College of Agriculture, Forestry and Life Sciences

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The College of Agriculture, Forestry and Life Sciences offers advanced degrees in these areas of study; concentrations within a major area are listed under the degree-granting program.

Agricultural and Applied Economics
Agricultural Education
Animal and Food Industries
Animal Physiology
Applied Economics
Aquaculture, Fisheries and Wildlife Biology
Biochemistry
Biosystems Engineering
Botany
Business Administration
Chemistry
Communication
Computer Science
Consumer Economics
Developmental Psychology
Economics
Education
Epidemiology
Entomology
Environmental Science
Environmental Toxicology
Forest Resources
Genetics
Geography
Geology
Geosciences
Geophysics
Microbiology
Nutrition
Oceanography
Plant and Soil Environmental Sciences
Plant Science
Political Science
Poultry Science
Psychology
Public Administration
Rural Development
Sociology
Soil Science
Soil and Water Conservation
Statistics
Sustainable Agriculture
Toxicology
Urban Planning
Urban Studies
Veterinary Medicine
Zoology

Courses are offered in experimental statistics and agricultural mechanization to provide minors for students in other areas, and in biological sciences, biology instruction, community and rural development, rural sociology, nutrition, botany, crop and soil environmental sciences, horticulture, plant pathology and plant physiology to provide electives for students in other areas.

Graduate work in agricultural and applied economics enables the student to attain a higher degree of specialized professional competence and to secure a greater mastery of techniques for applying quantitative economic analysis to agricultural and natural resource problems. Industry, government and universities offer challenging opportunities in research, development, education, management and other related areas for persons with advanced training.

Special emphasis in the graduate program is placed on the economics of agricultural production and marketing, economic development, analysis of government programs and policies, and statistical techniques used in solving economic and institutional problems. Flexibility is achieved through choice of elective courses and selection of an M.S. thesis or Ph.D. dissertation topic. A nonthesis option is available as well. There is no language requirement for the M.S. or Ph.D. degree.

The Department of Agricultural and Applied Economics offers courses in support of the Master of Agriculture degree, a nonthesis program.

In addition to applicants with baccalaureate degrees in agricultural economics and related programs, the department encourages applications from students who have a sound background in general economics. In many cases, such students may be admitted to full graduate status without prerequisites other than those required of all graduate students.

**AP EC 602: Production Economics, 3 cr. (3 and 0) E**
Economic analysis of agricultural production involving the concept of the farm as a firm, principles for decision making, the quantitative nature and use of production and cost functions and their interrelations, and application of these principles to resource allocation in farms and among areas. Prerequisites: AP EC 308 and ECON 314.

**AP EC 603: Land Economics, 3 cr. (3 and 0) S**
Characteristics of land; physical, legal, social and economic principles and problems relating to the control and use of land resources. Prerequisite: AP EC 202 or ECON 200.

**AP EC 609: Commodity Futures Markets, 3 cr. (3 and 0) F, S**
Economic theory, organization and operating principles of agricultural commodity futures markets in the United States; speculating, hedging and investing in agricultural commodity futures contracts from the standpoint of the agricultural entrepreneur. Prerequisite: AP EC 202 or ECON 211.

**AP EC 611 (C R D 611): Regional Impact Analysis, 2 cr. (2 and 0) F**
Techniques for analysis of the growth and decline of regions including economic-base theory, shift-share, regional input-output, regional econometric models and fixed impact models. Prerequisite: AP EC 202 or ECON 211 and 212.

**AP EC 612 (C R D 612): Spatial Competition and Rural Development, 3 cr. (3 and 0) S**
Development of rural economic activity in the context of historical, theoretical and policy aspects of friction associated with spatial separation; location factors, transfer costs, location patterns and regional-growth policy. Prerequisite: AP EC 202 or ECON 211 or equivalent.

**AP EC 613: Advanced Real Estate Appraisal, 3 cr. (3 and 0) S**
Highest and best use analysis, data collection and analyses; advanced appraisal procedures for income, cost and comparable sales approach to real estate valuation; eminent domain, the appraisal of property in transition and specialized property. Prerequisite: AP EC 313, FIN 307 or permission of instructor.
AP EC 620: World Agricultural Trade, 3 cr. (3 and 0) S
Practical considerations of agricultural trade and trade policy analysis; role of international institutions; concepts of agricultural trade, analysis of trade policies of major trading partners/competitors and export/import marketing of products. Prerequisite: AP EC 309, ECON 412 or permission of instructor.

AP EC 625: Aquaculture Economics, 3 cr. (3 and 0) F (alternate years)
Application of economics and business principles by firms engaged in fish farming. Basic microeconomic theory applied to aquacultural enterprises; financial management, investment analysis and marketing management; public policy affecting aquaculture; international aquaculture development. Prerequisites: AP EC 202 and 309 and W F B 350 or permission of instructor.

AP EC 626 (CS ENV 626): Cropping Systems Analysis, 3 cr. (2 and 2) F
Application of agronomic and economic principles in solving problems relating to the production and marketing of agronomic crops. A case study with a detailed analysis of a farm, agribusiness or environmental situation and formal written and oral presentations of results. Prerequisite: AP EC 202, AGRIC 104, junior or senior standing.

AP EC 633: Agricultural Law and Related Environmental Issues, 3 cr. (3 and 0) S
Agricultural and agricultural-related environmental legal issues; review of laws, agencies, programs, court structure, torts, taxation, biotechnology, land and water use, regulated industry and environment liabilities as they relate to agriculture and natural resources. Prerequisite: LAW 322 or permission of instructor.

AP EC 652: Agricultural Policy, 3 cr. (3 and 0) S
Public agricultural policy programs in the United States; critical examination of current and proposed government policies and programs affecting the agricultural sector of the economy; economic considerations as related to past and current farm price and income problems. Prerequisites: AP EC 302 and 309.

AP EC 656: Prices, 3 cr. (3 and 0) S
Basic theory of price under competitive conditions and various modifications; nature, measurement and causes of daily, seasonal and cyclical price fluctuations; geographical price relationships; nature, function and behavior of futures markets; government price programs. Prerequisites: AP EC 308, ECON 314, EX ST 462.

AP EC 660: Agricultural Finance, 3 cr. (3 and 0) S
Principles and technique of financing in the agricultural sector; capital situation in agriculture, concepts of farm financial management, use of credit, capital markets, lending agencies and estate planning. Prerequisites: ACCT 200 or 201, AP EC 202.

AP EC 675: Economics of Wildlife Management and Policy, 3 cr. (3 and 0)
Integrated approach to the study of the economics of wildlife; determination of market and nonmarket value, single and multiple species management, enterprise cost and returns, marketing wildlife, leasing methods, complementary and competitiveness with agricultural and forestry enterprises, and timber and crop damage cost estimates and control. Prerequisite: AP EC 202, ECON 200, FOR 304, W F B 306 or permission of instructor.

AP EC 719: Professional Problems in Agribusiness Management, 3 cr. (3 and 0) F
Concepts and principles of agribusiness firm management; decision theory, information systems, systems analysis and organization theory applied to the organization, administration and management of agriculturally related businesses.

AP EC 800 (ECON 800): History of Economic Thought, 3 cr. (3 and 0)
Development of economic thought from early Greek to Keynesian economics; writings of major economists such as Smith, Ricardo, Marx, Marshall and Keynes; development of major economic theories.

AP EC 801 (ECON 801): Microeconomic Theory, 3 cr. (3 and 0) F
Microeconomic theory and its use to analyze and predict the behavior of industries, firms and consumers under various market conditions.

AP EC 802 (ECON 802): Advanced Economic Concepts and Applications, 3 cr. (3 and 0)
Rigorous development of price theory under alternative product and resource market structures. Prerequisite: Permisision of instructor.

AP EC 804 (ECON 804): Applied Mathematical Economics, 3 cr. (3 and 0)
Mathematical tools needed in economic analysis: matrix algebra, differentiation, unconstrained and constrained optimization, integration and linear programming.

AP EC 806 (ECON 806): Econometrics I, 3 cr. (3 and 0)
Application of econometric techniques and stochastic models to economic problems; distribution theory, simple and multiple regression modeling, hypothesis testing and other issues in regression analysis.

AP EC 807 (ECON 807) (MA SC 807): Econometrics II, 3 cr. (3 and 0) F
Econometric models expressed as systems of equations; problems of identification, parameter estimation, measurement errors and statistical inference; techniques of simulation, forecasting, model validation and interpretation.

AP EC 808 (ECON 808) (MA SC 808): Econometrics III, 3 cr. (3 and 0) S
Continuation of AP EC 807; current economic models and estimation procedures. Prerequisite: AP EC (ECON, MA SC) 807.

AP EC 809 (ECON 809): Advanced Natural Resource Economics, 3 cr. (3 and 0) S
Applications of economic theory to problems of natural resource management; epistemological considerations; rent theory; public and private investment criteria; benefit-cost analysis and general equilibrium management models. Prerequisite: AP EC 802 or permission of instructor.

AP EC 810 (ECON 810): Natural Resources Management and Policy, 3 cr. (3 and 0) F
Economic, institutional and legal aspects of control and management of natural resources; concepts of economic science applied to public policy questions related to land and water resources. Specialized background in economics not necessary. Prerequisite: Permission of instructor.

AP EC 811 (ECON 811): Economics of Environmental Quality, 3 cr. (3 and 0) F (even numbered years)
Economic, institutional and legal aspects of control and management of natural resources; concepts of economic science applied to public policy questions related to land and water resources. Specialized background in economics not necessary. Prerequisite: Permission of instructor.

AP EC 816 (ECON 816): Labor Economics, 3 cr. (3 and 0)
Wage and employment theory; labor markets; labor history; current problems in labor and manpower economics.

AP EC 817 (ECON 817): Advanced Production Economics, 3 cr. (3 and 0) S
Production economics theory in a quantitative framework; technical and economic factor-product, factor-factor and product-product relationships in single- and multiproduct firms under conditions of perfect and imperfect competition in both factor and product markets. Prerequisite: AP EC 804 or permission of instructor.

AP EC 820 (ECON 820): Public Finance, 3 cr. (3 and 0)
Impact of government on resource allocation, income distribution and stability; role of regulation; principles of taxation.
AP EC 821 (ECON 821): Public Choice, 3 cr. (3 and 0)
Economic theory to analyze collective decisions: the pure theory of collective choice; applied analyses of democratic governments and their policy processes.

AP EC 822 (ECON 822): Contemporary Public Policy, 3 cr. (3 and 0) S
Contemporary public policy, including price and resource policy, affecting rural areas; public participation, or the lack thereof, related to programs designed to implement public policy.

AP EC 824 (ECON 824): Organization of Industry, 3 cr. (3 and 0)
Structure of markets and firms; forces that determine the size of firms and the boundaries of markets; behavior of firms, both singly and in concert, to exploit market positions.

AP EC 826 (ECON 826): Economic Theory of Government Regulation, 3 cr. (3 and 0)
Scope of governmental regulation in the economy of the United States, its evolution and development; application of the tools of economic analysis to the issues of regulated enterprise. Prerequisite: ECON 314 or equivalent.

AP EC 827 (ECON 827): Economics of Property Rights, 3 cr. (3 and 0)
Evolution and impact of various property rights institutions on individual behavior and the subsequent use of resources; importance of property rights structures in the organization of business and in managerial decision-making. Prerequisite: AP EC (ECON) 801.

AP EC 828 (ECON 828): Market Structure in Agricultural Industries, 3 cr. (3 and 0)
Market structure and other approaches related to agricultural marketing. Individual assignments in the student's field of interest required. Prerequisite: Permission of instructor.

AP EC 831 (ECON 831): Economic Development, 3 cr. (3 and 0)
Economic analysis of development of urban areas within the system of cities; central place theory and general equilibrium models of interregional economic activity emphasizing central place systems, spatial interaction and stochastic processes; internal development of the city focusing on housing and land use patterns, transportation and urban form.

AP EC 832 (ECON 832): Community and Regional Economics, 3 cr. (3 and 0) F
Economic theory and research methods needed to understand happenings in the regional and community economy and how local and non-local decisions influence local economic change. Prerequisite: C R D 612 or permission of instructor.

AP EC 840 (ECON 840): International Trade Theory, 3 cr. (3 and 0)
Theory of free trade from Ricardo to present; theory and application of optimal and second-best tariffs; recent empirical testing of trade and tariff theory. Prerequisites: ECON 314 and 802 or permission of instructor.

AP EC 841 (ECON 841): International Finance, 3 cr. (3 and 0)
Financial economics of decision-making in a multinational environment featuring autonomous governments and multiple currencies; examination of the macroeconomic problems of unemployment and inflation in an international economy, management of exchange rate risk, credit risk, political risk and taxation. Prerequisite: ECON 315 or equivalent.

AP EC 852: Research Methods for Agricultural Economists I, 2 cr. (2 and 0) S
Linear models and their application to problems related to the economics of agriculture; simplex method, developing farm planning LP models, solving LP problems using the MPSX computer program, parametric analysis techniques and other LP applications related to rural problems.

AP EC 855 (ECON 855): Financial Economics, 3 cr. (3 and 0)
Modern theory of corporate finance; basic theories of efficient markets, portfolio selection, capital asset pricing, option pricing and agency costs. Prerequisite: ECON 801 or permission of instructor.

AP EC 881: Internship in Community and Resource Development, 1-6 cr.
Supervised employment in an agency dealing with socioeconomic aspects, community development and/or natural resource management; monthly reports covering student's experience required. Prerequisite: 18 semester hours of graduate credit.

AP EC 888 (ECON 888): Directed Readings in Economics, 1-3 cr. (1-3 and 0) F
Directed reading and research in the student's field of interest. May be repeated for up to three credit hours.

AP EC 891: Master’s Thesis Research, credit to be arranged

AP EC 899 (ECON 899): Selected Topics, 1-3 cr. (1-3 and 0) F, S
Selected topics under guidance of a professor. Course may be repeated for a maximum of six credits.

AP EC 901 (ECON 901): Price Theory, 3 cr. (3 and 0)
Neoclassical paradigm of market price and quantity; rigorous consideration of consumer behavior, the theory of the firm and market equilibrium, production and resource demands, and the supply of resources. Prerequisite: ECON 801 or equivalent.

AP EC 903 (ECON 903): General Equilibrium and Welfare Theory, 3 cr. (3 and 0)
Continuation of advanced price theory; development of the theory of general equilibrium and the economics of welfare; the capital theory and the determination of the rate of interest. Prerequisite: AP EC 901.

AP EC 904 (ECON 904): Seminar in Resource Economics, 3 cr. (3 and 0) F
Special problems and recent periodical literature relating to the control, management, development and use of land and water resources in the United States and in other parts of the world. Prerequisite: AP EC 403/603.

AP EC 905 (ECON 905): Advanced Macroeconomic Issues, 3 cr. (3 and 0)
Current unsettled issues in macroeconomic analysis; disequilibrium macro models, macro models of open economies, rational expectations and its critics, government stabilization policies and the controversy surrounding the concept of Ricardian equivalence. Prerequisite: ECON 805 or equivalent.

AP EC 906 (ECON 906): Seminar in Area Economic Development, 3 cr. (3 and 0) S
Recent research developments in economic development; review of research publications, journal articles and other literature; objectives, analytical techniques and procedures used in area or regional development efforts. Prerequisite: AP EC 806.

AP EC 917 (ECON 917): Advanced Seminar in Labor Economics, 3 cr. (3 and 0) S
Continuation of ECON 816, bridging the gap between theory and modern empirical research in labor economics; emphasis on reading recent empirical research papers to understand the techniques of modern research in labor economics. Prerequisite: ECON 816.

AP EC 950 (ECON 950): Monetary Economics, 3 cr. (3 and 0)
Economic analysis of money in our economy and effects of monetary policy on prices, interest rates, output and employment.

AP EC 991 (ECON 991): Doctoral Dissertation Research, credit to be arranged

C R D 611 (AP EC 611): Regional Impact Analysis, 2 cr. (2 and 0) F
Techniques for analysis of the growth and decline of regions including economic-base theory, shift share, regional input-output, regional econometric models and fixed impact models. Prerequisite: AP EC 202 or ECON 211 and 212.
The Master of Agricultural Education is a professional degree designed to enhance the human resource skills in agriculture and education. The flexible program provides a core of planning, delivery, evaluation and administrative strategies while encouraging specialization in teacher education, adult extension education, agricultural communications, youth development or technology transfer. Degree recipients hold positions as agricultural teachers, extension agents, agricultural and environmental agency employees, as well as human resource development specialists in the agricultural industry.

Candidates for the degree are required to:
1. Plan an individual program of study in consultation with the major adviser and graduate committee;
2. Complete a minimum of three semester hours in adult education, three semester hours in research methods and three semester hours in statistics;
3. Complete a minimum of 12 semester hours in the major field; and
4. Complete a minimum of six semester hours in an area of concentration outside the major field.

A minimum of 30 semester hours is required for the professional degree. At least one-half of the credit hours in the student’s program must come from courses numbered 700 or above. The student’s program of study must be approved by his/her advisory committee.

**AG ED 601: Methods in Agricultural Education, 3 cr. (2 and 3) F**

Appropriate methods of teaching vocational agriculture in high schools; procedures for organizing teaching programs, teaching high school students and directing FFA activities.

**AG ED 603: Principles of Adult/Extension Education, 3 cr. (3 and 0)**

Overview of adult/extension education and adult learning. Selection of adult education providers will be reviewed with emphasis on extension. Prerequisite: Junior standing or permission of instructor.

**AG ED 610: History, Philosophy and Future of the Land-Grant System, 3 cr. (3 and 0)**

Broad perspective of the American land-grant system; examination of assumptions and investigation of the concepts, paradigms, issues, strategies and programs of the system; organizational structures, research methodologies, change processes and adoption-diffusion strategies. Prerequisite: Junior standing or permission of instructor.

**AG ED 623: Curriculum, 2 cr. (2 and 0)**

Curriculum goals and related planning for career and continuing education programs.

**AG ED 625: Teaching Agricultural Mechanics, 2 cr. (1 and 3)**

Organizing course content, performing and managing an agricultural mechanicals laboratory, shop safety, microteaching demonstrations of psychomotor skills and methods of teaching manipulative abilities.

**AG ED 628: Special Studies in Agricultural Education, 1-3 cr. (1-3 and 0)**

Individual or collective study of selected topics and/or problems in agricultural education to meet the particular needs of the clientele enrolled. May be taken for a maximum of six credits.

**AG ED 631: Methods in Environmental Education, 3 cr. (3 and 0)**

Various techniques and strategies for teaching environmental education. Applicable to elementary, high school and adult-level teachers.

**AG ED 632: Visual Media for Agribusiness, 3 cr. (2 and 3)**

Theoretical and practical course for professionals in agriculture with major emphasis on visual communications.

