
Effects of processing, packaging and preservation
on the quality of foods. Demonstrations of
use of ingredients, evaluation of products and
results of various processing methods.

331. Physical Principles of Food Processing
Fall, Winter. 4(3-8) 211; MTH 109;
PHY 239 or approval of department.
Food preservation by heat, low temperature,
dehydration and radiation.

332. Biological Principles of Food Processing
Winter. 4(3-3) MPH 200 or ap­
proval of department.
Biological problems related to food processing
including waste disposal, sanitizing and bac­
terial compounds, pesticides and residues,
plant and animal growth regulators, radio­
active elements, preservatives and toxicology of
additives.

333. Chemical Principles of Food Processing
Spring. 4(3-3) 211 and CEM 241
or approval of department.
Chemical changes in foods that affect the tex­
ture, color, flavor, odor, stability, and nutritive
quality during processing and storage.

400. Milk Processing Technology
Fall. 4(3-3) CEM 132 or approval of
department.
The fluid milk industry. Composition, quality,
sanitation, nutritive value, processing, packag­
ing and distribution of milk and milk products.

401. Industrial Food Fermentations
Fall. 3(3-0) 440 and organic chem­
istry or approval of department.
Physical, microbiological and chemical proce­
dures in utilizing microbial cultures in con­
trolled fermentations of foods and food con­
stituents.

402. Chemistry and Technology of
Lipids
Winter. 3(3-3) One term organic
chemistry.
Chemical and physical properties of edible fats
and oils. Refining and processing of lipids into
margarine, butter, shortening and salad oils.
Chemical methods for analysis of lipids.

404. Dehydrated Foods
Spring. 3(2-3) 331; 333 concurrent­
ly or approval of department.
Concentration and dehydration of foods by roller,
spray, and freeze drying and foam, puff and
intermittent drying. Stability and nutritional
aspects of dehydrated foods.

405. Chemistry and Technology of
Dairy Products Manufacturing
Winter. 3(3-3) May re-enroll for a
maximum of 6 credits if a different topic is
taken. 400 or approval of department.
Physical, chemical and microbiological factors in
the processing of dairy products. Ice cream,
sherbets, ice milks and special frozen deserts
are studied in odd-numbered years; cheese,
and related dairy products in even-numbered years.

421. Food Plant Management
Spring. 3(2-3) Seniors or approval of
department.
Efficiency concepts, merchandising, personnel
utilization and organization.
440. Food Microbiology (MPH 371) Fall, Dietetics majors only. Spring. 3(3-0) MPH 200 or 301 or 401, or approval of department. Interdepartmental with the Department of Microbiology and Public Health.

Major groups of microorganisms of importance to the food industry are studied with emphasis on ecological, physiological, and public health aspects.

445. Meat, Poultry and Fishery Products III Spring. 3(1-0) 333 or approval of department. Processing, formulation and quality control.

448. Fruit, Vegetable and Cereal Products I Fall. 4(3-3) 331 or approval of department. Quality factors involved in canning, sugar and salt preservation and milling.

449. Fruit, Vegetable and Cereal Products II Winter. 4(3-3) 331 or approval of department. Quality factors involved in cooling, freezing and other preservation procedures.

450. Food Analysis I Fall. 4(2-4) CEM 132 and 162 or approval of department. Modern methods of analysis for fat, protein, moisture and other macromolecules of food. Application of spectrophotometry in determination of microconstituents; use of dye-binding, colorimetric and other techniques in food analysis.

456. Food Analysis II Winter. 4(2-6) CEM 163 and 341 or approval of department. Use of colorimetry and spectrophotometry, chromatographic methods and other techniques for the analysis of food constituents and additives.

457. Quality Control in the Food Industry Winter of even-numbered years. 3(2-6) STT 201 or approval of department. Organization of quality control within the food industry by case study. Use of control charts, sampling plans, flavor panel analyses.