**AG ED 640: Program Development in Adult/Extension Education, 3 cr. (3 and 0)**

Principles, theory and practice in planning and conducting educational programs in adult/extension settings. Prerequisite: Junior standing or permission of instructor.

**AG ED 645: Evaluation of Adult/Extension Education Programs, 3 cr. (3 and 0)**

Philosophy and methodology of conducting evaluations of adult educational programs such as extension or adult continuing education programs: designing and conducting different types of program evaluations including appropriate data collection methods. Prerequisite: Junior standing or permission of instructor.

**AG ED 650: Modern Topics and Issues, 3 cr. (3 and 0)**

A major area of concern to teachers of agriculture and county agents will be selected for intensive study at least one semester prior to offering the course. Team teaching with faculty from other departments in the College of Agriculture, Forestry and Life Sciences will be utilized when feasible. Prerequisite: Senior standing or relevant experience.

**AG ED 680 (THRD 680) (ED F 680): Educational Applications of Microcomputers, 3 cr. (2 and 2)**

Fundamentals of computer applications for teachers; competency in general computer applications such as word processing and database management; educational uses of the Internet and computer-assisted instruction; legal and ethical issues and the impact of computer technology upon society. Prerequisites: Admission to a teacher education program; graduate standing.

**AG ED 682 (ED F 682) (THRD 682): Advanced Educational Applications of Microcomputers, 3 cr. (2 and 2)**

Knowledge and skills needed to apply microcomputer technology to the utilization and generation of educational software in accordance with sound educational principles. Prerequisite: ED F (AG ED, THRD) 480/680.

**ED 736: Internship: Teaching, 3 cr. (1 and 6)**

Professional competency and program development through classroom and practical experiences in planning, conducting and evaluating educational programs.
AG ED 737: Internship in Agribusiness Firms, 3 cr. (1 and 0) SS
Classroom and practical experiences in selected agribusinesses and industries. Students identify and practice entry-level competencies required in selected agribusiness and natural resource management enterprises.

AG ED 750: Special Institute Course: Selected Topics in Agricultural Education, 1-3 cr. (1-3 and 0)
Subject areas organized according to institute needs. Topics vary from course to course. May be repeated for a maximum of nine credits. Prerequisite: Permission of instructor.

AG ED 801: Systems for Technology Transfer, 3 cr. (3 and 0)
Development of a philosophical foundation and utilization of cooperative learning strategies and techniques to disseminate effectively technological change for expanding clientele and diverse socioeconomic environments.

AG ED 803: Evaluation of Instructional Programs, 3 cr. (2 and 3) F (odd numbered years)
Measurement and evaluation in general and as applied to agricultural and vocational education; selection and/or development and use of instruments for appraising educational outcomes of student achievement and total programs. Prerequisite: Permission of instructor.

AG ED 804: Special Problems, 3 cr. (2 and 3)
Planning, conducting and reporting a special problem in agricultural and vocational education appropriate to students' needs.

AG ED 805: Administration and Supervision in Agricultural Education, 3 cr. (3 and 0) S (even numbered years)
Developing a philosophy of education including application of administrative concepts in supervising agricultural education programs. Prerequisite: Experience in agricultural education.

AG ED 815: Teaching Agricultural and Power Mechanics, 3 cr. (2 and 3) SS (odd numbered years)
Methods of determining course content, organizing teaching modules in logical sequence, equipping shop, teaching agricultural and power mechanics to farm and agribusiness clientele, providing individualized instruction and developing off-farm experience programs.

AG ED 821: Theories and Practices of Adult Education, 3 cr. (3 and 0) S
Recent research on adult learning; a comparison of the assumptions supporting pedagogy and andragogy; teaching adults through formal classes and community organizations. Prerequisite: PSYCH 201 or ED 302 or equivalent.

AG ED 869: Seminar, 1-3 cr. (1-3 and 0)
Students and faculty review current topics in agricultural education.

AG ED 889 (ED 889) (CTE 889): Research in Education, 3 cr. (3 and 0)
Problem selection; types of educational research and techniques employed; use of ERIC system and computer program packages; interpretation of research findings.

AG M 601: Environmental Control for Plants and Animals, 1 cr. (1 and 0)
Basic concepts of environmental control for plant and animal production and human housing; heat transfer, psychrometry, heating, cooling, ventilation and heat/moisture balances. Prerequisite: PHYS 200 or permission of instructor.

AG M 602: Drainage, Irrigation and Waste Management, 3 cr. (2 and 3)
Continuation of AG M 302. Basic soil-water-plant relationships are used to determine the need for and methods of irrigation, drainage and waste management; irrigation methods, drainage needs, drainage methods and waste-treatment methods. Prerequisite: AG M 302.

AG M 603: Structures for Plants and Animals, 2 cr. (1 and 3)
Structures for agricultural production systems are planned and designed with regard to function, materials, loads and component sizes; utilizing the approach of an engineering or construction technologist. Prerequisite: PHYS 200 or permission of instructor.

AG M 606: Mechanical and Hydraulic Systems, 3 cr. (2 and 3)
Power transmission systems for agricultural production with emphasis on mobile equipment; characteristics, requirements and design of both V-belt drive and roller-chain drives; hydraulic power transmission systems including pumps, actuators, control devices and hydraulic circuitry. Prerequisite: AG M 206, PHYS 207 or permission of instructor.

AG M 652: Farm Power, 3 cr. (2 and 3)
Study of tractors with emphasis on internal combustion engines and support systems necessary for their proper functioning; application of power, maintenance, adjustment and general repair. Prerequisite: PHYS 207 or permission of instructor.

AG M 660: Farm and Home Utilities, 3 cr. (2 and 3)
Electric and other utilities on the farm and in the home; selection, installation and maintenance of wiring systems, lighting systems, motors, controls, water systems and waste disposal systems. Pre-

AG M 712: Farm Machinery Management, 3 cr. (2 and 3)
Selection, functional analysis and maximum utilization of existing and developing farm machinery; computer applications to programming of field operations; available capital and labor; machine size; critical field operations; growing degree days; weather; maintenance equipment, procedures and scheduling.

AG M 771: Selected Topics in Agricultural Mechanization, 1-3 cr. (1-3 and 0)
Selected topics not covered in other course offerings; performance measured by oral or written reports or examinations. May be repeated for a maximum of six credits.

AG M 781: Special Problems, 1-3 cr. (1-3 and 0)
Independent analysis through literature review and laboratory or field research. Requires written documentation. May be repeated for a maximum of six credits.

AG M 772: Transfer, 3 cr. (3 and 0)
A specific degree is not offered by this department, but the above degrees are granted through interdepartmental, interdisciplinary programs. Studies in animal production, nutrition, reproduction, meat and milk products, health and microbiology are offered. Excellent animal and laboratory facilities are available for graduate student research. Candidates must complete a research project and submit a thesis or dissertation. The department also participates in the animal industries option of the Master of Agriculture degree.

Animal and Food Industries
Glenn P. Birrenkott, Chair, Department of Animal and Veterinary Sciences

Major Degree
Animal and Food Industries M.S.

Students may concentrate in animal science, dairy science, food science or poultry science. See departmental listings in animal and veterinary sciences and in food science and human nutrition for course descriptions. Candidates for the M.S. degree are required to complete a thesis.

Animal and Veterinary Sciences
Glenn P. Birrenkott, Chair, Department of Animal and Veterinary Sciences

Majors Degrees
Animal and Food Industries M.S.
Animal Physiology M.S., Ph.D.
gestion and reproduction. Students study organ system(s) of their choice using quantitative physiological techniques. Prerequisites: AN PH 301, AVS 201 or permission of instructor.

AVS 601: Beef Production, 4 cr. (3 and 2) F
Breeding, feeding, reproduction and management of beef cattle with emphasis on production systems integrating disciplines of animal agriculture into management plans and alternatives; practical applications of beef production and management practices. Prerequisites: AVS 202 and 370.

AVS 602: Poultry Management, 4 cr. (3 and 2) S (odd numbered years)
Continuation of AVS 201 emphasizing management, decision-making and application of technology to the commercial production of poultry and poultry products. Prerequisite: AVS 201 or permission of instructor.

AVS 603: Laboratory Techniques, 3 cr. (2 and 3) F
Research and quality control techniques commonly used in dairy science and related agri-sciences. Prerequisites: CH 101 and 102.

AVS 604: Dairy Cattle Feeding and Management, 4 cr. (3 and 2) F (alternate years)
Fundamental principles in the care, feeding and management of dairy cattle of all ages; general consideration in selecting a breed and the individual cow, calf raising, growth and development of dairy heifers, care and maintenance of the milking herd and feeding for milk production. Prerequisites: AVS 202 and 370.

AVS 606: Special Problems, 1-3 cr. (0 and 3-9)
Research problems of special interest to the student; laboratory experience and concentrated study in an area not covered in depth in other courses. May be taken for a cumulative maximum of three credits. Prerequisite: Permission of instructor.

AVS 607: Equine Theriogenology, 3 cr. (2 and 2) F
Review of reproductive anatomy and physiology in the mare and stallion; induction of estrus and ovulation; practices for optimal reproductive efficiency; semen collection, preservation and transport; embryo transfer; regulatory aspects of reproduction by various breed registries; noninfectious and infectious diseases affecting reproduction; reproductive health management. Prerequisite: AVS 453.

AVS 608: Pork Production, 4 cr. (3 and 2) S
Breeding, feeding, grading, marketing and management of swine. Practical applications from all phases of the production cycle will be outlined in problem form to develop the student’s problem-solving ability. Prerequisites: AVS 202 and 370.

AVS 609: Selected Topics, 1-3 cr. (1-3 and 0)
Selected topics of interest in AVS not covered in other courses. May be repeated for credit. Prerequisite: Permission of instructor coordinating the topic.

AVS 612: Horse Production, 4 cr. (3 and 2) S
Feeding, breeding and management of the horse in relation to health, genetics, reproduction, nutrition and selection. Prerequisites: AVS 202 and 370.

AVS 618: Muscle Biology and Lean Meats, 3 cr. (2 and 2)
Biology of animal muscle, connective, fat and bone tissue with laboratory emphasis on low-fat sausages and restructured, value-added meat products. Prerequisite: AVS 202.

AVS 630: Dairy Processing I, 4 cr. (3 and 3) F (alternate years)
Processing and distribution of fluid milk and other dairy products with emphasis on composition, quality control, chemical, microbiological and public health aspects. Prerequisites: BIOL 103 and 104, CH 101 and 102.

AVS 658: Avian Microbiology and Pathology, 2 cr. (0 and 3-9)
Diseases affecting reproduction; reproductive, developmental, and biological processes; effects of naturally occurring toxins; hand formulation; linear programming. Prerequisite: AVS 202 and permission of instructor.

AVS 661: Physiology of Lactation, 2 cr. (2 and 0) S
Anatomy and development of the mammary gland; physiological and biochemical regulation of mammary growth and milk secretion with emphasis on farm animals and reference to other mammals. Prerequisites: AVS 202 and BIOC 110.

AVS 670: Animal Breeding, 3 cr. (3 and 0) S
Fundamental principles relating to the breeding and improvement of livestock including variation, heredity, selection, linebreeding, inbreeding, crossbreeding and other related subjects. Prerequisite: AVS 202 or permission of instructor.

AVS 801: Selected Topics, 1-3 cr. (1-3 and 0)
Current topics of special interest in animal, dairy or veterinary sciences not covered in other courses. May be repeated for credit. Prerequisite: Permission of coordinating instructor.

AVS 802: Meat Technology, 3 cr. (3 and 0)
Biochemistry, histology and microbiology of fresh, frozen, cured, smoked and processed meats; quality of meats and meat products; processing methods; nutritive value; research techniques. Prerequisites: AVS 253 and 255.

AVS 803: Physiology of Reproduction and Milk Secretion, 3 cr. (3 and 0)
Advanced concepts of steroidogenesis, gametogenesis, fertilization, placentaion, embryogenesis, embryonic-endometrial relationships, parturition and lactation, and the influence of hormones on these processes. Students evaluate the most recent scientific literature in these areas for information, experimental methods and validity of authors’ conclusions, and select a problem, review related literature and write a research proposal for solving the problem. Prerequisites: AVS 453 and 461 or permission of instructor.

AVS 804: Methods in Animal Breeding, 3 cr. (3 and 0)
Gene and zygotic frequency, system of mating, heritabilities, genetic consequences of selection and criteria for evaluating improvement in all domestic livestock. Prerequisite: AVS 652.
Animal and Veterinary Sciences

Animal Physiology

Glenn P. Birrenkott, Chair, Department of Animal and Veterinary Sciences

<table>
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<tr>
<th>Major</th>
<th>Degrees</th>
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<tbody>
<tr>
<td>Animal Physiology</td>
<td>M.S., Ph.D.</td>
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</table>

Animal physiology is a graduate program developed and offered by faculty in the Department of Animal and Veterinary Sciences. Applicants should have a strong background in the biological and physical sciences. Students with deficiencies in these sciences may be admitted provided they correct these deficiencies during the first year of their program of study.

Students enrolled in the M.S. program are required to complete BIOCH 623, EX ST 801 and BIOSC 659, except as waived by the student’s graduate advisory committee if equivalent courses have been taken already. Additional course work may be taken in areas of the student’s interest as approved by the graduate advisory committee. The student’s academic program and research emphasize a study of physiological processes, particularly those relating to reproduction, endocrinology, digestion and environmental factors. A thesis or dissertation is required.

The Ph.D. degree does not have formal course work requirements, but it is recognized that students will have individual deficiencies. Therefore, it is the responsibility of the student and his or her major adviser, in consultation with the graduate advisory committee, to prescribe course work to correct these deficiencies. All students majoring in animal physiology are required to complete AN PH 851.

AN PH 802: Selected Topics, 1-3 cr. (1-3 and 0-3) F, S
Current topics of special interest in animal physiology not covered in other courses. May be repeated for a maximum of six credits. Prerequisite: Permission of instructor.

AN PH 806: Care and Use of Research Animals, 3 cr. (1 and 6) F
Demonstration and practice of humane use and care of animals in research; pain, analgesia and anesthesia; regulatory aspects of the use of animals in teaching and research; surgical techniques and sample collection. Prerequisite: BIOSC 659 or permission of instructor.

AN PH 807: Special Problems in Animal Physiology, 1-3 cr. (1-3 and 0) Research not related to a thesis. May include a comprehensive review of related literature.

AN PH 808: Current Concepts in Endocrinology, 3 cr. (3 and 0) S
Advanced concepts relevant to interrelationships between the nervous and endocrine systems as they influence growth and development; body metabolism and regulatory mechanisms, reproduction and lactation. Prerequisite: BIOSC 680, BIOCH 817 or permission of coordinator.

AN PH 812: Digestive-Metabolic, Excretory and Respiratory Physiology, 5 cr. (4 and 3) F (even numbered years)
Advanced concepts of mechanisms and functions of gastrointestinal tract (mastication, salivation, digestion, absorption, metabolism, excretion), kidney (anatomy, filtration, secretion, reabsorption) and respiratory systems (transport, exchange and utilization of gases); the action of the nervous system, hormones and pharmacologic agents upon these organ systems. Prerequisite: BIOSC 659 or permission of course coordinator.

AN PH 814: Membrane, Cardiovascular and Neuromuscular Physiology, 5 cr. (4 and 3) S (even numbered years)
Advanced concepts in membrane physiology (permeability, action potentials, specialized functions), cardiovascular physiology (functions of the heart, blood-vascular system in maintaining acid-base balance, clotting mechanisms, homeostasis, circulation), neuromuscular physiology (anatomy and function of the nervous system, special senses, reflexes, control of muscular activity); the action of several pharmacologic agents on muscle and nerve functions. Prerequisite: BIOSC 659 or permission of course coordinator.

AN PH 851: Animal Physiology Seminar, 1 cr. (1 and 0) F, S
Current research and development in animal physiology through related literature and student and faculty participation. May be repeated for a maximum of two credit hours.

AN PH 891: Master’s Thesis Research, credit to be arranged

AN PH 991: Doctoral Dissertation Research, credit to be arranged

The following courses offered by various departments represent possible electives for the student in animal physiology.

AVS 653: Animal Reproduction, 3 cr. (2 and 2) S
Reproductive physiology and endocrinology of mammals with emphasis on farm animals and frequent reference to reproduction in laboratory animals and humans. Prerequisites: AVS 202 and AN PH 301.

AVS 655: Animal Reproductive Management, 1 cr. (0 and 3) S
Physiology and endocrinology of pregnant and nonpregnant cows; methods of artificial insemination, pregnancy detection and computer recordkeeping for achieving a high level of reproductive efficiency in cattle. Prerequisites: AVS 202, AN PH 301, and to be taken concurrently or to follow AVS 453/853.

AVS 661: Physiology of Lactation, 2 cr. (2 and 0) S
 Anatomy and development of the mammary gland; physiological and biochemical regulation of mammary growth and milk secretion with emphasis on farm animals and reference to other mammals. Prerequisites: AVS 202 and BIOCH 210.

AVS 803: Physiology of Reproduction and Milk Secretion, 3 cr. (3 and 0) S
Advanced concepts of steroidogenesis, gametogenesis, fertilization, placentation, embryogenesis, embryonic-endometrial relationships, parturition and lactation, and the influence of hormones on these processes. Students evaluate the most recent scientific literature in these areas for information, experimental methods and validity of authors’ conclusions, and select a problem, review related literature and write a research proposal for solving the problem. Prerequisites: AVS 453 and 461 or permission of instructor.

AVS 825: Immunobiology, 3 cr. (3 and 0) S
Conceptual approach to immunobiology emphasizing the molecular and cellular aspects. Classical and current literature
is the major source for the discussion/lecture format. Prerequisite: Permission of instructor.

BIOCH 606: Physiological Chemistry, 3 cr. (3 and 0)
Chemical basis of the mammalian physiological processes of muscle contraction, nerve function, respiration, kidney function and blood homeostasis; composition of specialized tissue such as muscle, nerve, bone and blood; regulation of water, electrolytes and acid-base balance. Prerequisites: BIOCH 210 or organic chemistry.

BIOCH 623: Principles of Biochemistry, 3 cr. (3 and 0)
Chemistry of amino acids, monosaccharides, fatty acids, purines, pyrimidines and associated compounds; their properties and the relationship between structure and function that make them important in biological processes; use of modern techniques. Prerequisites: CH 224 or equivalent.

BIOCH 632: General Biochemistry Laboratory I, 2 cr. (0 and 4)
Experiments selected to illustrate current methods used in biochemical research. Corequisites: BIOCH 423/623 or 431/631.

BIOCH 634: General Biochemistry Laboratory II, 2 cr. (0 and 4)

BIOCH 680: Vertebrate Endocrinology, 3 cr. (3 and 0)
Basic principles of neuro-endocrine integration and homeostatic maintenance in vertebrates; comparative morphology and physiology of various endocrine tissues and hormone chemistry and modes of action. Prerequisite: BIOCH 303, organic chemistry or permission of instructor.

ENT 640: Insect Behavior, 3 cr. (2 and 3) F (odd numbered years)
Insect behavior in an evolutionary and ecological perspective. Laboratories emphasize generation and testing of hypotheses and observation, description and quantification of insect behavior. Prerequisite: ENT 301 or permission of instructor.

EX ST 801: Statistical Methods, 4 cr. (3 and 3) F, S
Role and application of statistics in research; estimation, test of significance, analysis of variance, multiple comparison techniques, basic designs, mean square expectations, variance components analysis, simple and multiple linear regression and correlation, and non-parametric procedures. Prerequisite: Permission of instructor.

EX ST 803: Regression and Least Squares Analysis, 3 cr. (3 and 0) F
Regression analysis; simple and multiple linear, curvilinear and multiple curvilinear; curve fitting; least squares; computer techniques for fitting of constants and analysis of planned experiments. Prerequisite: EX ST 801.

EX ST 805: Design and Analysis of Experiments, 3 cr. (3 and 0) F, S
Basic designs and analysis; data transformations; single degree of freedom, orthogonality and responses in ANOVA; covariance; response surfaces; incomplete blocks; introduction to least squares analysis of experiments; uses of standard computer programs for selected analyses. Prerequisite: EX ST 801.
ANIMAL PHYSIOLOGY

Micro 614: Basic Immunology, 3 cr. (2 and 3) F
Nature, production and function of basic immune responses in animals; procedures and mechanisms of antigen-antibody and other immune reactions. Prerequisite: Micro 305.

Micro 811: Bacterial Cytology and Physiology, 4 cr. (4 and 0) S
(odd numbered years)
Structure, chemistry and physiology of the various bacterial cell components; physiology of bacterial growth and reproduction in batch, continuous and synchronous cultures; economy of the bacterial cell including endogenous metabolism and maintenance requirements; physiology of bacterial death; regulation of enzyme and nucleic acids syntheses. Prerequisites: Micro 605, Bioch 623 and Mthsc 206 or permission of instructor.

Applied Economics

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<th>Major</th>
<th>Degree</th>
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<tr>
<td>Applied Economics</td>
<td>Ph.D.</td>
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The graduate program in applied economics utilizes the facilities and faculty of the Department of Agricultural and Applied Economics and the Department of Economics in the College of Business and Behavioral Science. Students may carry out their dissertation research under the direction of a faculty member from either department.

Aquaculture, Fisheries and Wildlife Biology

<table>
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<tr>
<th>Majors</th>
<th>Degrees</th>
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<tr>
<td>Aquaculture, Fisheries and Wildlife Biology</td>
<td>M.S.</td>
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<tr>
<td>Fisheries and Wildlife Science</td>
<td>Ph.D.</td>
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Those who are interested in pursuing a graduate degree in aquaculture, fisheries or wildlife should have sound undergraduate training in the biological or related sciences. Initially, applicants should contact the faculty members whose research interests are closest to their own. Programs of study are designed to emphasize relationships between wild animals and their changing environments and production of aquatic organisms. Admission to either the master’s program or the doctoral program will require acceptance by the Graduate School and the Graduate Student Admission Committee of AFW. The Graduate Student Admission Committee of AFW will base their acceptance recommendation to the Graduate School on previous course work, GRE scores, letters of recommendation, undergraduate background and current research interests. Students are required to have completed a B.S./B.A. degree, preferably in a natural science, with a minimum of 30 semester hours in natural sciences. In addition, an M.S. in natural resource biology or related area usually is preferred, but not required, for acceptance into the doctoral program. Students approved for acceptance without the appropriate course background will be required to make up these deficiencies as outlined by the Graduate Student Admission Committee and consistent with Graduate School admission policies.

Requirements for the M.S. in aquaculture, fisheries and wildlife include 24 semester hours of course work, six hours of research credits (W F B 891), an acceptable thesis based on original research and satisfactory performance on a final oral examination. Additional course work usually includes subjects such as experimental statistics, biological sciences and forestry. Thesis research areas include aquaculture, conservation biology, upland and wetland wildlife biology, endangered species biology, freshwater fisheries science and marine fisheries science.

There are no specific credit hour requirements beyond 30 semester hours of post-baccalaureate course work and 19 hours of doctoral dissertation research for the Ph.D. in fisheries and wildlife science. However, the student’s advisory committee will insist on a rigorous and appropriate program of study and research. Students will be required to take, or have taken, at least two semesters of graduate statistics and two semesters of 800-level seminars in fisheries and wildlife science or related areas. Students must also have a minimum of one semester of professional experience, which will be evaluated by the student’s advisory committee. Examples of appropriate professional experience are teaching assistantships, internships or cooperative study program participants, or natural resource agency employees. Other course requirements will be identified by the student’s advisory committee and will include specific course work according to the elected emphasis area. The three emphasis areas are: fisheries biology, wildlife biology and conservation biology.

Research opportunities for graduate students are enhanced by cooperative programs with the S.C. Wildlife and Marine Resources Department, U.S. Fish and Wildlife Service’s Cooperative Research Unit at Clemson, Savannah River Ecology Laboratory, Webb Wildlife Research Center and Waddell Mariculture Center. The department also is associated with the National Council for Air and Stream Conservation, the South Carolina Wildlife and Marine Resources Center. The department also is associated with the South Carolina Wildlife and Marine Resources Center. The department also is associated with the South Carolina Wildlife and Marine Resources Center. The department also is associated with the South Carolina Wildlife and Marine Resources Center.

W F B 642: Wildlife Management, 3 cr. (2 and 3) S
Basic principles and general practices of wildlife management and conservation; major problems concerning the management of wildlife resources with emphasis on upland game species. Laboratory includes practical work on the Clemson University woodlands and field trips to areas where wildlife management is being practiced.

W F B 641: Wild Health Nutritional Ecology, 3 cr. (3 and 0) N
Concepts of how terrestrial wildlife obtains and utilizes energy and nutrients in wild ecosystems; energy and nutrient availability in the ecological context of distribution, flow and cycling in natural and modified foraging areas; physiology of digestion for major homeotherms. Prerequisite: For 415 or W F B 412.

W F B 616: Fishery Biology, 3 cr. (2 and 3) F
Principles underlying freshwater fish production, major groups of freshwater fishes and their habitats, identification, age and growth, fecundity, food habits, populations estimation, environmental evaluation, management practices and fish culture. Prerequisites: One year of introductory biology and junior standing.

W F B 630: Wildlife Conservation Policy, 3 cr. (3 and 0) F
Ecological rationale and management implications of public policy designed for the conservation of American wildlife resources. Emphasis is on managed-land issues. Prerequisite: W F B 350 or permission of the instructor.

W F B 650: Aquaculture, 3 cr. (3 and 0) S
Basic aquacultural techniques applied to freshwaters and marine organisms; past and present culture of finfishes and shellfishes around the world; principles underlying fish production; water quality, feeding and nutrition as they influence production of cultured aquatic organisms. Prerequisites: One year of general biology and junior standing.

W F B 660: Warmwater Fish Diseases, 2 cr. (2 and 0) SS
(odd numbered years) Diseases in warmwater fish including infectious and noninfectious processes. Prerequisites: One year of general biology, junior standing and permission of instructor.

W F B 662: Wetland Wildlife Biology, 3 cr. (3 and 0) F
Wetland wildlife habitats emphasizing classification by physical, chemical and biological characteristics; the importance of wetland habitat for management and production of wetland wildlife species. Prerequisites: Biol 103/105 and 104/106 or 110/111.

W F B 669 (ENT 669): Aquatic Insects, 3 cr. (1 and 6) S
(odd numbered years)
Identification, life history, habitats and interrelationships of aquatic insects; techniques of qualitative field collecting; important literature and research workers. Prerequisite: ENT 301 or permission of instructor.

W F B 712: Wildlife Conservation for Teachers, 2-3 cr. (2-3 and 0)
Principles and practices of wildlife conservation providing an overview of wild-
life diversity, ecology and management in the state; population census, wildlife identification, capture and habitat management of game and nongame species. For in-service teachers only. Prerequisite: Permission of instructor.

W F B 816: Applied Wildlife Biology, 3 cr. (2 and 3) S
Techniques and practices involved in management of wildlife species emphasizing upland game.

W F B 818: Waterfowl Ecology and Management, 3 cr. (2 and 3) F (odd numbered years)
Identification, ecology and management of waterfowl. Laboratory work includes demonstration and application of relevant waterfowl management techniques, current literature topics and field trips. Prerequisite: BIOSC 441/641 or W F B 412/612 or permission of instructor.

W F B 820: Seminar in Avian Ecology, 1 cr. (1 and 0) N
Current issues in avian ecology. Students read extensively from recent literature in avian ecology and are responsible for leading and participating in discussions of current research. May be repeated for credit. Prerequisite: Graduate standing in a life science or related course of study.

W F B 821: Wildlife Genetics, 3 cr. (2 and 3) S
Current genetics and associated problems of wildlife species. Students will be required to correct these deficiencies during the first year.

W F B 830: Estimation of Animal Population Parameters, 3 cr. (2 and 3) S
Techniques for sampling and estimation of parameters of free-ranging fish and wildlife populations such as size, density, survival, natality and movement patterns; underlying assumptions, statistical properties and proper interpretation of contemporary quantitative methodology. Prerequisite: EX ST 801.

W F B 840: Fish Management, 3 cr. (2 and 3) F (odd numbered years)
Principles and techniques of managing aquatic systems for recreational and/or commercial fishing emphasizing streams, rivers, estuaries and impoundments. Laboratory work includes demonstration and application of management techniques and field trips to observe management practices. Prerequisite: W F B 416/616 or ZOOL 463/663 or permission of instructor.

W F B 860: Diagnostic Procedures of Warmwater Fish Diseases, 2 cr. (1 and 2) SS (odd numbered years)
Warmwater fish disease diagnostic procedures employing proper protocol to be followed by a fish disease diagnostician. Corequisite: W F B 460/660 or permission of instructor.

W F B 861: Selected Topics, 1-4 cr. (1-4 and 0)
Current areas of aquaculture, fisheries and wildlife management and research. May be repeated for credit. Prerequisite: Permission of instructor.

W F B 863: Special Problems in Wildlife and Fisheries Biology, 1-3 cr. (0 and 3-9)
Research not related to a thesis. Credit varies with problems selected. Prerequisite: Permission of instructor.

W F B 891: Master’s Thesis Research, credit to be arranged
W F B 991: Doctoral Dissertation Research, credit to be arranged

Enrollment in the biochemistry program is open to students with baccalaureate degrees in agricultural, biological or physical sciences, or engineering. Entering students must have satisfactory academic records in mathematical, physical and biological sciences. Students with deficiencies may be admitted but will be required to correct these deficiencies during the first year.

Biochemistry 631, 632, 633 and 634 (10 total credit hours) constitute the core of the biochemistry program. All students are expected to complete these courses if they have not had their equivalents at another accredited institution.

In addition to core courses, the M.S. degree requires a minimum of 14 credit hours of course work. At least eight of these 800-level credits (including two credits of BIOCH 851) must be in biochemistry courses. Two of the following four courses are required: BIOCH 815, 822, 831 and 841. A minimum of six semester hours of M.S. research, culminating in a thesis, is required.

The Ph.D. degree requires, in addition to the core courses, four credits of BIOCH 851 for students coming directly from the undergraduate degree or two credits of BIOCH 851 for students already having M.S. degrees and three of the four courses: BIOCH 815, 822, 831 and 841. Successful completion of written and oral comprehensive examinations (before six semesters in residence) will admit the student to candidacy for the Ph.D. degree.

BIOCH 606: Physiological Chemistry, 3 cr. (3 and 0)
Chemical basis of the mammalian physiological processes of muscle contraction, nerve function, respiration, kidney function and blood homeostasis; composition of specialized tissue such as muscle, nerve, blood and bone, and regulation of water, electrolytes and acid-base balance. Prerequisite: BIOCH 210 or organic chemistry.

BIOCH 623: Principles of Biochemistry, 3 cr. (3 and 0)
Chemistry of amino acids, monosaccharides, fatty acids, purines, pyrimidines and associated compounds; their properties and the relationship between structure and function that make them important in biological processes; use of modern techniques. Prerequisite: CH 224 or equivalent.

BIOCH 631: A Physical Approach to Biochemistry, 3 cr. (3 and 0)
Chemical and physical properties of amino acids, lipids, nucleic acids, sugars and their biopolymers. Physical and mathematical analyses will be correlated with biological structure and function. Prerequisite: BIOCH 301 with a grade of C or higher or permission of instructor. Corequisite: Physical chemistry.
BIOCH 632: Biochemistry of Metabolism, 3 cr. (3 and 0) Central pathways of carbohydrate, lipid and nucleotide metabolism. Bioenergetics, limiting reactions and the regulation and integration of the metabolic pathways will be emphasized. Prerequisite: BIOCH 423/623 or 431/631 or permission of instructor.

BIOCH 633: General Biochemistry Laboratory I, 2 cr. (0 and 4) Experiments illustrate current methods used in biochemical research. Corequisite: BIOCH 423 or 431.

BIOCH 634: General Biochemistry Laboratory II, 2 cr. (0 and 4) Continuation of BIOCH 633. Corequisite: BIOCH 432/632.

BIOCH 636: Nucleic Acid and Protein Biosynthesis, 2 cr. (2 and 0) Examination of how nucleic acids and proteins are synthesized in prokaryotic and eukaryotic cells. Designed for students interested in biochemistry, cell biology, molecular biology and cell physiology. Prerequisite: BIOCH 423/623, 431/631 or 432/632 or permission of instructor.

BIOCH 815: Lipids and Biomembranes, 3 cr. (3 and 0) Isolation, chemical and physical properties, and metabolism of lipids; purification, structure, function and biosynthesis of biomembranes. Prerequisite: BIOCH 632 or permission of instructor.

BIOCH 817: Chemistry and Metabolism of Hormones, 3 cr. (3 and 0) Isolation, assay and chemistry of the various hormones; hormonal control of metabolism and body functions; endocrinopathies of hormone imbalance. Prerequisite: BIOCH 632 or permission of instructor.

BIOCH 821: Proteins, 3 cr. (3 and 0) Isolation, composition, structure and properties of proteins; methods of isolation, analysis and characterization; properties of "unusual" protein systems. Prerequisite: BIOCH 631 or 623 or permission of instructor.

BIOCH 822: Enzymes, 3 cr. (3 and 0) Kinetics, mechanisms of action, inhibitors and general properties of enzymes. Prerequisite: BIOCH 631 or 623.

BIOCH 831: Physical Biochemistry, 3 cr. (3 and 0) Description and theory of physical methods and instrumentation used in analysis of biological macromolecules. Prerequisites: BIOCH 631 or 623 and one semester of physical chemistry or permission of instructor.

BIOCH 841: Biochemical Genetics, 3 cr. (3 and 0) Regulation of replication and transcription. Students present papers from recent literature and write a research proposal. Prerequisite: One year of biochemistry or permission of instructor.

BIOCH 851: Biochemistry Seminar, 1 cr. (1 and 0) Current topics in biochemistry.

BIOCH 891: Master's Thesis Research, credit to be arranged

BIOCH 991: Doctoral Dissertation Research, credit to be arranged

### Biological Sciences

<table>
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<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
<th>Prerequisites</th>
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<tr>
<td>BIOSC 601: Plant Physiology, 3 cr. (3 and 0)</td>
<td>Relations and processes that pertain to maintenance, growth and reproduction of plants, including absorption of matter and energy, water relations of the plant, utilization of reserve products and liberation of energy. Prerequisites: BIOL 104 or 111 or BIOSC 205 and CH 102 or 112.</td>
<td>BIOSC 402/602.</td>
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<tr>
<td>BIOSC 602: Plant Physiology Laboratory, 1 cr. (0 and 3)</td>
<td>Laboratory exercises and experiments designed to indicate the relations and processes that pertain to maintenance, growth and reproduction of plants, including absorption of matter and energy, water relations of the plant, utilization of reserve products and liberation of energy. Corequisite: BIOSC 401/601.</td>
<td>BIOSC 408/608.</td>
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<tr>
<td>BIOSC 603: Protozoology, 3 cr. (3 and 0)</td>
<td>Survey of the protozoa with emphasis on organization and function. Representative types of both free-living and parasitic forms will be examined for each major taxon. Prerequisite: BIOL 104 or 111.</td>
<td>BIOSC 410/610 or 443/643.</td>
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<tr>
<td>BIOSC 604: Protozoology Laboratory, 2 cr. (1 and 2)</td>
<td>Laboratory exercises reinforce the material presented in BIOSC 403/603 and introduce techniques used in collection, preservation and examination of protozoans. Corequisite: BIOSC 403/603.</td>
<td>BIOSC 410/610 or 443/643.</td>
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<tr>
<td>BIOSC 605: Molecular Genetics of Eukaryotes, 3 cr. (3 and 0)</td>
<td>Molecular genetic analyses of eukaryotes in relation to mutations and repair, complex phenotypes, biochemical pathways, short- and long-term regulation of gene expression and evolution. Prerequisites: GEN 302 or equivalent and one semester of biochemistry or permission of instructor.</td>
<td>BIOSC 410/610 or 443/643.</td>
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<tr>
<td>BIOSC 606: Introductory Plant Taxonomy, 3 cr. (3 and 0)</td>
<td>Basic principles and concepts of plant systematics with emphasis on the plants of South Carolina. Prerequisite: BIOL 104 or 111 or BIOSC 205. Corequisite: BIOSC 407/607.</td>
<td>BIOSC 408/608.</td>
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<tr>
<td>BIOSC 607: Plant Taxonomy Laboratory, 1 cr. (0 and 3)</td>
<td>Basic techniques of plant taxonomy with laboratory and field emphasis on the flora of South Carolina. Corequisite: BIOSC 406/606.</td>
<td>BIOSC 408/608.</td>
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<tr>
<td>BIOSC 608: Comparative Vertebrate Morphology, 3 cr. (3 and 0)</td>
<td>Phylogeny and diversity of vertebrates; their comparative morphology; relationships and functioning of living organisms. Prerequisite: BIOL 104 or 111. Corequisite: BIOSC 409/609.</td>
<td>BIOSC 408/608.</td>
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<tr>
<td>BIOSC 609: Comparative Vertebrate Morphology Laboratory, 1 cr. (0 and 3)</td>
<td>Comparative anatomy of representative vertebrates; methods used in preparing specimens for study and display. Corequisite: BIOSC 408/608.</td>
<td>BIOSC 408/608.</td>
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<tr>
<td>BIOSC 610: Limnology, 3 cr. (3 and 0)</td>
<td>Physical, chemical and biological interrelationships that characterize inland water environments. A fundamental approach to the interactions of components of the environment is developed at a theoretical level. Prerequisite: Junior standing in a life science or permission of instructor.</td>
<td>BIOSC 408/608.</td>
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<tr>
<td>BIOSC 611: Limnological Analyses, 2 cr. (1 and 2)</td>
<td>Broad range of topics covered with both standing and running fresh waters. About one-third of the laboratory exercises address the major physical components of lakes and streams. The remainder provide rationale and methods for quantitative analyses of biota, as well as some integrated analyses of whole ecosystems. Prerequisite or Corequisite: BIOSC 410/610 or 443/643.</td>
<td>BIOSC 408/608.</td>
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<tr>
<td>BIOSC 616 (GEN 616): Recombinant DNA, 3 cr. (3 and 0)</td>
<td>Current facts and concepts of molecular genetics; gene organization, structure and expression in prokaryotes and eukaryotes; current technologies and research. Prerequisites: GEN 302 or its equivalent and one semester of biochemistry or permission of instructor. A development biology course is also strongly recommended.</td>
<td>BIOSC 408/608.</td>
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</tr>
<tr>
<td>BIOSC 617: Marine Biology, 3 cr. (3 and 0)</td>
<td>Organisms that live in the sea and their adaptations to the marine environment; characteristics of marine habitats, organisms and the ecosystems. Prerequisite: BIOSC 407/607.</td>
<td>BIOSC 408/608.</td>
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BIOSC 618 (MICRO 618) (GEN 618): Biotechnology I: Nucleic Acids Technology, 3 cr. (2 and 4) N
Basic training in the manipulation of genetic information using recombinant DNA technology; techniques in molecular cloning, Southern and Northern analyses, clone library construction. Prerequisites: BIOCH 210 or 301 and MICRO 305 or permission of instructor.