480. Special Problems in Food Science Fall, Winter, Spring, Summer. 1 to 3 credits. May re-enroll for a maximum of 9 credits. Advanced undergraduates may select research work in food chemistry, food microbiology, food engineering, food plant management, processing of dairy products, meat, poultry and fishery products, fruits and vegetables, cereals or beverages.

490. Seminar Fall. 1(1-0) Approval of department. Preparation and presentation of reports on a specialized aspect of food science.

828. Food Processing Concepts, Systems and Selected New Processes Winter. 3(3-0) 331, 332 or 440, or approval of department. Concepts of and requirements for processing systems and continuous processes. Use of computers in food processing; microwave heating of foods; radiation preservation of foods and related processing methods.

830. Thermal Processing of Food Products Winter. 4(3-3) 331; 332 or 440, or approval of department. Heating and cooling characteristics of foods in containers, thermal resistances of microorganisms, and derivation of process times and temperatures for pasteurization and sterilization.

832. Microbiology of Food Processing Winter. 3(2-3) 440 or approval of department. Control of food spoilage and food poisoning microorganisms in food processing and the role of bacterial spores in process selection.

833. Advanced Food Plant Management Fall of even-numbered years. 3(3-0) 421 or approval of department. Advanced concepts and strategy of policies and practices in the management of food plants.

834. Flavor Quality Control Spring of odd-numbered years. 4(3-3) Approval of department. Sensory methods used for food evaluation and panel analyses. Flavor chemistry and analytical methods. Sampling plans, control charts, and acceptance sampling for statistical quality control.

835. Carbohydrates in Foods Fall of odd-numbered year. 3(3-0) 333. The chemistry and food technology of mono-, di-, and polysaccharides.

850. Selected Topics in Food Science Fall, Winter, Spring, Summer. 2 to 4 credits. May re-enroll for a maximum of 12 credits. Approval of department. Advanced studies; food utilization, texture, additives, toxicants, food proteins, ingredient safety, nutrient stability, new processing techniques, flavors, quality control, storage stability, state and federal food regulations.

880. Special Problems in Food Science Fall, Winter, Spring, Summer. 1 to 3 credits. May re-enroll for a maximum of 12 credits. Approval of department. Investigation of food science areas of special interest to individual graduate students.

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

900. Food Science Seminar Fall, Winter, Spring. Fall and Spring of even-numbered year. May re-enroll for a maximum of 3 credits toward M.S. and 6 credits toward the Ph.D. Approval of department. Preparation and presentation of reports on a specialized aspect of research findings in food science.

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

Human Nutrition and Foods HNF

100. Elementary Food Preparation Fall, Winter, Spring. 4(2-4) Composition and properties of food related to quality characteristics; methods of preparation, evaluation of quality and use of selected foods.

101. Food and Society Fall, Winter. 3(3-0) Interdepartmental with and administered by Food Science. Analysis of the scientific, social and environmental aspects of food in determining the quality of man's life. Introduction into the principles of food preservation and safety.

102. Nutrition for Man Fall, Winter, Spring. 3(3-0) Fundamentals of nutrition with reference to diverse ways man provides for and attaches meaning to his food.

221. Food and the Consumer Fall, Winter. Spring. 3(3-0) Sophomores or approval of department. Factors affecting the food supply, consumer protection, food buying and management of human and material resources in feeding the family.

222. Laboratory for Food Management Fall, Winter, Spring. 2(0-4) 221 concurrently. Planning, organizing, preparing and serving meals with consideration of human and material resources as well as nutrient needs.
301. Dynamics in Dietetics I
Fall, 2(0-4) Approval of department, 461 concurrently.
Basic knowledge and experience in the functions and responsibilities of the professionally qualified dietitian. Local field trips required.

302. Dynamics in Dietetics II
Winter, 2(0-4) Approval of department, 301, 320 or concurrently and 462 concurrently.
Principles and practices in the duties of professionally qualified dietitians with focus on providing food service for groups and nutritional care for patients and/or clients. Local field trips required.