BIOSC 620: Neurobiology, 3 cr. (3 and 0)
Broad background in neurobiology including neuroanatomical structure-function; construction of neural circuits; nerve growth and development; neuromuscular junction; chemistry, physiology and pharmacology of specific neurotransmitters and receptors; visual process; axoplasmic transport; hypothalamic-pituitary regulation; theories of behavior; theories of learning and memory. Prerequisite: BIOCH 210 or 301 or permission of instructor.

BIOSC 625: Introductory Mycology, 3 cr. (3 and 0)
Biography of all the groups of fungi and some related organisms, with considerations of the taxonomy, morphology, development, physiology and ecology of representative forms. Prerequisite: BIOL 104 or 111 or BIOSC 205.

BIOSC 626: Mycology Practicum, 2 cr. (1 and 2)
Principles of mycological techniques including isolation, culture, identification and microscopic study of fungi. Examples from all major groups of fungi will be included. Prerequisite or Corequisite: BIOSC 425/625.

BIOSC 630 (B E 630): Problem-Solving Methods and Models in Biosystems Engineering, 3 cr. (3 and 0)
Mathematical and computer modeling of physical, chemical and biological phenomena applied to biosystems engineering; modeling problem, process-solving methods, numerical techniques, estimating model coefficients, validation and classic models used in biosystems, biomedical, environmental and agricultural engineering. Prerequisite: BIOCH 301 or BIOCH 210 or permission of instructor. Corequisite: M E 310 or instruction in thermodynamics.

BIOSC 632: Animal Histology, 3 cr. (3 and 0)
Structural and functional study of the basic tissues of animals and tissue makeup of organs. Emphasis is on light microscopy level with selected tissue studied at the electron microscope level. Prerequisite: BIOSC 303 or permission of instructor. Corequisite: BIOSC 433/633.

BIOSC 633: Animal Histology Laboratory, 2 cr. (1 and 2)
Microscopic examination of basic animal tissue types and the tissue makeup of organs which comprise systems. Corequisite: BIOSC 432/632.

BIOSC 640: Developmental Animal Biology, 3 cr. (3 and 0)
Events and mechanisms responsible for the development of multicellular animals. Gametogenesis, fertilization, embryonic development, cellular differentiation, morphogenesis, larval forms and metamorphosis, asexual reproduction, regeneration, malignancy and aging will be analyzed in terms of fundamental concepts and control processes. Prerequisite: BIOCH 210 or 301 or permission of instructor. Corequisite: BIOSC 450/650.

BIOSC 641: Ecology, 3 cr. (3 and 0)
Basic ecological principles underlying the relationships between organisms and their biotic and abiotic environments including physiological, population and community ecology, with applications of each to human ecological concerns. Prerequisite: BIOL 104, 111 or BIOSC 205 or permission of instructor.

BIOSC 642: Biogeography, 3 cr. (3 and 0)
Patterns of distribution of plants and animals in space and time. Prerequisites: BIOSC 302 or 303 and 304 or 305 or permission of instructor.

BIOSC 643: Aquatic Ecology, 3 cr. (3 and 0)
Basic ecological principles and concepts as they apply to aquatic environments: rivers and streams, lakes and ponds, reservoirs, swamps, marshes, estuaries and marine systems. Prerequisite: Junior standing in a life science or permission of instructor.

BIOSC 645: Ecology Laboratory, 2 cr. (1 and 2)
Modern and classical approaches to the study of ecological problems discussed in BIOSC 441/442, laboratory and computer-based analyses of plant and animal populations and communities. Prerequisite or Corequisite: BIOSC 441/641.

BIOSC 646: Plant Ecology, 3 cr. (3 and 0)
Ecology of plants in relation to their biotic and abiotic environments. Individual organisms, populations and communities will be considered with an emphasis on seed plants in terrestrial environments. Prerequisite: BIOL 104, 111 or BIOSC 205 or permission of instructor.

BIOSC 647: Plant Ecology Laboratory, 2 cr. (1 and 2)
Experimental and observational approach to addressing principles discussed in BIOSC 446; field and laboratory methods involving individual organisms, populations and communities. Prerequisite or Corequisite: BIOSC 446/646 or permission of instructor.

BIOSC 650: Developmental Biology Laboratory, 2 cr. (1 and 2)
Broad range of topics concerned with the development of multi-cellular animals such as gametogenesis, fertilization, embryonic development, cell differentiation, morphogenesis, larval metamorphosis and regeneration. Laboratory exercises provide the rationale and methods for the descriptive and experimental analysis of development in representative invertebrates and vertebrates. Prerequisite or Corequisite: BIOSC 440/640 or equivalent.

BIOSC 652: Plant Anatomy and Morphology, 3 cr. (3 and 0)
Anatomy, reproduction and phylogenetic relationships of vascular plants. Prerequisite: BIOL 104, 111 or BIOSC 205 or permission of instructor.

BIOSC 653: Plant Anatomy and Morphology Laboratory, 2 cr. (1 and 2)
Laboratory focusing on the anatomy, reproduction and phylogenetic relationships of vascular plants. Corequisite: BIOSC 452/652.

BIOSC 655: Medical and Veterinary Parasitology, 3 cr. (3 and 0)
Parasitism in the animal kingdom with emphasis on both basic and applied principles as they relate to economically and medically important diseases. Classical and experimental approaches to the study of parasitism are examined in reference to protozoa, helminths and arthropods. Prerequisite: BIOL 104 or 111. Corequisite: BIOSC 457/657.

BIOSC 657: Medical and Veterinary Parasitology Laboratory, 2 cr. (1 and 2)
Laboratory exercises reinforce the material presented in BIOSC 456/656 and introduce students to both live and preserved human/animal parasites; techniques used in collection, preservation and examination of animal parasites. Corequisite: BIOSC 456/656.

BIOSC 658 (BE 658): Cell Physiology, 3 cr. (3 and 0)
Chemical and physical principles of cell function emphasizing bioenergetics and membrane phenomena. Prerequisite: BIOCH 210 or 301 or permission of instructor.

BIOSC 659: Systems Physiology, 3 cr. (3 and 0)
Physiological systems of vertebrates and their homeostatic controls. Function of the major physiological systems is described in terms of anatomical structure and chemical and physical principles. Prerequisites: One year each of biology, chemistry and physics or permission of instructor.

BIOSC 660: Systems Physiology Laboratory, 2 cr. (1 and 2)
Modern and classical experimental methods demonstrate fundamental physiological principles discussed in BIOSC 459/659; introduction to computer-aided data acquisition and computer simulations of physiological function. Prerequisite or Corequisite: BIOSC 459/659.
BIOSC 661: Cell Biology, 3 cr. (3 and 0)
In-depth analysis of how and where intracellular and extracellular molecules control general and specific cellular functions such as gene expression, secretion, motility, signaling, cell-cycle control, and differentiation. Taught and graded at a level where students are expected to infer from and integrate cellular events. Prerequisite: BIOCH 301 or permission of instructor.

BIOSC 662: Cell Biology Laboratory, 2 cr. (1 and 2)
Focus on molecular and microscopic analysis of eukaryotic cells. Corequisite: BIOSC 461/661.

BIOSC 664: Mammalogy, 3 cr. (2 and 3)
Origin, evolution, distribution, structure, and function of mammals with laboratory emphasis on the mammals of South Carolina. Field collection required. Prerequisite: BIOSC 303 or permission of instructor.

BIOSC 665 (HORT 665): Plant Molecular Biology, 3 cr. (3 and 0)
Fundamental plant processes at both the cellular and molecular levels including genome structure and organization (both nuclear and organellar); regulation of gene expression and its role in cellular and whole-plant processes; transposable genetic elements; applications for biotechnology. Prerequisites: Junior standing or permission of instructor and BIOSC 304 or 305 and GEN 302.

BIOSC 668: Herpetology, 3 cr. (2 and 3)
Systematics, life history, distribution, ecology and current literature of amphibians and reptiles; laboratory study of morphology and identification of world families, U.S. genera and all Southeastern species. Field trips required. Prerequisite: BIOSC 303 or permission of instructor.

BIOSC 670: Animal Behavior, 3 cr. (3 and 0)
Historical and modern developments in animal behavior emphasizing the evolutionary and ecological determinants of behavior; synthesis of ethology and comparative psychology. Prerequisite: BIOSC 302 or 303 or permission of instructor.

BIOSC 671: Animal Behavior Laboratory, 1 cr. (0 and 3)
Laboratory exercises that explore the behavior of animals. Emphasis is on behavioral observation and analysis and presentation of findings in a report format. Prerequisite or Corequisite: BIOSC 470/670 or permission of instructor.

BIOSC 672: Ornithology, 4 cr. (3 and 3)
Biology of birds: their origin and diversification, adaptations, phylogeny, classification, structure and function, behavior, ecology, and biogeography. Field identification is emphasized, and field trips are required. Prerequisite: BIOSC 303 or permission of instructor.

BIOSC 675: Comparative Physiology, 3 cr. (3 and 0)
Physiological systems of invertebrates and vertebrates with emphasis on environmental adaptation; physiological principles as they relate to metabolism, thermoregulation, osmoregulation, respiration, and neural and integrative physiology. Prerequisite: One year each of biology, chemistry and physics or permission of instructor.

BIOSC 676: Comparative Physiology Laboratory, 2 cr. (1 and 2)
Modern classical experimental methods demonstrate fundamental physiological principles discussed in BIOSC 475/675; introduction to computer-aided data acquisition and manipulation as well as computer simulations of physiological function. Prerequisite or Corequisite: BIOSC 475/675.

BIOSC 677: Ichthyology, 3 cr. (2 and 3)
Systematics, life history, distribution, ecology and current literature of fish; laboratory study of morphology and identification of U.S. genera and all Southeastern species. Field trips required. Prerequisite: BIOSC 303 or permission of instructor.

BIOSC 680: Vertebrate Endocrinology, 3 cr. (3 and 0)
Basic principles of neuro-endocrine integration and homeostatic maintenance in vertebrates; comparative morphology and physiology of various endocrine tissues and hormone chemistry and modes of action. Prerequisite: BIOSC 303, organic chemistry or permission of instructor.

BIOSC 730: SC Life: Topics for Teachers, 3 cr. (2 and 2)
Topics relating to the SC Life curriculum. Lectures, laboratories and extensive field studies focus on the natural history and biodiversity of South Carolina. Restricted to elementary and secondary school teachers. May be repeated for credit, but only if different topics are covered. Prerequisite: Permission of instructor.

BIOSC 801: Electron Microscopy of Biological Specimens, 3 cr. (1 and 6) F, S
Concepts and practice in preparing biological specimens for electron microscopy: fixing, embedding, thin-sectioning, staining, operating microscopes and photographing, developing, printing and interpreting micrographs. Each student must achieve proficiency with a selected specimen including writing a brief research proposal, preparing specimen, studying specimen with electron microscope and interpreting micrographs. Prerequisite: Permission of instructor.

BIOSC 812: Seminar, 1 cr. (1 and 0)
Review and presentation of current literature in biological sciences. May be repeated for a maximum of four credits. Prerequisite: Permission of instructor.

BIOSC 815: Developmental Genetics, 3 cr. (3 and 0)
Current research in developmental genetics including model systems, homeotic genes of Drosophila, primary induction, adhesion molecules and cancer, axis formation, fringe mutants in plants, homeobox genes in plants and photo regulation. Prerequisities: A semester of biochemistry and a semester of genetics.

BIOSC 871: Selected Topics Laboratory, 1-4 cr. (1-4 and 0)
Cellular and developmental biology, ecology, behavior, evolutionary biology, molecular biology, physiology, systems and other topics of interest to graduate students in the biological sciences. May be repeated for credit, but only if different topics are covered. Prerequisite: Permission of instructor.

BIOSC 872: Selected Topics, 1-4 cr. (0 and 2-8)
Specialized laboratory experiences in cellular and developmental biology, ecology, behavior, evolutionary biology, molecular biology, physiology, systems and other topics of interest to graduate students in the biological sciences. May be repeated for credit, but only if different topics are covered. Prerequisite: Permission of instructor.

### Biology Instruction

William M. Surver, Chair, Department of Biology Instruction and Agricultural Education

The Department of Biology Instruction and Agricultural Education does not offer advanced degrees in biology; see the Department of Biological Sciences for graduate programs in biology. The course listed below is taught by faculty in the life sciences for elementary and secondary education majors.

### BIOL 710: Selected Topics for Teachers, 1-6 cr. (0-6 and 0-18)

One or more topics organized according to institute needs. Lecture and laboratory emphasize the incorporation of new or updated subject matter into classroom instruction. Restricted to elementary and secondary school teachers. May be repeated for credit, but only if different topics are covered.

### Biosystems Engineering

John C. Hayes, Chair, Department of Agricultural and Biological Engineering

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<th>Major</th>
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<tr>
<td>Biosystems Engineering</td>
<td>M.Engr., M.S., Ph.D.</td>
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This program is administered jointly by the College of Engineering and Science and the College of Agriculture, Forestry and Life Sciences. The degrees are awarded by the College of Engineering and Science. See the College of Engineering and Science for information on this program.
BOT 821: Inorganic Plant Metabolism, 3 cr. (3 and 0) F
(odd numbered years)
Plant, soil, water and nutrient relations; permeability; uptake and translocation; transpiration; mineral nutrition. Prerequisites: BIOSC 601 and 602 or permission of instructor.

BOT 822: Organic Plant Metabolism, 3 cr. (3 and 0) S
(even numbered years)
Respiration and photosynthesis; synthesis, translocation, storage, transformation and degradation of organic materials, fats, carbohydrates, proteins, pigments and nucleic acids. Prerequisites: BIOSC 601 and 602 and BIOC 623 or permission of instructor.

BOT 823: Plant Growth and Development, 3 cr. (3 and 0) F
(even numbered years)
Vegetative and reproductive growth and development from seed to maturity, flowering, fruiting and senescence; natural and synthetic growth regulators; morphogenesis. Prerequisites: BIOSC 601 and 602 and organic chemistry or permission of instructor.

BOT 824: Mode of Action of Growth Substances, 4 cr. (3 and 3) S
(odd numbered years)
Physiology and biochemistry of both natural and synthetic growth regulators, hormones, growth retardants, herbicides and other inhibitors; methodology and mechanism of action. Prerequisites: BIOSC 601 and 602 and general biochemistry or BOT 822 or permission of instructor.

BOT 831: Advanced Plant Taxonomy, 4 cr. (3 and 3) S
(odd numbered years)
Principles of plant classification; relationships and characteristics of major groups of vascular plants; student collects and identifies spring flora of area. Prerequisite: BIOSC 606 or permission of instructor.

BOT 846: Plant Ecology, 4 cr. (3 and 3) F
Effects of environmental factors upon plants and the influence of plants upon the environment; identification and analysis of interrelated biotic and physical factors that affect the structure, distribution and dynamics of individual plants, plant populations and ecosystems. Prerequisite: BIOSC 641 or permission of instructor.

BOT 847: Plant-Animal Interactions, 3 cr. (3 and 0) S
Examination of plant-animal interactions from an ecological and evolutionary perspective. Topics include herbivory, pollination and seed dispersal as well as effects of animals on plant populations and influence of plants on animal diversity and abundance. Prerequisite: BIOSC 641 or 646 or permission of instructor.

BOT 850: Plant Tissue and Cell Culture, 3 cr. (2 and 3) F
(odd numbered years)
Methods and principles of plant tissue and cell culture; cloning, embryogenesis, protoplast fusion, plant regeneration, potential of plant genetic engineering. Prerequisite: Introductory plant physiology or permission of instructor.

BOT 851 (HORT 851): Plant Anatomy, 3 cr. (2 and 3) S
(odd numbered years)
Origin, development and comparative structures of tissues, systems and organs of higher plants. Prerequisite: BIOSC 652 or permission of instructor.

BOT 856 (HORT 856): Plant Cell Biology, 3 cr. (3 and 0) F
(odd numbered years)
Structure, development and activities of plant cells; ultrastructural organization of cells; cellular processes associated with cellular growth and development in plants. Prerequisites: BIOSC 601 and 602 or permission of instructor.

BOT 891: Master's Thesis Research, credit to be arranged

BOT 991: Doctoral Dissertation Research, credit to be arranged

ENR 650: Conservation Issues, 3 cr. (3 and 0)
Interactive study and discussion of issues related to the conservation of natural resources, emphasizing current issues in the conservation of biodiversity, identification of conflicting issues between consumptive and nonconsumptive resource management and development of viable solutions for conservation of natural resources. Prerequisite: W F B/ BIOSC 313 or permission of instructor.

Conservation Issues
The following course is offered as an elective to any student enrolled in the College of Agriculture, Forestry and Life Sciences.

CS ENV 603: Soil Genesis and Classification, 2 cr. (1 and 3) F
Soil morphology and characterization, pedogenic processes, soil-forming factors and classification of soils. Prerequisite: CS ENV 202 or permission of instructor.

CS ENV 604: Soils and Land Use, 2 cr. (1 and 3) F
Soils interpretations for nonagricultural purposes and facilities; use of modern soil surveys; properties and features of soils important in nonfarm land uses. Not open to agronomy majors or minors or to students who have taken CS ENV 202.

CS ENV 605: Plant Breeding, 3 cr. (2 and 2) S
Application of genetic principles to the development of improved crop plants including the genetic and cytogenetic basis of plant breeding, mode of reproduction, techniques in selecting and crossing, methods of breeding, inheritance in the major crops and biometrical methods. Prerequisite: GEN 302 or equivalent.

CS ENV 607: Weed Ecology and Management, 3 cr. (2 and 2) F
Weeds, their introduction, ecology, methods of reproduction, dissemination and management; chemistry and mode of action of herbicides, equipment and techniques of application; characterization of the common weeds of the Southeast. Prerequisite: AGRIC 104, CS ENV 202 or permission of instructor.

CS ENV 608 (EE&S 608) (BE 608): Land Treatment of Wastewater and Sludges, 3 cr. (3 and 0) F
Principles for designing environmentally acceptable land application systems using municipal and industrial wastewater and sludges; land-limiting constituent analysis; soil-plant interactions; solid equipment and design; system operation and management; public acceptance, social and regulatory issues. Case studies and field trip(s) are planned. Prerequisite: Senior standing in agriculture or engineering or permission of instructor.
CS ENV 621: Principles of Field Crop Production, 3 cr. (3 and 0) F
Principles for production of field crops including botany and physiology, tillage, harvesting, storage and crop quality. Principles will be illustrated using examples from various crops. Prerequisite: AGRIC 104 or equivalent introductory plant science, CS ENV 202.

CS ENV 622: Major World Crops, 3 cr. (3 and 0) S
Distribution, adaptation, production and utilization of major agronomic crops of the world; crops important to U.S. agriculture including corn, wheat, rice, sorghum, soybean, cotton, tobacco and peanuts. Prerequisites: AGRIC 104 or equivalent introductory plant science, CS ENV 202.

CS ENV 623: Field Crops — Forages, 3 cr. (3 and 0) S
Establishment, management and utilization of forage crops in a forage-livestock agro-ecosystem context; hay, silage and pasture utilization. Computer model used to study complexity of forage-livestock production systems. Prerequisite: AGRIC 104, CS ENV 202 or permission of instructor.

CS ENV 624: Applied Aspects of Forage Management, 1 cr. (0 and 2)
Hands-on exposure to forage plantings, establishment and management practices; pasture and harvested forage systems, equipment and practices; analysis of forage-livestock systems. Prerequisite or Corequisite: CS ENV 423/623.

CS ENV 625: Seed Science and Technology, 3 cr. (2 and 2) S (even numbered years)
Seed development, germination, dormancy, pathology, storage and deterioration; seed and commercial production of seed; useful applications of current seed science knowledge. Prerequisites: AGRIC 104, BIOSC 205.

CS ENV 626 (AP EC 626): Cropping Systems Analysis, 3 cr. (2 and 2) F
Application of agronomic and economic principles in solving problems relating to the production and marketing of agronomic crops. A case study with a detailed analysis of a farm, agri-business or environmental situation and formal written and oral presentations of results. Prerequisites: AP EC 202, AGRIC 104, junior or senior standing.

CS ENV 633 (HORT 633): Integrated Weed Management for Agronomic and Horticultural Crops, 3 cr. (2 and 2) S
Weed management systems consisting of cultural, chemical and biological methods for the major agronomic and horticultural crops of South Carolina; problem-solving methodology and herbicide injury diagnosis. Prerequisite: CS ENV 407 or equivalent introductory weed science.

CS ENV 646: Soil Management, 3 cr. (3 and 0) F
Basic soil properties related to compaction, water and solute movement, and root growth; practical management problems and solutions based upon basic soil characteristics. Problems include erosion, no-tillage, compaction, irrigation, leaching, waste application, golf-green management and orchard establishment. Prerequisite: CS ENV 202.

CS ENV 652: Soil Fertility and Management, 3 cr. (3 and 0) S
Soil properties, climatic factors and management systems in relation to soil fertility maintenance for crop production; plant nutrition and growth in relation to crop fertilization and management. Prerequisite: CS ENV 202 or permission of instructor.

CS ENV 653: Soil Fertility Laboratory, 1 cr. (0 and 3) S
Evaluation and interpretation of soil fertility production. Prerequisite: CS ENV 202 or permission of instructor.

CS ENV 675: Soil Physics and Chemistry, 3 cr. (2 and 3) S
Principles of soil physics and chemistry and their applications including soil texture, structure, compaction, water relations, solute movement, mineral composition, adsorption phenomenon and soil acidity. Prerequisites: CS ENV 202, CH 101, 112, PHYS 207.

CS ENV 690: Beneficial Soil Organisms in Plant Growth, 3 cr. (3 and 0) F (odd numbered years)
Aspects of biological nitrogen fixation, mycorrhizal fungi, microbial-pesticide interactions, bioremediation, nutrient cycles and biological pest control related to plant growth, soil/environmental quality, sustainable agriculture. Students who desire laboratory experience in these topics can register for CS ENV 406 after consultation with instructor. Prerequisite: CS ENV 202, MICRO 305, PL PA 401 or permission of instructor.

CS ENV 701: Soils and Man, 3 cr. (3 and 0)
Different kinds of soils, their properties, uses, management, conservation and relationship with the environment and other human endeavors. Not open to agronomy majors pursuing the M.S. or Ph.D. degrees.

CS ENV 804: Theory and Methods of Plant Breeding, 3 cr. (3 and 0) F (even numbered years)
Concepts and principles of plant breeding and genetics as applied to development and maintenance of improved crop varieties; theoretical considerations of various breeding methods. Prerequisites: CS ENV 405/605 and EX ST 801 or permission of instructor.

CS ENV 805: Soil Fertility, 3 cr. (3 and 0) S (even numbered years)
Soil properties affecting nutrient availability and plant growth; inventory of major soil groups with reference to plant stress features; behavior of essential elements in soils in relation to plant availability; current soil fertility research. Prerequisite: CS ENV 452 or 403 or permission of instructor.

CS ENV 806: Special Problems, 1-3 cr. (0 and 3-9)
Research not related to a thesis.

CS ENV 807: Soil Physics, 4 cr. (3 and 3) F (even numbered years)
Principles and applications of transport of water and solutes in soils emphasizing unsaturated flow phenomenon. Prerequisite: MTHSC 108 or equivalent.

CS ENV 808: Soil Chemistry, 3 cr. (2 and 3) S (odd numbered years)
Principles and theories concerning the structure and chemical properties of soil colloids, ion exchange and surface phenomena, chemical equilibria, soil acidity and oxidation-reduction reactions.

CS ENV 810: Soil Microbiology, 3 cr. (3 and 0) F (even numbered years)
Biological nitrogen fixation, mycorrhizal fungi and pesticide interactions in soils with emphasis on microbial-plant-soil relationships. Prerequisites: CS ENV 690 or MICRO 610 and permission of instructor.

CS ENV 812: Crop Ecology and Land Use, 3 cr. (3 and 0) F (even numbered years)
Concepts and factors affecting adaptation and distribution of crop plants; microclimate and crop response to environmental factors with modifications of microclimate by agricultural operations; interactions among crop plants and between weeds and crop plants under field conditions.

CS ENV 825: Seminar, 1 cr. (1 and 0) F, S
Special topics and original research in agronomy. Credit may be earned for more than one semester by doctoral candidates. Graded on a pass/fail basis.

CS ENV 890: Special Topics in Agronomy, 1-3 cr. (1-3 and 0)
Group discussion of recent developments in agronomic research. May be repeated for a maximum of six credit hours. Prerequisite: Permission of instructor.
CS ENV 891: Master’s Thesis Research, credit to be arranged
CS ENV 991: Doctoral Dissertation Research, credit to be arranged

### Entomology

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<th>Major</th>
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<tr>
<td>Entomology</td>
<td>M.S., Ph.D.</td>
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The department is dedicated to providing leadership in environmental entomology. Research programs fall into four emphasis areas: aquatic arthropod diversity, crop-insect management, genetics and biotechnology, and urban entomology. Facilities of the Agricultural Experiment Station on campus and at four research and education centers located in various regions of the state are available for graduate student research. In addition to teaching and research laboratories, specialized facilities within the department include the Clemson University Arthropod Collection; laboratories for molecular genetics, tissue culture and analytical chemistry/toxicology; wet laboratories; controlled and ambient temperature insect-rearing facilities; a free-flight butterfly facility; and greenhouses. Candidates for the M.S. degree are required to complete a thesis.

**ENT 601: Insect Pests of Ornamental Plants and Shade Trees, 3 cr. (2 and 3)**
Recognition, biology, damage and control of insect pests of woody and other ornamental plants and shade trees. **Prerequisite:** ENT 301.

**ENT 604: Urban Entomology, 3 cr. (2 and 3) (even numbered years)**
Pests common to the urban environment with emphasis on biology, damage, control and identification of household, structural, stored products and food pests; theoretical and practical aspects of urban pest management and the pest-control industry. **Prerequisite:** ENT 301.

**ENT 606 (PL PA 606): Diseases and Insects of Turfgrasses, 3 cr. (2 and 2) F**
Host-parasite relationships, symptomatology, diagnosis, economics and control of infectious and noninfectious diseases of turfgrasses; life histories, diagnosis and control of important insect pests of turfgrasses. **Prerequisites:** ENT 301 and PL PA 401 or equivalent.

**ENT 607: Applied Agricultural Entomology, 4 cr. (3 and 3)**
Recognition, biology, damage and control of economically important insects and mites found on major Southeastern field, fruit, nut and vegetable crops; principles and practices of crop protection including pesticide application, economic basis for decision-making and development of scouting programs. **Prerequisite:** ENT 301 or equivalent.

**ENT 610: Insect Taxonomy, 3 cr. (1 and 6)**
Identification of the principal families of the major orders of adult insects through intensive laboratory work and theoretical discussion of taxonomic features observed in the laboratory. **Prerequisite:** ENT 405 or permission of instructor.

**ENT 620: Toxicology of Insecticides, 3 cr. (2 and 3)**
Concepts of insecticide toxicology; principles of insecticide action; toxicological and pharmacological effects in insects and higher animals; safety; current regulations governing the use of insecticides. **Prerequisite:** ENT 301.

**ENT 630 (ENTOX 630): Toxicology, 3 cr. (3 and 0)**
Basic principles of toxicology including quantitation of toxicity, toxicokinetics, biochemical action of poisons and environmental toxicology; acute and chronic effects of various classes of poisons (e.g., pesticides, drugs, metals and industrial pollutants) in relation to typical routes of exposure and regulatory testing methods. **Prerequisite:** Organic chemistry, one year of general biology or permission of instructor.

**ENT 640: Insect Behavior, 3 cr. (2 and 3)**
Fundamentals of insect behavior in an evolutionary and ecological perspective. Laboratories emphasize generation and testing of hypotheses and observation, description and quantification of insect behavior. **Prerequisite:** ENT 301 or permission of instructor.

**ENT 655: Medical and Veterinary Entomology, 3 cr. (2 and 3)**
Insects and their arthropod relatives of economic importance in their effect on man and animals. **Prerequisite:** ENT 301 or permission of instructor.

**ENT 662: Seminar Presentation, 1 cr. (1 and 0)**
Advanced instruction and practice in delivering oral seminar presentations of scientific information emphasizing preparing visual aids, organization, content and practice in speaking to a specialized scientific audience.

**ENT 665 (W F B 669): Aquatic Insects, 3 cr. (1 and 6) S (odd numbered years)**
Identification, life history, habitats and interrelationships of aquatic insects; techniques of qualitative field collecting; important literature and research workers. **Prerequisite:** ENT 301 or permission of instructor.

**ENT 695 (GEN 695): Insect Biotechnology, 3 cr. (3 and 0)**
Unique features exhibited by insects; applications of biotechnology to enhance useful products from insects and to affect the control of destructive insects. **Prerequisites:** ENT 301 and GEN 302.

**ENT 700: Entomology for Teachers, 3 cr. (2 and 2) S**
General entomology course for secondary school science teachers with emphasis on collecting and identifying the more common insects; insect morphology, physiology, metamorphosis and methods available for control of destructive species. Not open to entomology majors pursuing the M.S., M.Ag. or Ph.D. degrees. **Prerequisite:** Permission of instructor.

**ENT 808: Taxonomy of Immature Insects, 3 cr. (1 and 6) F (odd numbered years)**
Identification of immature insects emphasizing the Holometabola. Identified collection required.

**ENT 809: Seminar in Entomology, 1 cr. (1 and 0)**
Current literature and research in entomology. Class attendance is mandatory. May be repeated for credit. Graded on a pass/fail basis.

**ENT 810: Selected Topics, 1-4 cr. (1-4 and 0)**
Current areas of entomological research and pest management. Course may be repeated for credit. **Prerequisite:** Permission of instructor.

**ENT 840: Insect Ecology, 3 cr. (2 and 3) S (odd numbered years)**
Principles of insect ecology, population dynamics and natural regulating mechanisms of insect populations; effect of environment on distribution and abundance of insects.

**ENT 843: Insect Pathology, 3 cr. (2 and 3) F (odd numbered years)**
Insect diseases, their etiology, symptomatology and epizootiology; infectious diseases caused by viruses, bacteria, fungi and protozoa; ecological significance of these pathogens; their practical applications in medicine and agriculture. **Prerequisites:** ENT 301 or permission of the instructor.

**ENT 853: Applied Systematics, 3 cr. (2 and 3) S (even numbered years)**
Application of evolutionary principles to resolution of contemporary zoological problems; legal issues and technical skills for efficient operation of international zoological information storage and retrieval system. **Prerequisite:** A taxonomic course in entomology or zoology or permission of instructor.

**ENT 860: Insect Pest Management, 3 cr. (3 and 0) S (even numbered years)**
Application of ecological principles to the management or control of insect populations; major factors influencing insect population fluctuations; integrated systems including biological, cultural, physical, chemical and other techniques forming a unified multifaceted approach based on applied ecology.
ENVIRONMENTAL TOXICOLOGY

John Rodgers, Chair, Department of Environmental Toxicology

Major Degrees

Environmental Toxicology M.S., Ph.D.

Environmental toxicology is the scientific study of chemical, physical and biological stimuli in environments and the effects of these stimuli on living systems and their external and internal physical, chemical and biological integrity. Emphasis includes the metabolism of contaminants, their decomposi-
tion, fate and effects in aquatic and terrestrial environments. This interdisciplinary program provides a strong background in fundamental environmental toxicology and ecotoxicology. The program is in the School of Natural Resources and collaborates with several other programs across the University. It is administered jointly by the College of Agriculture, Forestry and Life Sciences and the College of Engineering and Science.

Students with a baccalaureate degree in the basic and life sciences, agriculture or engineering may be admitted. Strong faculty expertise and areas of student specialization are available in wildlife toxicology, environmental chemistry, biochemical and mechanistic toxicology, ecological modeling, ecological risk assessment and biological control. Each student’s research program is designed to meet his or her professional goals.

Candidates for the M.S. degree must complete 30 hours of graduate credit, including six hours of research, and write a thesis. Candidates for the Ph.D. degree must complete 18 hours of dissertation research and write a dissertation.

Graduate research programs are conducted in conjunction with the Clemson Institute of Environmental Toxicology, providing a unique and innovative environment for graduate education. Collaborative research opportunities exist nationally and internationally with other universities, state and federal agencies, and industrial groups.

ENTOX 600: Environment and Wildlife Toxicology, 3 cr. (3 and 0)
Assessment of impacts of toxic substances on reproduction, health and well-being of wildlife species; acute and chronic effects of agricultural chemicals, pesticides, hazardous waste, industrial waste and oil releases. Prerequisites: BIOC 210 or organic chemistry, one year of general biology, W F B 350 or permission of instructor.

ENTOX 621: Chemical Sources and Fate in Environmental Systems, 3 cr. (3 and 0)
Chemical cycles in the environment on global and microcosm scales; dependence of fate processes on physical and chemical properties and environmental conditions; breakdown, movement and transport of selected toxicants illustrate the mechanisms that govern chemical fate. Prerequisites: Organic and analytical chemistry or permission of instructor.

ENTOX 630 (ENTOX 630): Toxicology, 3 cr. (3 and 0)
Basic principles of toxicology including quantitation of toxicity, toxicokinetics, biochemical action of poisons and environmental toxicology; acute and chronic effects of various classes of poisons (e.g., pesticides, drugs, metals and industrial pollutants) in relation to typical routes of exposure and regulatory testing methods. Prerequisite: Organic chemistry, one year of general biology or permission of instructor.

ENTOX 801: Advanced Wildlife Toxicology, 3 cr. (3 and 0)
Interactions between chemical contaminants and wildlife species focusing on mechanisms of differential toxicities between chemicals and among species. Pesticide and chemical contaminant impacts are developed with emphasis on chemical, biochemical and physiological underpinnings and assessed in terms of organismal, species and trophic responses. Prerequisites: ENTOX 430/630 and 421/621 or permission of instructor.

ENTOX 806: Advanced Environmental Toxicology, 3 cr. (3 and 0)
Impacts of chemical contaminants upon ecosystems; description and prediction of ecological changes resulting from a variety of human activities which involve release of xenobiotic and other chemicals into the environment. Prerequisites: Organic chemistry, ENTOX 430/630 and analytical chemistry or permission of instructor.

ENTOX 822: Analytical Toxicology Laboratory, 3 cr. (1 and 6)
Laboratory instrumentation, procedures and experimental methods used for identification and quantitation of toxic substances and their transformation products in environmental and biological samples; application of these procedures in the isolation, detection and quantitation of toxicants in authentic samples. Prerequisites: Organic and analytical chemistry or permission of instructor; instrumental analysis recommended.

ENTOX 830: Mechanistic Toxicology, 3 cr. (3 and 0)
Detailed biochemical toxicology; control, regulation and activity of metabolic enzymes; molecular and cellular mechanisms of toxic action; proposed mechanisms for initiation and development of cancer; mode of action and kinetics of cholinesterase inhibitors; structure/activity relationships of ion channel blockers; biochemical and molecular biomarkers. Prerequisite: ENTOX/ENTOX 430/630.

ENTOX 841: Procedures and Techniques in Ecological Risk Assessment, 2 cr. (1 and 3)
Evaluation and application of the procedures and techniques used in ecological risk assessments, including laboratory and field methods, to determine, measure and evaluate the risks to aquatic, terrestrial and avian species; impacts to biota within, and resulting from, chemical waste disposal facilities and hazardous waste sites. Prerequisites: CH 223, 224 and 313; EX ST 804 or 805; and ENTOX 630; or permission of instructor.