303. Dynamics in Dietetics III
Spring, 2(0-4) 302; 470 concurrently.
Principles and practice of instructional design and instruction applied to problems in dietetics. Local field trips required.

320. Food Service Systems
Fall, Winter, 5(3-4) 221. Juniors.
Management of food service systems with varying organizational patterns and objectives. Emphasis on human and material resources and their interrelationships in quality food production and service.

340. Experimental Foods
Fall, 4(3-4) CEM 132; MPH 200 or concurrently.
Physical and chemical changes occurring in foods during storage, preservation and preparation in terms of palatability, microbial safety and nutritive value. Emphasis on carbohydrates and fats.

341. Experimental Foods
Winter, 4(2-4) 340.
Continuation of 340. Emphasis on proteins.

400H. Honors Work
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 16 credits. Seniors, approval of department.

403. Fats and Carbohydrates in Food Systems
Fall, 4(3-3) 341 or approval of department.
Chemical and physical reactions in fat and carbohydrate food systems, including oils, gels, emulsions, etc. Food evaluation techniques will be introduced.

404. Role of Proteins in Food Systems
Winter, 4(3-3) 341 or approval of department.
Physical and chemical reactions with protein foods, meats, eggs, cheese, seeds. Emphasis on time-temperature data in relation to quality.

408. Cultural Aspects of Food
Spring, Summer of odd-numbered years. 3(3-0) Juniors.
A cross-cultural investigation of food and its consumption. Factors such as history, religion, food sources and socio-economic status are considered.

408L. Laboratory-Cultural Aspects of Food
Spring, 1(0-3) 100 or 340 or approval of department, 465 or concurrently.
Art and science of cookery in relation to historical, national, regional, racial and religious customs.

407. Patterns of Food Selection
Fall, Summer of even-numbered years. 3(3-0) 411 or 481.
Sociological and psychological factors influencing food choices. Evaluation of dietary habits in relation to nutritional needs of individuals.

409. Presentations in Foods and Nutrition
Winter, 4(2-4) 340; 411 or 461.
Principles and techniques of presenting foods and nutrition information as applied to teaching or promotional work.

411. Principles of Human Nutrition
Winter, Summer, 4(3-2) BCH 200.
Identification, function and sources of nutrients required by man. Metabolism as affected by deficiency or excess of specific nutrients.

453. Readings in Nutrition
Winter, Summer of odd-numbered years. 3(3) or approval of department.
A study of recent developments in research in human nutrition.

454. Readings in Foods
Fall, Summer of even-numbered years. 3(3-0) 340 or approval of department.
Selected topics in food research. Emphasis on experimental data and basic scientific principles related to food quality.

461. Energy Nutrients and Proteins for Human Nutrition
Fall, 4(4-0) BCH 200; PSL 332 or 241.
Metabolism of protein, fats and carbohydrates, as applied to nutritional requirements and food supplies of people.

462. Vitamins and Minerals for Human Nutrition
Winter, 3(3-0) 461.
Metabolism of vitamins and minerals as applied to the nutritional requirements and food supplies of people.

463. Nutrition and Human Development
Winter, 3(3-0) 461.
The role of nutrients in physiological systems and biochemical processes related to the perspective of human growth and development.

469. Physical and Physiological Growth of Children
Winter, Spring, 4(4-0) 102; three terms of natural science. Interdepartmental with and administered by the Department of Family and Child Sciences.
Physical and physiological growth patterns. Experimental evidence for nutritional requirements. Applications to feeding practices, and physical activity of children.

470. Clinical Nutrition
Spring, 4(4-0) 469.
Changes in physiological and/or biochemical functions or processes due to illness and use of modified diets as an essential part of treatment.

473. Clinical Chemistry in Dietetics
Spring, 4(3-2) 470 or concurrently.
Principles, procedures and interpretation of clinical laboratory methods with particular emphasis on their interpretation relative to nutritional status and therapeutic nutrition.

475. Community Nutrition
Spring, 4(3-3) 462 or approval of department.
Identification of nutritional needs of population groups and available resources in communities.