ENTOX 852: Ecological Models, 3 cr. (2 and 3) N
Systems analysis applied to ecology; construction of models which predict ecological consequences to the environment; frequency response analysis, energy models, information flow and transfer functions for population interactions. Prerequisite: A course in ecology and in computer programming or permission of instructor.

ENTOX 854: Aquatic Toxicology, 3 cr. (3 and 0)
Concepts and practices in aquatic toxicology including physiological responses to toxic substances, bioconcentration, biomagnification, toxicity testing (algal, invertebrate and fish) and criterion development; basic concepts of toxicology as applied to aquatic environments. Prerequisites: One year of general biology, one year of general chemistry and introductory biochemistry.

ENTOX 860: Graduate Seminar, 1 cr. (1 and 0)
Recent research in environmental toxicology; presentation, review and discussion of current issues by graduate students in an area of specialization selected by the instructor. May be repeated four times for credit. Graded on a pass/fail basis.
EX ST 662: Statistics Applied to Experimental Statistics

Hoke S. Hill Jr., Chair, Department of Experimental Statistics

Advanced degrees in experimental statistics are not awarded. A minor is offered at the master’s and doctoral levels. Courses are offered for students majoring in other disciplines. Courses to be used to satisfy a minor should be approved by this department at the beginning of the student’s program. At the master’s level, minimum requirements are eight credit hours of 800-level courses with one hour of EX ST 811 acceptable. At the doctoral level, minimum requirements are 12 credit hours of 800-level courses with up to four hours of EX ST 811 acceptable.

EX ST 611: Statistical Methods for Process Development and Control, 3 cr. (3 and 0) F, S

Experimental design techniques for use in process development; application of screening experiments and response surface experiments; techniques for process control with implications for product quality control; use of statistical computer analyses and interpretations including computer generated graphics. Prerequisite: MTHSC 206 or permission of instructor.

EX ST 662: Statistics Applied to Economics, 3 cr. (3 and 0) F

Continuation of EX ST 301 with emphasis on statistical methods used in the collection, analysis, presentation and interpretation of economic data; time series analysis; construction of index numbers; designing samples for surveys in the social science fields. Prerequisite: EX ST 301.

EX ST 801: Statistical Methods I, 4 cr. (3 and 0) F, S, SS

Role and application of statistics in research; estimation, test of significance, analysis of variance, multiple comparison techniques, basic designs, mean square expectations, variance components analysis, simple and multiple linear regression and correlation, and nonparametric procedures. Prerequisite: Permission of instructor.

EX ST 802: Statistical Methods II, 3 cr. (3 and 0) F, S, SS

Extended coverage of several methods introduced in EX ST 801: multiple regression model building and diagnostics, experiment design and analysis, and nonparametric methods; mixed models and repeated measures analyses; categorical data analysis; multivariate methods and sampling designs; appropriate use of statistical software. Prerequisite: EX ST 801.

EX ST 803: Regression and Least Squares Analysis, 3 cr. (3 and 0) S

Regression analysis: simple and multiple linear, curvilinear and multiple curvilinear; curve fitting; least squares and computer techniques for fitting of constants and analysis of planned experiments. Prerequisite: EX ST 801.

EX ST 804: Sampling, 3 cr. (3 and 0) F

Principles of scientific sampling; finite population sampling; simple random, stratified, multistage and systematic sampling; optimum allocation; methods of obtaining, processing and reporting survey information; sampling as related to the environment, natural resources, and social and economic problems. Prerequisite: EX ST 801.

EX ST 805: Design and Analysis of Experiments, 3 cr. (3 and 0) F, S

Basic designs and analysis; data transformations; single degree of freedom, orthogonality and responses in ANOVA; covariance; response surfaces; incomplete blocks; introduction to least squares analysis of experiments; uses of standard computer programs for selected analyses. Prerequisite: EX ST 801.

EX ST 811: Special Problems in Experimental Statistics, 1-3 cr. (0 and 2-0) F, S, SS

Statistical aspects of an individualized research problem; determining an appropriate experimental design; performing proper analyses and generating effective reports.

EX ST 812: Selected Topics, 1-3 cr. (1-3 and 0) N

Topics in applied statistics not covered in other courses. May be repeated for different topics.
FD SC 608: Food Process Engineering, 4 cr. (3 and 3)
Basic engineering principles and their application in food processing operations; relation between engineering principles and fundamentals of food processing. Prerequisites: FD SC 214, CH 102 or 112, MTHSC 106, PHYS 207 or 200 or 122 or permission of instructor.

FD SC 664 (PKGSC 664): Food Packaging Systems, 3 cr. (3 and 0)
Characteristics and application of various materials and systems used in the packaging of foods; engineering properties of the materials and methods used to measure properties; packaging systems for specific food applications. Prerequisite: Permission of instructor.

FD SC 665 (PKGSC 666): Food Packaging Systems Laboratory, 1 cr. (0 and 3)
Laboratory and field exercises on food packaging operations and packaging materials; methods to evaluate the physical and chemical properties of packaging materials. Prerequisite: Permission of instructor.

FD SC 801: Biochemical Aspects of Poultry Products, 3 cr. (2 and 3)
Five research areas of product texture, flavor, color (appearance), nutrition and microbiology. Texture, flavor and color will be approached from a biochemical and chemical viewpoint, dealing with the meat and egg components comprising various poultry products. Prerequisite: AVS 355 or FD SC 401/601 or permission of instructor.

FD SC 810: Chemical and Biochemical Aspects of Foods, 4 cr. (4 and 0)
Chemical, biochemical and functional properties of food components and their interactions in food emulsions, foams, colloids, and gel and solution state; the influences of processing on isolation, utilization and production of the constituents using techniques based on constituent properties. Prerequisites: BIOCH 623 and FD SC 401/601 or permission of instructor.

FD SC 811: Physical and Thermophysical Properties of Foods, 3 cr. (3 and 0)
Principles involved in relating physical and thermophysical properties to food quality, including standard methods and instruments to determine texture and the relationship of physical properties to sensory evaluation; interrelationships of chemical structure and physical properties in food processing operations. Prerequisite: FD SC 810 or permission of instructor.

FD SC 812: Microbiological Aspects of Food Systems, 3 cr. (3 and 0)
Function and characteristics of microorganisms in the utilization and manufacture of food products; food fermentations, microbially induced chemical and physical changes, environmental aspects and production of food ingredients and resources. Prerequisite: MICRO 407/607 or equivalent or permission of instructor.

FD SC 814: Shelf Life Evaluation of Foods, 3 cr. (3 and 0)
Theoretical and practical aspects of the shelf life determination of foods; factors affecting food product quality and eventual product failure. Prerequisites: FD SC 601 or 810 or permission of instructor.

FD SC 820: Selected Topics in Food Science, 1-3 cr. (1-3 and 0)
Special topics in food science not covered in other courses. May be repeated for up to nine credits.

FD SC 821: Selected Topics, 1-4 cr. (0 and 3-12)
Independent research investigation in food science areas not conducted in other courses. May be repeated for a maximum of 12 credits. Prerequisite: Permission of instructor.

FD SC 851: Food Science Seminar, 1 cr. (1 and 0)
Current research and related developments in food science reviewed by faculty, students and invited lecturers.

FD SC 852: Food Science Seminar, 1 cr. (1 and 0)
Continuation of FD SC 851.

FD SC 891: Master’s Thesis Research, credit to be arranged
Advanced degrees are not currently awarded in human nutrition as a major. These courses are taught by faculty in the Department of Food Science and Human Nutrition as part of degrees awarded in animal and food industries and food technology.

NUTR 601: Fundamentals of Nutrition, 3 cr. (3 and 0) F
Biochemical and physiological fundamentals of nutrition applicable to domestic animals and man; digestive processes; absorption and metabolism of carbohydrates, lipids, proteins, water, minerals and vitamins; energy metabolism and comparative anatomy and physiology of digestive systems. Prerequisite: BIOCH 210, CH 223 or permission of instructor.

NUTR 624: Medical Nutrition Therapy I, 4 cr. (3 and 3)
Nutritional assessment, education and counseling skills; development of medical nutrition therapy for individuals with obesity and eating disorders, gastrointestinal disorders, metabolic and renal disorders. Prerequisite: NUTR 451, BIOSC 222, BIOOS 223 or permission of instructor.

NUTR 625: Medical Nutrition Therapy II, 4 cr. (3 and 1) F
Development of medical nutrition therapy for individuals with various disease states including cardiovascular, hepatic, musculoskeletal and neoplastic disorders; with consideration of sociocultural and ethnic aspects of food consumption and alternative nutrition therapies. Prerequisite: NUTR 424/624, BIOSC 222, 223 or permission of instructor.

NUTR 626: Community Nutrition, 3 cr. (3 and 0)
Fundamentals of nutrition care delivery in community programs beginning with assessment and problem identification and continuing through the development, implementation and evaluation of nutrition intervention programs. Prerequisite: NUTR 451 or equivalent or permission of instructor.

NUTR 651: Human Nutrition, 3 cr. (3 and 0) F, S
Essentials of nutrition and principal nutritional deficiency conditions; factors affecting adequacy of dietary intake, methods of determining nutritional status; development of nutrition standards; recent advances in human nutrition. Prerequisite: BIOCH 210/211 or equivalent or permission of instructor.

NUTR 655: Nutrition and Metabolism, 3 cr. (3 and 0) S
Concepts of metabolism fundamental to understanding normal and therapeutic nutrition; bioenergetics as well as metabolism of carbohydrates, lipids, amino acids, vitamins and minerals as they relate to nutrition. Prerequisites: NUTR 451 and BIOCH 210 or 423 or 406 or permission of instructor.

NUTR 706: Nutrition for Teachers, 3 cr. (3 and 0) SS
Principals of nutrition applied to nutrition education. Prerequisite: Permission of instructor.

NUTR 801: Topical Problems in Nutrition, 1-3 cr. (1-3 and 0) N
Topics not covered in other courses or by thesis research. Credit varies with problems selected.

NUTR 802: Special Topics in Nutrition, 1-3 cr. (1-3 and 0) N
Topics of special interest or contemporary subjects not examined in other courses.

NUTR 808: Monogastric Nutrition, 3 cr. (3 and 0) F
Basic concepts and current research related to nutrient requirement and metabolism of poultry, swine and other monogastric species. Prerequisite: NUTR 401/601 or 451/651.

NUTR 809: Ruminant Nutrition, 3 cr. (3 and 0) F
Microbiological, biochemical and physiological processes involved in the synthesis of amino acids, proteins and B-vitamins; relation of these processes to utilization of proteins, lipids and fibrous and nonfibrous feed ingredients; properties and functions of nutrients, nonprotein nitrogen compounds and growth-
promoting substances for dairy cattle, beef cattle and sheep. **Prerequisite:** NUTR 401/601 or permission of instructor.

**NUTR 811: Carbohydrate Nutrition**, 2 cr. (2 and 0) Dietary sources, chemistry, absorption/excretion and functions of carbohydrates; the aberrations of metabolism and possible role in the etiology of degenerative diseases. **Prerequisites:** BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or permission of instructor.

**NUTR 815: Lipid Nutrition**, 2 cr. (2 and 0) Nutrition of lipids in humans and domestic animals emphasizing their source, digestion and absorption, metabolism, function, dietary needs and interrelationships. **Prerequisites:** BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or permission of instructor.

**NUTR 816: Amino Acids and Protein Nutrition**, 2 cr. (2 and 0) (odd numbered years) Nutrition of amino acids, nonprotein nitrogen and proteins related to humans and domestic animals; essentiality, interrelationships and metabolism of amino acids.

**NUTR 817: Mineral Nutrition**, 2 cr. (2 and 0) Occurrence, chemistry, absorption/excretion, and general and specific physiological functions of minerals. **Prerequisites:** BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or permission of instructor.

**NUTR 819: Vitamin Nutrition**, 2 cr. (2 and 0) Overview of the chemistry, metabolism, physiology, digestion, absorption and excretion of the vitamins as applied to the nutrition of humans and domestic animals. **Prerequisites:** BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or permission of instructor.

**NUTR 820: Nutritional Bioenergetics**, 2 cr. (2 and 0) Quantitative approach to the losses of dietary energy during digestion and metabolism, and the factors governing the energetic efficiency of different biological functions in animals and man; regulation of energy balance, body temperature regulation and techniques of calorimetry. **Prerequisites:** BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or permission of instructor.

**NUTR 851: Nutrition Seminar I**, 1 cr. (1 and 0) F Current research and developments in nutrition. Topics, selected by the instructor and students, will come from student research and nutrition literature.

**NUTR 852: Nutrition Seminar II**, 1 cr. (1 and 0) S Continuation of NUTR 851.

**NUTR 891: Doctoral Dissertation Research**, credit to be arranged

**The following courses offered by various departments represent possible electives for students in the food science and human nutrition program.**

**BIOCH 606: Physiological Chemistry**, 3 cr. (3 and 0) Chemical basis of the mammalian physiological processes of muscle contraction, nerve function, respiration, kidney function and blood homeostasis; composition of specialized tissue such as muscle, nerve, blood and bone, and regulation of water, electrolytes and acid-base balance. **Prerequisite:** BIOCH 210 or organic chemistry.

**BIOCH 815: Lipids and Biomembranes**, 3 cr. (3 and 0) Isolation, chemical and physical properties, and metabolism of lipids; purification, structure, function and biosynthesis of biomembranes. **Prerequisite:** BIOCH 632 or permission of instructor.

**BIOCH 817: Chemistry and Metabolism of Hormones**, 3 cr. (3 and 0) Isolation, assay and chemistry of the various hormones; hormonal control of metabolism and body functions; endocrinopathies of hormone imbalance. **Prerequisite:** BIOCH 632 or permission of instructor.

**BIOCH 821: Proteins**, 3 cr. (3 and 0) Isolation, composition, structure and properties of proteins; methods of isolation, analysis and characterization; properties of “unusual” protein systems. **Prerequisite:** BIOCH 631 or 623 or permission of instructor.

**BIOCH 822: Enzymes**, 3 cr. (3 and 0) Kinetics, mechanisms of action, implications and general properties of enzymes. **Prerequisite:** BIOCH 631 or 623.

**Food Technology**, Paul L. Dawson, Program Coordinator, Department of Food Science and Human Nutrition

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The interdepartmental food technology doctoral program is offered by selected faculty from the departments of Agricultural and Biological Engineering, Animal and Veterinary Sciences, Food Science and Horticulture. Applicants must have a strong background in food science and technology and related areas.

Required courses include FDTH 851, Food Technology Seminar, and FD TH 991, Doctoral Dissertation Research. Additional courses may be selected from those offered in agricultural and applied economics, biosystems engineering, animal and veterinary sciences, experimental statistics, food science, horticulture and microbiology, as required by the student’s graduate advisory committee.

**FD TH 851: Food Technology Seminar**, 1 cr. (1 and 0) F, S Current and ongoing research, as well as developments in food technology reviewed by faculty, students and invited lecturers. **Prerequisite:** Enrollment in the food technology Ph.D. program or permission of instructor.

**FD TH 991: Doctoral Dissertation Research**, credit to be arranged

**Forest Resources**

Patricia A. Layton, Chair, Department of Forest Resources

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Enrollment in the Master of Forest Resources and Master of Science programs is open to students who have earned a baccalaureate degree in forestry, forest products or a related field. A master’s degree, preferably in a forestry discipline, is required for enrollment in the Doctor of Philosophy program. The candidate may be required to satisfy undergraduate deficiencies before being admitted to full status.

The Master of Forest Resources, a nonthesis degree, requires a minimum of 36 semester hours of graduate course work with at least 18 of the required hours coming from courses numbered 700 or above.

A formal thesis is required for the Master of Science and the Doctor of Philosophy degrees. The Master of Science degree requires a minimum of 24 semester hours of course work and six hours of research. The Doctor of Philosophy degree requires a minimum of 16 semester hours of course work and 18 hours of research. For both degrees, one-half of the semester hours must be courses numbered 800 and above.

**FOR 600: Public Relations in Natural Resources**, 3 cr. (3 and 0) S Identifying relevant policies, their characteristics and acceptance to natural resource management; techniques of maintaining appropriate public relations. **Prerequisite:** Senior standing.

**FOR 604: Forest Resource Economics**, 3 cr. (3 and 0) F Economic problems and principles involved in the utilization of forest resources and distribution of forest products; analysis of integrated forest operations. **Prerequisite:** ECON 200 or permission of instructor.
FOR 607: Forest Operations, 3 cr.  
(2 and 3) S  
Theory and practice of conducting forestry operations emphasizing methods, analysis of associated cost and productive rates for timber harvesting and other mechanized field operations. Prerequisite: Senior standing or permission of instructor.

FOR 608: Aerial Photographs in Forestry, 3 cr. (2 and 3) S  
Photographic measurements, aerial photointerpretations, mapping and timber estimating. Prerequisite: Forestry summer camp or permission of instructor.

FOR 609: Multiple-Use Forestry, 2 cr.  
(2 and 0) S  
The demand placed on forests for a variety of products and uses; how these can and must be reconciled in planning the management of each forest. Prerequisite: Senior standing or permission of instructor.

FOR 611: Harvesting Forest Products, 3 cr. (2 and 3) S  
Application of engineering and cost-analysis techniques to the evaluation of the forest transport system and various harvesting situations. Prerequisite: FOR 407 or permission of instructor.

FOR 612: Forest Protection, 2 cr.  
(2 and 0) S  
Prevention and suppression of forest fires; their effect upon the environment and people; factors affecting fire behavior; use of fire in resource management. Prerequisite: Senior standing or permission of instructor.

FOR 613: Integrated Forest Pest Management, 3 cr. (3 and 0) F  
Nature and control of pests of forest trees and products focusing on the relation of pests to silviculture, management and natural forest ecosystems. Prerequisite: Junior standing in forest resource management.

FOR 614: Forest Management Plans, 2 cr. (2 and 0) S  
Analysis of factors entering into forest working plans of several forestry organizations; preparation of a preliminary management plan of a sample area. Prerequisite: FOR 417.

FOR 615: Forest Wildlife Management, 3 cr. (2 and 3) S  
Principles, practices and problems of wildlife management with emphasis on upland forest game species; habitat manipulation through use of appropriate silvicultural practices in association with other techniques. Prerequisite: FOR 310 or permission of instructor.

FOR 616: Forest Policy and Administration, 2 cr. (2 and 0) F  
Development, principles and legal provisions of forest policy in the United States; administrative and executive management in forestry.

FOR 617: Forest Resource Management and Regulation, 3 cr. (3 and 0) F  
Fundamental principles and analytical techniques in planning, management and optimization of forest operations. Prerequisites: FOR 302, 304, 308, 310 and forestry summer camp.