490. Practice of Dietetics
Fall, Winter, Spring, Summer. 12(2-30) May re-enroll for a maximum of 24 credits. 303, 470.
Application and integration of nutritional and managerial concepts related to the practice of dietetics.

495. Independent Study
Fall, Winter, Spring. (1 A 400.) Fall, Winter, Spring. 1 to 3 credits. May re-enroll for a maximum of 9 credits. Students approval of department.
Individual study of selected topics in foods, nutrition and food service management under staff guidance.

498. Field Study
Fall, Winter, Spring, Summer. 4 to 12 credits. May re-enroll for a maximum of 12 credits. Approval of department.
Planned program of research, observation, study or work in selected organizations under staff guidance.

500. Seminar in Foods and Nutrition
Fall, Winter, Spring, 1(1-0) 403 or 463.

502. Seminar in Food Service Management
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

503. Problems in Food Service Management
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

505. Experimental Foods II
Spring, 4(1-0) 404 or approval of department.
Planning, executing, and reporting individual research project. Data collection, evaluation and interpretation to demonstrate understanding of research techniques and attitudes, and an awareness of significant problems in the field.

513A. Special Studies in Nutrition
Fall, Winter, Spring, Summer. Variable credit. 461.

513B. Special Studies in Experimental Foods
Fall, Winter, Summer. Variable credit. 404; BCH 200 or 451 and 464.

513C. Special Studies in Food Service Management
Fall, Winter, Spring, Summer. Variable credit. Approval of department.
Special studies in facility management, manpower coordination and tools and methods of operational control.

516. Applied Human Nutrition
Spring, 3(3-0) 462.

525. Techniques in Nutrition Research
Winter of odd-numbered years. 1 to 3 credits. CEM 333; approval of department. Interdepartmental with and administered by the Animal Husbandry Department.
Use of specialized instruments and techniques. Laboratory safety. Management of laboratory animals. Development of abilities in areas of particular interest to individual students.
989. Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

992. Comparative Nutrition — Lipids and Carbohydrates
Winter of even-numbered years. 3(3-0)
BCH 452 and a previous course on principles of nutrition. Interdepartmental with the Department of Animal Husbandry.
Regulatory aspects of carbohydrate and lipid metabolism as influenced by nutrition in mammals. Emphasis on normal and abnormal physiological states such as obesity, ketosis and diabetes.

997. Comparative Nutrition — Protein Metabolism and Developmental Biology
Winter of even-numbered years. 3(3-0)
BCH 452, PSL 502 or concurrently. Interdepartmental with Animal Husbandry Department.
Protein quality assessment, protein status, protein caloric malnutrition, amino acid metabolism, protein turnover, digestion and absorption, hormonal control of protein metabolism, developmental aspects of protein metabolism and growth.

998. Comparative Nutrition — Minerals
Spring of odd-numbered years. 3 credits.
BCH 452, PSL 502. Interdepartmental with and administered by the Animal Husbandry Department.
Forms and location in body, metabolic roles, deficiency and toxicity signs, interrelationships, requirements and biological availability of sources.

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

FOOD SYSTEMS ECONOMICS AND MANAGEMENT
See Agricultural Economics

FOREIGN LANGUAGES
See German and Russian, Linguistics and Oriental and African Languages, and Romance and Classical Languages.

FORESTRY FOR
College of Agriculture and Natural Resources
In 305, 306, 402 and 430, field trips are scheduled for several consecutive days away from the campus for integrated field experience, primarily in the second half of fall term of the junior year, so that these courses must be taken concurrently. The core includes enrollment in other courses during that term. The approximate cost of these field trips is $200.

IDC. Resource Ecology and Man
For course description, see Interdisciplinary Courses.

402. Introduction to Forestry
Fall, Spring. 3(3-0)
Forestry in its broadest sense, including: historic development, forest growth, protection and management, economic, social and legal relationships, all with emphasis on northwestern states.

204. Forest Vegetation
Fall, Spring. 4(3-4) BOT 205 or approval of department.

220. Plants and Their Environment
Winter. 3(3-0) Interdepartmental with Natural Resources.
Edaphic and biotic interactions with important plants and land use concepts.

301. Quantitative Methods for Natural Resources
Winter. 4(3-2) MTH 109 or 111.
Mathematical techniques for investigation of natural resources. Probabilities, ordinary and partial differentiation, multiple regression, least squares, multiple comparison techniques.

304. Forest Ecology
Fall. 4(3-3) 204; BOT 205.
The forest is viewed as a biological community. Forest site relationships are quantified by examining the existing physical environment and relating it to the forest species occupying that community.

305. Silviculture
Spring. 4(3-3) 204, 304. Must be taken concurrently with 306, 402 and 430.
Natural and artificial forest reproduction methods: intermediate stand treatments; timber management; various climatic, edaphic and biotic environmental factors of the ecosystem and plant response, including structure, function and evaluation of species.

306. Forest Fire Protection and Use
Spring. 3(2-2) Juniors or approval of department. Must be taken concurrently with 304, 305, 402 and 430.
Causes and effects of forest fires. Combustion, fire behavior and fire weather. Prevention and control planning and techniques. Fire in forest land management. Extended field trips required.

309. Wood Technology
Fall. 3(3-3)
Structure of wood. Mechanical and physical properties of wood. Wood anatomy and relation to growth.

402. Forest Inventory
(302.) Spring. 4(2-6) 301. Must be taken concurrently with 305, 306 and 430.
Field and office techniques of forest inventory, with primary emphasis on timber resources. Extended field trips required.

409. Forest Hydrology
Fall. 3(3-0) CSS 210.
Hydrologic cycle, with emphasis on soil, water and ground water regimes; instrumentation and measurement of the various components. Effects of forest management on watersheds and water yields.

410. Forest Tree Improvement
Fall. 3(2-2)
Distribution of genetic variation in natural tree populations. Introduction, selection, breeding, hybridization, and polyploidy to obtain superior tree populations.

411. Tree Physiology
Winter. 3(3-0) BOT 301.
The fundamental principles of plant physiology with particular reference to the growth and development of woody plants, and consideration of the influence of genetic and environmental factors on physiological processes in trees.

424. Forest Soils Spring. 4(3-3) 302 or 304, CSS 210.
Interdepartmental with the Department of Crop and Soil Sciences.
Interrelationships of forest site and the growth of forests. Classification and productivity of forest soils. Effects of silvicultural and forest management practices on the soil. Two-day field trip required.

430. Timber Harvesting and Utilization
Spring. 4(3-3) 309. Must be taken concurrently with 305, 306 and 402.

431. Finishing, Preservation and Drying of Wood
Winter. 3(3-0) 309.
Properties, selection, application of decorative and protective coatings, wood preservatives and fire retardants. Air and kiln drying of lumber.

435. Law and Resources
Spring. 3(3-0) R D 417 or BIO 440.
Interdepartmental with and administered by the Department of Resource Development.
Legal theories, cases, statutes and constitutional considerations are applied to natural resource utilization. Private and public property interests in natural resources are illustrated through case studies of use conflicts.

432. Methods in Wood Science
Spring. 3(2-2) 309.
Application of standard laboratory testing procedures to the evaluation of basic properties of sawed wood and wood products. Laboratory exercises in wood microtechnique and wood finishing.

446. Range Management
Winter. 4(4-0) 203 or 304 or approval of department.
Development of range industry; grazing regions and reconnaissances; planning multiple-use management on forest ranges and watered areas.

450. Natural Resource Administration
Fall. Spring. 4(4-0) Seniors. Interdepartmental with the departments of Fisheries and Wildlife, Parks and Recreation Resources and Resource Development and Natural Resources.

454. World Forestry
Winter. 3(3-0)
Forest resources, forestry practices, and the forest economy throughout the world.