FOR 618: Forest Resource Valuation, 3 cr. (2 and 0) F  
Capital investment tools and their application to decision making among forestry investment alternatives; valuation of land, timber and other resources associated with forestry, including the impact of inflation and taxes. Prerequisite: FOR 304 or permission of instructor.

FOR 620: Forest Products, 3 cr.  
(2 and 3) S  
Primary forest products including lumber, poles and piles, veneers and plywood, secondary wood products; chemically derived products from wood including pulp and paper, distillation products, wood hydrolysis; miscellaneous and minor forest products. Prerequisite: FOR 306, forestry summer camp or permission of instructor.

FOR 621: Biology and Silviculture of Hardwood Forests, 2 cr. (1 and 2) F  
Silvics, growth and development of major hardwood species of North America that will relate these biological characteristics to the ecology, silviculture and utilization of the hardwood forests of the Eastern United States. Prerequisite: FOR 205, 206, 306, 310 or permission of instructor.

FOR 622: Forest Products International Trade, 3 cr. (3 and 0) F  
Major supply regions, major trade flows, international demand, trade patterns, and industry structure and practices involved in international trade of forest products. Prerequisite: Senior standing or permission of instructor.

FOR 623: Current Issues in Natural Resources, 2 cr. (2 and 0) F, S  
Lectures in various fields of forestry delivered by selected representatives from forest industries, consultants, agencies, associations and other forestry operations. Course will not be taught when enrollment is less than 15. To be taken pass/fail only. Prerequisite: Junior standing or permission of instructor.

FOR 627: Urban Tree Care, 3 cr.  
(3 and 0)  
Principles, practices and challenges of establishing, maintaining and protecting trees as valuable assets in urban and recreational areas; biological and environmental factors affecting trees in high-use areas, management techniques for trees in those areas, training and pruning, tree protection, problem tree diagnosis and hazard tree assessment. Prerequisite: Junior standing or permission of instructor.

FOR 628: Wood Design, 3 cr.  
(2 and 3) F  
Technical mechanical properties of wood; load analysis and design criteria; design of structural elements in wood. Prerequisite: FOR 328 or permission of instructor.

FOR 631: Recreation Resource Planning in Forest Management, 2 cr. (1 and 3) S  
Forest recreation as a component of multiple-use forest management; techniques of planning; physical and biological effects on forest environments; forest site, user and facility management.

FOR 632: Forest Site Capability, 2 cr.  
(2 and 0) S  
Analysis of use pressures on the forest land base and their effects on the capability of the forest to satisfy resource demands; productivity and sensitivity of sites. Prerequisite: Senior standing in forestry or permission of instructor.

FOR 633: Global Positioning System Applications, 3 cr. (2 and 3) S  
Global positioning system (GPS) technology including theory, methods and application to natural resources mapping; basic concepts of GPS, projection systems, types of data, mission planning and data capture, correction and export to geographical information systems (GIS). Prerequisite: Senior standing or permission of instructor.

FOR 634 (C R P 634): Geographic Information Systems for Landscape Planning, 3 cr. (1 and 6) S  
Geographic information systems (GIS) technology and its application to various spatial analysis problems in landscape planning; data development and management, spatial analysis techniques, critical review of GIS applications, needs analysis and institutional context. GIS hardware and software, hands-on application project.

FOR 641: Properties of Wood Products, 3 cr. (3 and 0) S  
Basic properties of wood including the hygroscopic, thermal, electrical, mechanical and chemical properties; standard testing procedures for wood. Prerequisite: Junior standing or permission of instructor.

FOR 642: Manufacture of Wood Products, 3 cr. (3 and 0) S  
Manufacture of lumber, plywood, poles, piles; drying, preservation, grading and uses of wood products; particleboard, flakeboard, oriented-strand board, fiberboard and paper products. Includes physical, mechanical and chemical properties and their applications. Prerequisite: Permission of instructor.

FOR 643: Manufacture of Wood Products II, 3 cr. (3 and 0) S  
Manufacture of particleboard, flakeboard, oriented-strand board, fiberboard and paper products; their physical, mechanical
FOR 644: Forest Products Marketing and International Trade, 3 cr. (3 and 0)
Marketing and international trade practices currently employed by the forest products industry and the application of basic marketing principles and global trade concepts in the industry's current and future environment. Prerequisite: FOR 442 or 443 or permission of instructor.

FOR 645: Forest Products and the Environment, 3 cr. (3 and 0)
Use of wood as a basic material and its impact on the environment; environmental issues affecting wood processing, pulp and paper, and preservation industries; reuse and recycle of wood and paper wastes and the development of composites from these wastes. Prerequisite: FOR 442 or permission of instructor.

FOR 646: Wood Products Applications and Specifications, 3 cr. (3 and 0)
Application of lumber, plywood, particleboard, waferboard, oriented-strand board and treated-wood products in building construction; proper application of load tables, allowable span and spacing. Prerequisite: FOR 442 or 443 or permission of instructor.

FOR 651 (EE&S 651) (B E 651): Newman Seminar and Lecture Series in Natural Resources Engineering, 1 cr. (0 and 2) S, F
Topics dealing with the development and protection of land, air, water and related resources will be covered by seminar with instructor and by invited lecturers. Current environmental and/or resource conservation issues will be addressed. Prerequisite: Senior or graduate standing, permission of instructor.

FOR 660: Silviculture I, 3 cr. (3 and 2)
Theory and practice of establishing, maintaining and harvesting forest stands in accordance with ecological and economic principles. Prerequisite: FOR 206 and forestry summer camp or permission of instructor.

FOR 662: Silviculture II, 3 cr. (2 and 3)
Forest management practices that affect ability of the land to produce multiple forest resources with emphasis on water, nutrients and fire. Prerequisite: FOR 401 or permission of instructor.

FOR 707: Special Problems in Forestry, 1-3 cr. (1-3 and 0)
Directed individual study of a special problem in an applied field of forestry. Written report of study results required.

FOR 802: Advanced Mensuration, 3 cr. (2 and 3) S (even numbered years)
Specialized sampling techniques and statistical methods often required only in forestry; compilation of timber volume tables; forest survey problems. Prerequisite: EX ST 301 or permission of instructor.

FOR 804: Advanced Forest Economics, 3 cr. (2 and 3) F (even numbered years)
Examination, discussion and application of economic principles to forestry problems in use of land, labor and capital; use of theory in problems of resource allocation and efficiency in forest management. Prerequisites: FOR 304/604 and 418/618 or permission of instructor.

FOR 805: Forest Landscape Ecosystems, 4 cr. (3 and 3) F (even numbered years)
Three basic landscape components of soils, landform and vegetation; their interrelationships in forest ecosystems; factors and processes of soils as interacting components with landform and vegetation. Prerequisite: Graduate standing or permission of instructor.

FOR 806: Advanced Silviculture—Forest Tree Growth and Development, 3 cr. (3 and 0) F (odd numbered years)
Growth and development of economically important forest tree species; structure, function, phenology and wood formation related under forest stand conditions emphasizing manipulation of forest tree growth by cultural practice; current research in growth and culture of forest trees and stands. Prerequisites: BIOSC 401/601 and 402/602 or permission of instructor.

FOR 807: Special Problems in Forestry, credit to be arranged
Special problems in forestry research methods that do not directly pertain to the candidate's thesis.

FOR 808: Seminar, 1 cr. (1 and 0) F, S
Research and current developments in forestry; students and staff participate. May be taken up to two semesters for credit. Graded on a pass/fail basis.

FOR 809: Products Biodeterioration, 2 cr. (1 and 3) F (even numbered years)
Role of microorganisms in reducing the strength, aesthetics and value of products in service emphasizing the deterioration of wood.

FOR 810: Forest Landscape Ecosystems of the Great Smoky Mountains, 2 cr. (1 and 1)
Observation and measurements of species composition, community structure, soil-site relationships, land use practices within the forest ecosystems of Great Smoky Mountains National Park; field data interpreted and illustrated using ordination and classification techniques common in ecological studies. Prerequisite: Permission of instructor.

FOR 811: Forest Wetland Ecology and Management, 2 cr. (2 and 0) S
Assessment of ecological processes and how they influence forest wetland productivity, management and regulation. Prerequisite: Introductory ecology or permission of instructor.

FOR 812: Fire Ecology and Management, 3 cr. (2 and 3)
Historical presence of fire in various regions of North America and its effects on forests; analysis of current fire management strategies with emphasis on usage of prescribed fire as an ecosystem management tool. Prerequisites: Graduate standing or permission of instructor.

FOR 814: Advanced Forest Resource Management and Planning, 3 cr. (3 and 0) S (odd numbered years)
Current forest resource management and planning topics; operational emphasis on application of various quantitative tools to solve economic and management problems; advanced topics in forest regulation, forest valuation, mathematical programming and harvest scheduling, simulation, multiple-use alternatives and selected areas. Prerequisite: FOR 417/617 or permission of instructor.

FOR 815: Systems Processes in Natural Resources, 3 cr. (2 and 3)
Use of system thinking and system analysis to define the issues, model, simulate and evaluate alternatives for forest landscape problems and opportunities. Prerequisite: Graduate standing.

FOR 816 (PRTM 816): Remote Sensing and GIS in Natural Resources, 3 cr. (2 and 3) S (odd numbered years)
Practical application of computer mapping, spatial analysis and natural resource inventory using remote sensing and geographical information systems. Prerequisite: Permission of instructor.

FOR 825: Wood Chemistry, 3 cr. (2 and 3) F (even numbered years)
Chemical composition of wood and related lignocellulosic substances and the chemistry of individual wood components; chemical reactions and applications of cellulose, hemicelluloses, lignin and extractives.

FOR 826: Applied Wood Mechanics, 3 cr. (3 and 0)
Stress and strain of wood and wood products, orthotropic elasticity, stiffness and compliance matrices, application of elastic theory to structural systems, creep and relaxation of wood, theories and prediction of failure, analyses of layered wood composites, determination of mechanical properties and allowable stresses.

FOR 827: Wood Physics, 3 cr. (3 and 0)
Thermodynamics and theories of moisture sorption in wood products; transport of moisture and heat. Prerequisite: Permission of instructor.

FOR 891: Master's Thesis Research, credit to be arranged

FOR 991: Doctoral Dissertation Research, credit to be arranged
The M.S. and Ph.D. degrees in genetics (plant, animal and microbial) are offered through an interdepartmental program. Basic and applied research emphasis areas include biochemical, biometrical, molecular and population genetics, as well as bioinformatics, breeding, cytogenetics and structural and functional genomics.

Applicants to the program must have a bachelor’s or master’s degree; chemistry through organic or biochemistry; physics; mathematics through calculus; and biology including introductory genetics. Students with more than 18 hours of deficiencies will be admitted as postbaccalaureate enrollees until eligibility for graduate status is attained.

GEN 616 and 651 are required of all students. In addition, four of the following eight courses must be completed for the M.S. or Ph.D. degree: GEN/BIOCSI/MICRO 618, MICRO 615, CS ENV 605, AVS 670, BIOCS/HORT 665, GEN 812, BIOCSI 815 and BIOCH 841. Other 800-level courses pertinent to the program of study and research are planned by the student and advisory committee to provide the student with a comprehensive knowledge of genetics.

The M.S. degree requires completion of 30 semester hours including 24 hours of course work, six hours of research and a research thesis. Twelve of the required 24 hours of course work must be 800-level courses. The Ph.D. degree requires 18 hours of doctoral research credit, a research dissertation and a minimum of 24 hours of course work beyond the bachelor’s degree. The course work is specified by the student’s advisory committee with concurrence of the Genetics Program Committee.

**GEN 616 (BIOSCI 616): Recombinant DNA, 3 cr. (3 and 0)**
Current facts and concepts of molecular genetics focusing on gene organization, structure, and expression in prokaryotes and eukaryotes; current technologies and research in these areas. Prerequisites: GEN 302 or its equivalent and one semester of biochemistry or permission of instructor. A developmental biology course is also strongly recommended.

**GEN 618 (MICRO 618) (BIOSCI 618): Biotechnology I: Nucleic Acids Techniques, 4 cr. (2 and 4) N**
Basic training in the manipulation of genetic information using recombinant DNA technology including techniques in molecular cloning, Southern and Northern analyses, clone library construction. Prerequisite: BIOCH 210 or 301 and MICRO 305 or permission of instructor.

**GEN 651: Advanced Genetics, 3 cr. (3 and 0) F**
Principles of general genetics emphasizing variations in chromosome number and structure, natural and induced mutations, extranuclear inheritance, recombination, control of gene activity, genes and development, genetics of behavior patterns, population genetics, systems of mating, genetics and man. Prerequisite: GEN 302 or equivalent.

**GEN 695 (ENT 695): Insect Biotechnology, 3 cr. (3 and 0)**
Unique features exhibited by insects; applications of biotechnology to enhance useful products from insects and to affect the control of destructive insects. Prerequisites: ENT 301 and GEN 302.

**GEN 801: Cytogenetics, 3 cr. (2 and 3) S (odd numbered years)**
Classical and contemporary problems of chromosome structure, behavior and transmission; recombination; interspecific hybridization; euchromatin and heterochromatin; polyploidy; mutable genetic systems; structural and numerical aberrations of chromosomes and their effects upon breeding systems of plants and animals. Prerequisite: GEN 302 or equivalent.

**GEN 803: Biometrical Genetics, 3 cr. (3 and 0) S**
Statistical methodology in the study of population genetics; probability as applied to genetic systems, gene and zygotic frequencies, derivation of genetic expectations, forces that change gene frequency, inbreeding, estimation and testing of genetic parameters, partitioning of variance, responses to selection and other statistical aspects of continuous variation. Prerequisites: GEN 651 and EX ST 801 or equivalent.

**GEN 806: Special Problems in Genetics, 1-3 cr. (0 and 3-9)**
Research not related to a thesis.

**GEN 812: Physiological Genetics, 3 cr. (3 and 0)**
Advanced topics in the molecular aspects of physiological genetics including genes and metabolism, genes and signal transduction, oncogenes and growth, chromosomal aberrations, immunogenetics and others. Prerequisites: A semester of biochemistry and introductory genetics.

**GEN 825: Genetics Seminar, 1 cr. (1 and 0)**
Special topics and original research in genetics reviewed by students, faculty and invited lecturers. May be repeated for credit. Prerequisite: One semester of genetics.

**GEN 890: Special Topics in Genetics, 1-3 cr. (1-3 and 0)**
Group discussion of recent developments in genetic research. May be repeated for a maximum of six credit hours. Prerequisites: GEN 302 and permission of instructor.

**GEN 891: Master’s Thesis Research, credit to be arranged**

**GEN 991: Doctoral Dissertation Research, credit to be arranged**
characteristics, culture, production, harvesting and handling of both commercial and home-grown grapes, blueberries, strawberries, brambles and kiwifruit. Prerequisite: HORT 101 or permission of instructor.

HORT 656: Vegetable Crops, 3 cr. (3 and 0) Principles and practices employed in the commercial growing and marketing of vegetable crops with emphasis on plant characteristics, cultivars, management practices, harvest, quality factors and grading, storage, economic importance and areas of production.

HORT 661: Problems in Landscape Design, 4 cr. (3 and 3) S Landscape planning for larger residential properties, schools, industrial plants, real estate developments; detailed finished plans; further study of materials used; original problems; field study. Prerequisites: HORT 308, 407 or permission of instructor.

HORT 665 (BIOSC 665): Plant Molecular Biology, 3 cr. (3 and 0) Fundamental plant processes at both the cellular and molecular levels including genome structure and organization (both nuclear and organelar); regulation of gene expression and its role in cellular and whole-plant processes; transposable genetic elements; applications for biotechnology. Prerequisites: Junior standing or permission of instructor and BIOSC 304 or 305 and GEN 302.

HORT 671: Advanced Internship, 1-6 cr. (0 and 2-12) Preplanned work experience under competent supervision in approved agency dealing with horticultural endeavors. Designed to give advanced students on-the-job learning opportunities to apply acquired knowledge and skills. Monthly reports and final departmental seminar required. Undergraduates may accumulate a maximum of six credits for participation in HORT 271 and/or 471. Prerequisites: Junior standing and permission of instructor.

HORT 672: Garden Experiences in Youth Development, 2 cr. (1 and 3) Role of gardening and related outdoor experiences in enhancement of educational development, self-esteem and prosocial behavior in elementary school children. Prerequisites: Senior standing and permission of instructor.

HORT 701: Horticulture: Plant and Environmental Science, 3 cr. (2 and 3) SS Scope of South Carolina horticulture and how it affects the quality of life economically and aesthetically; environmental responsibilities; methods of teaching plant principles. Three-day statewide field trip to horticultural industries included. Not to be taken for credit by graduate students in horticulture.

HORT 800: Topics in Horticultural Science, 1 cr. (1 and 0) Timely topics in horticultural science. May be repeated for a total of four credits, as topics and instructors vary. Prerequisite: Permission of instructor.

HORT 802: Research Systems in Horticulture, 3 cr. (2 and 3) F (even numbered years) Current trends, developments and techniques in horticultural research. Prerequisites: CH 223 and 227, or CH 201 and PHYS 207, or BIOCH 210.

HORT 806: Postharvest Physiology and Handling of Horticultural Crops, 3 cr. (3 and 0) S Principles, developments and research findings dealing with physiological and biochemical changes and processes occurring in horticultural plant organs after harvest; biological aspects of methods and practices relating to harvesting, handling, transportation and storage of horticultural commodities for fresh market. Prerequisites: BIOSC 401/601 and 402/602 or equivalent.

HORT 809: Seminar I, 1 cr. (1 and 0) F Current topics in horticulture prepared and presented by the student.

HORT 810: Seminar II, 1 cr. (1 and 0) S Continuation of HORT 809.

HORT 812: Special Problems in Horticulture, 1-4 cr. (1-4 and 0) Research not related to a thesis. Course may be repeated for up to four credits. Prerequisite: Permission of instructor.

HORT 813: Photomorphogenesis, 3 cr. (2 and 2) F Regulatory role of light quality in plant development (photomorphogenesis) and its consequences in applications for crop production. Prerequisites: BIOSC 401/601 and 402/602 or permission of instructor; BOT 823 preferred.

HORT 814: Environmental Plant Stress Physiology, 3 cr. (2 and 2) F Environmental stresses associated with water (drought, waterlogging), temperature, light and air pollution with quantitative treatment of stress effects on plants; mechanisms by which plants may avoid, tolerate or modify stress effects on plant growth and function at the molecular, cellular and whole-plant levels. Prerequisites: BIOSC 401/601 and 402/602 or permission of instructor.

HORT 851 (BOT 851): Plant Anatomy, 3 cr. (2 and 3) S (odd numbered years) Origin, development and comparative structures of tissues, systems and organs of higher plants. Prerequisite: BIOSC 652 or permission of instructor.
MICRO 600: Public Health Microbiology, 3 cr. (3 and 0) S
Epidemiology of transmissible diseases including pathogenic characteristics of the infectious organism, modes of transmission, mechanism of infection, diagnostic aids, effective treatments, immunizing procedures and methods of preventing infection. Prerequisite: MICRO 305.

MICRO 601: Advanced Bacteriology, 4 cr. (2 and 6) F
Metabolism, nutrition, growth and death of bacteria; microbiological assays and industrial fermentation. Emphasis is on laboratory procedures for the identification of the more common taxonomic groups. Prerequisite: CH 201 or 223, 227 and MICRO 305.

MICRO 603: Marine Microbiology, 3 cr. (2 and 3) N
Microbes that inhabit the marine environment, their peculiar physiological traits and contributions to the ecology of oceans. Prerequisites: MICRO 305 and organic chemistry.

MICRO 607: Food and Dairy Microbiology, 4 cr. (3 and 3) S
Physical-chemical factors limiting survival and growth of microorganisms during processing and manufacturing of food and dairy products; standard methods for enumerating and identifying indicator bacteria, yeasts, molds and microbes producing food and food-borne illness; starter cultures, fungal toxins, microbial cell injury and standards for food and dairy products. Prerequisite: BIOCH 210 or CH 201 or 223 and MICRO 305.

MICRO 610: Soil Microbiology, 3 cr. (2 and 3) N
Role of microorganisms in the decomposition of organic substances, transformation of nitrogen and mineral substances in the soil; interrelationships between higher plants and microorganisms; importance of microorganisms in soil fertility. Prerequisite: MICRO 305.

MICRO 611: Pathogenic Bacteriology, 4 cr. (3 and 3) S
Pathogenic bacteria, their morphology, cultural requirements and classification; diagnostic tests, methods of differentiation and the diseases caused. Prerequisite: MICRO 305.

MICRO 612: Bacterial Physiology, 4 cr. (3 and 3) S
CytoLOGY, physiology, metabolism and genetics of bacteria including growth and death, reproduction and mutation, nutrition and metabolic pathways, regulatory mechanisms and effects of environment. Prerequisites: CH 224, MICRO 305 and one semester of biochemistry or permission of instructor.

MICRO 613: Industrial Microbiology, 3 cr. (2 and 3) F
Microbial aspects of large-scale processes for the production of foods, antibiotics, enzymes, fine chemicals and beverages including strain selection, culture maintenance, biosynthetic pathways, continuous cultivation and production of single cell protein. Prerequisite: MICRO 305.

MICRO 614: Basic Immunology, 3 cr. (2 and 3) F
Nature, production and function of basic immune responses in animals; procedures and mechanisms of antigen-antibody and other immune reactions. Prerequisites: MICRO 305 and organic chemistry.

MICRO 615: Microbial Genetics, 4 cr. (3 and 3) S
Cytological basis of bacterial, fungal and viral genetics; molecular aspects; mechanisms of genetic transfers; episomes and plasmids; and population changes. Prerequisite: BIOCH 301, CH 224 and MICRO 305 or permission of instructor.

MICRO 616: Introductory Virology, 3 cr. (3 and 0) F
Introduction to the field of virology including animal, bacterial and plant viruses. Topics include nomenclature and classification, biochemical and biophysical characteristics, mechanisms of replication, chemotherapy and techniques for isolation, assay and purification. Prerequisite: BIOCH 301, MICRO 305 or permission of instructor.

MICRO 617: Molecular Mechanisms of Carcinogenesis and Aging, 3 cr. (3 and 0) S
Changes that occur at the cellular and subcellular levels during transformation and aging; accumulated damage and "intrinsic clock" theories of aging; genetic and epigenetic theories of carcinogenesis; epidemiology of cancer; viral, radiation-induced and chemical carcinogenesis; the immune system and cancer. Prerequisite: BIOCH 301, MICRO 305 or permission of instructor.

MICRO 618 (BIOSC 618) (GEN 618): Biotechnology I: Nucleic Acids Techniques, 4 cr. (2 and 4) N
Basic training in the manipulation of genetic information using recombinant DNA technology including techniques in molecular cloning, Southern and Northern analyses, clone library construction. Prerequisite: BIOCH 210 or 301, MICRO 305 or permission of instructor.

MICRO 619: Molecular Medicine, 3 cr. (3 and 0) S
Introduction to various areas of molecular medicine; the latest research and developments in molecular medicine; designed for students interested in medicine and biomedical research. Prerequisite: MICRO 304, BIOCH 301 or permission of instructor.

MICRO 620: Bacteriological Technic, 4 cr. (2 and 6) F
Analytical and experimental procedures used in bacteriology including techniques for studying bacterial cytology, physiology and metabolism; experience in more advanced methods of investigation.

MICRO 803: Special Problems in Microbiology, credit to be arranged, F, S, SS
Research not related to a thesis.

MICRO 804: Selected Topics in Microbiology, 1-3 cr. (1-3 and 0) F, S, SS
Evaluation of current research literature in various areas of microbiology; critical evaluation of specific publications in terms of their scientific merit. Required of all microbiology graduate students. May be repeated for credit.

MICRO 805: Techniques of Clinical Microbiology and Immunobiology, 3 cr. (2 and 3)
Methods for isolating, identifying and culturing different mammalian cell types; techniques used to analyze cell function and viability and for protein and DNA analysis emphasizing application to the diagnosis of disease, determination of prognosis, optimization of treatment and determination of etiology. Prerequisite: MICRO 614, 615, BIOCH 623 or equivalent, or permission of instructor.

MICRO 806: Pathogenesis and Infectious Disease, 3 cr. (3 and 0) N
Medically important host-parasite relationships at the cellular and subcellular levels with emphasis on bacterial and viral infections in man. Prerequisite: MICRO 611 or permission of instructor.

MICRO 807: Seminar, 1 cr. (1 and 0) F, S
Topics not covered in other courses; students review literature, organize and present material. May be taken twice for credit.

MICRO 808: Biotechnology and Medicine, 3 cr. (3 and 0)
Medical problems currently receiving attention due to the application of biotechnology to diagnosis or treatment, basic information essential to understanding the molecular biology of the disease and its diagnosis or treatment. Prerequisite: Permission of instructor.

MICRO 809 (HLTH 809): Epidemiological Research, 3 cr. (3 and 0)
Basic concepts of epidemiology with emphasis on applied aspects rather than theoretical. Examples drawn from clinical practice. Use of relevant PC-based computer packages required. Prerequisite: MTHSC 405/605 or EX ST 801 or permission of instructor.

MICRO 811: Bacterial Cytology and Physiology, 4 cr. (4 and 0) S
(odd numbered years)
Structure, chemistry and physiology of the various bacterial cell components; physiology of bacterial growth and reproduction in batch, continuous and synchronous cultures; economy of the bac-
terial cell including endogenous metabolism and maintenance requirements; physiology of bacterial death; regulation of enzyme and nucleic acids syntheses. **Prerequisite:** BIOC 423/623; MTHSC 206; or permission of instructor.

MICRO 812: Bacterial Metabolism, 3 cr. (3 and 0) S (even numbered years) Various biochemical pathways occurring in bacterial cells; fermentations of carbohydrates and related compounds and of nitrogenous organic compounds; anaerobic and aerobic respiration including electron transport systems and oxidative phosphorylation; bacterial photosynthesis; nitrogen fixation; biosyntheses of amino acids, purines, pyrimidines, lipids, proteins, nucleic acids and polysaccharides. **Prerequisite:** BIOC 423/623; MTHSC 206; or permission of instructor.

MICRO 815: Advanced Microbial Genetics, 3 cr. (3 and 0) F Current developments in microbial genetics; integration of genetics and biochemistry; analysis of genetic fine structure in microorganisms; nature of bacterial variation and expression of mutations; population dynamics; physiochemical mechanisms of heredity; regulation of gene action in microorganisms; physiology and genetics of virulent and lysogenic bacteriophages. **Prerequisite:** MICRO 415/615.

MICRO 891: Master's Thesis Research, credit to be arranged

MICRO 991: Doctoral Dissertation Research, credit to be arranged

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**PKGSC 802: International Packaging, 3 cr. (3 and 0)**

International packaging, including material, practices, machinery, marketing and regulatory compliance principles. **Prerequisite:** Permission of instructor.

**PKGSC 804: Flexible Packaging, 3 cr. (2 and 1)**

Guidelines to identify quality requirements for products, determine the packaging to maintain the quality and evaluate that the requirements have been met; quality maintenance testing and prediction. **Prerequisite:** Permission of instructor.

**PKGSC 821: Selected Problems, 1-4 cr. (0 and 1-12)**

Independent research investigations in packaging science related to packaging materials, machinery, design and applications in areas not covered in other courses. May be repeated for credit. **Prerequisite:** Permission of instructor.

**PKGSC 822: Selected Topics, 1-4 cr. (1-4 and 0)**

Selected topics in packaging science not covered in detail or contained in other courses. May be repeated for credit. **Prerequisite:** Permission of instructor.

**PKGSC 851: Packaging Science Seminar, 1 cr. (1 and 0)**

Current research and related developments in packaging science reviewed by faculty, students and invited lecturers. May be repeated for a maximum of four credits. **Prerequisite:** Permission of instructor.

**PKGSC 891: Master's Thesis Research, credits to be arranged**

Research on a master's thesis topic. **Prerequisite:** Graduate student status.

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**The following courses offered by various departments represent possible electives for the student in packaging science.**

CH E 612: Polymer Engineering, 3 cr. (3 and 0)

Design-oriented course in synthetic polymers; reactor design used in polymer production, effect of step versus addition kinetics on reactor design, epoxy curing reactions, polymer solubility, influence of polymerization and processing conditions on polymer crystallinity. **Prerequisites:** CH 224 and 332 or permission of instructor.
CH E 804: Chemical Engineering Thermodynamics, 3 cr. (3 and 0) Equilibria of physical and chemical systems; generalized properties of hydrocarbons; application of thermodynamic methods in equipment design.

C M E 815: Colloidal and Surface Science, 3 cr. (3 and 0) Theory and application of colloidal and surface chemistry to ceramic materials and processes.

EX ST 801: Statistical Methods I, 4 cr. (3 and 3) F, S Role and application of statistics in research; estimation, test of significance, analysis of variance, multiple comparison techniques, basic designs, mean square expectations, variance components analysis, simple and multiple linear regression and correlation, and non-parametric procedures. Prerequisite: Permission of instructor.

EX ST 802: Statistical Methods II, 3 cr. (3 and 0) F, S, SS Extended coverage of several methods introduced in EX ST 801: multiple regression model building and diagnostics, experiment design and analysis, and non-parametric methods; mixed models and repeated measures analyses; categorical data analysis; multivariate methods and sampling designs; appropriate use of statistical software. Prerequisite: EX ST 801.

FD SC 601: Food Chemistry I, 4 cr. (3 and 3) F (even numbered years) Basic composition, structure and properties of food and the chemistry of changes occurring during processing utilization. Prerequisite: BIOCH 210 or permission of instructor.

FD SC 602: Food Chemistry II, 4 cr. (3 and 3) S (odd numbered years) Application of theory and procedures for quantitative and qualitative analysis of food ingredients and food products; methods for protein, moisture, lipid, carbohydrate, ash, fiber, rancidity, color and vitamin analyses and tests for functional properties of ingredients. Prerequisite: BIOCH 210 or permission of instructor.

FD SC 604: Food Preservation and Processing, 3 cr. (3 and 0) S (even numbered years) Principles of food preservation applied to flow processes, ingredient functions and the importance of composition and physical characteristics of foods related to their processing; product recalls and product development concepts. Prerequisites: Physics and organic chemistry or biochemistry.

FD SC 606: Food Preservation and Processing Laboratory, 1 cr. (0 and 3) S (even numbered years) Laboratory exercises on preservation methods, equipment utilized and processes followed in food manufacture. Corequisite: FD SC 404/604.

FD SC 608: Food Process Engineering, 4 cr. (3 and 3) Basic design and application principles and their application in food processing operations; relation between engineering principles and fundamentals of food processing. Prerequisites: FD SC 214, CH 102 or 112, MTHSC 106, PHYS 207 or 200 or 122 or permission of instructor.

FD SC 610: Chemical and Biochemical Aspects of Foods, 4 cr. (4 and 0) Chemical, biochemical and functional properties of food components and their interactions in food emulsions, foams, colloids, and gel and solution states; the influences of processing on isolation, utilization and production of the constituents using techniques based on constituent properties. Prerequisites: BIOCH 623 and FD SC 401/601 or permission of instructor.

FD SC 611: Physical and Thermophysical Properties of Foods, 3 cr. (3 and 0) Principles involved in relating physical and thermophysical properties to food quality, including standard methods and instruments to determine texture and the relationship of physical properties to sensory evaluation; interrelationships of chemical structure and physical properties in food processing operations. Prerequisite: FD SC 610 or permission of instructor.

FD SC 612: Microbiological Aspects of Food Systems, 3 cr. (3 and 0) Function and characteristics of microorganisms in the utilization and manufacture of food products; food fermentations, microbiologically induced chemical and physical changes, environmental aspects and production of food ingredients and resources. Prerequisite: MICRO 407/607 or equivalent or permission of instructor.

G C 606: Package and Specialty Printing Laboratory, 2 cr. (0 and 6) Laboratory techniques for printing and converting in package, label and specialty printing industries. Experiences in flexographic prepress, printing, die design, die making and diecutting for labeling, folding cartons and corrugated; sublimation and plastisol transfer screen printing; and glass, plastic and metal container printing. Prerequisite or Corequisite: G C 405 or permission of instructor.

G C 607: Advanced Flexographic Methods, 4 cr. (2 and 6) Methods used in flexographic printing and converting porous and nonporous substrates. Theory and laboratory applications include setting standards for process color, preparation of plate systems, ink mixing and color matching, testing of films and foils, analysis of recent developments and prediction of future markets. Prerequisites: G C 406 and 444 or permission of instructor.

G C 648: Planning and Controlling Printing Functions, 3 cr. (3 and 0) Systems for setting printing production standards, estimating, scheduling, job planning and the selection of new hardware and technologies. Prerequisite: G C 350, 406, 440, 450.

MGT 623: International Business Management, 3 cr. (3 and 0) The theoretical and institutional complexities of international business operations. Topics include exporting, importing, foreign investment, multinational corporations and the international payment system. Prerequisite: Junior or senior standing.

MGT 624: International Transportation and Logistics, 3 cr. (3 and 0) International transportation systems and their logistics support systems. Topics include ocean shipping, international air transportation, port management and EEC and Soviet-block transport systems, and international transport legislation and policies. Prerequisite: Senior standing or permission of instructor.

MKT 627: International Marketing, 3 cr. (3 and 0) Marketing from the international point of view; the necessary modification of marketing thinking and practice for foreign markets due to individual environmental differences. Prerequisite: MKT 301.

MKT 630: Marketing Product Management, 3 cr. (3 and 0) Management of the firm’s product or service offerings. Topics include new product screening, evaluation and development; product line and mix analysis; abandonment decisions; brand manager’s role; new product development department. Emphasis is on decision making. Prerequisites: MKT 301 and MA SC 310 or permission of instructor.

The degree programs in plant and environmental sciences have subsumed programs in botany, crop and soil environmental sciences, horticulture, plant pathology and plant physiology. The degrees are offered through an interdepartmental program comprised of faculty from disciplines including botany, crop science, genetics, horticulture, plant pathology, plant physiology and soil science. Candidates for this program should have a strong undergraduate background in the biological, agricultural and/or physical sciences as appropriate to their focus area. Undergraduate curricula that may provide
this background are botany, biology, chemistry or one of the agricultural plant and soil environmental sciences such as agronomy, forest resources or horticulture. Students with nontraditional backgrounds may need to complete some relevant undergraduate courses to supplement this graduate program.

Each student’s degree program is tailored to his/her professional goals and is guided by an adviser and graduate committee with areas of expertise appropriate to the student’s area of specialization. All graduate students must select an adviser before admission.

Candidates for the M.S. degree must complete 24 semester credit hours of course work and six hours of research, and must present and defend a thesis based on original research. M.S. students who plan nonresearch-related careers in public gardening, landscape design, extension, consulting or agribusiness may complete 30 semester hours of course work and undertake a professional development/public service project option in lieu of thesis-related research. Interdisciplinary studies in plant health and integrated pest management are also available under this option. A dissertation based on original research is required for the Ph.D. degree. There is no specific semester credit hour requirement; the plan of course work is based on areas of expertise appropriate to the student’s area of specialization. All graduate students must select an adviser before admission.

Candidates for the M.S. degree must complete 24 semester credit hours of course work and six hours of research, and must present and defend a thesis based on original research. M.S. students who plan nonresearch-related careers in public gardening, landscape design, extension, consulting or agribusiness may complete 30 semester hours of course work and undertake a professional development/public service project option in lieu of thesis-related research. Interdisciplinary studies in plant health and integrated pest management are also available under this option. A dissertation based on original research is required for the Ph.D. degree.

PL PA 602: Diseases of Ornamental Plants, 3 cr. (2 and 2) S (odd numbered years)
Survival mechanisms, life cycles, host-parasite relationships, symptomatology, diagnosis, economics and integrated control of infectious diseases; causal factors, diagnosis and control strategies of noninfectious diseases of ornamental plants. Prerequisites: PL PA 310 or equivalent.

PL PA 606: Diseases of Turfgrasses, 3 cr. (2 and 2) F
Host-parasite relationships, symptomatology, diagnosis, economics, and control of infectious and noninfectious diseases of turfgrasses; life histories, diagnosis and control of important insect pests of turfgrasses. Prerequisites: ENT 301 and PL PA 310 or equivalents.

PL PA 611: Plant Disease Diagnosis, 2 cr. (1 and 2) SS (odd numbered years)
Methods and procedures used in the diagnosis of plant diseases, especially late spring and early summer diseases; basic techniques of pure culture and identification of plant pathogens and Koch’s postulates; diagnosis of a wide variety of diseases of cultivated and wild plants. Prerequisite: PL PA 310 or equivalent.

PL PA 656: Plant Virology, 3 cr. (2 and 3) S (odd numbered years)
Plant viruses with emphasis on their morphology, biochemistry, purification and transmission; symptoms resulting from virus infection; virus-vector relationships; serological procedures; importance and control of plant virus diseases. Prerequisites: BIOL 103 and any biochemistry or plant physiology course.

PL PA 658: Plant Parasitic Nematodes, 3 cr. (2 and 3) F (even numbered years)
Morphology and taxonomy of stylet-bearing nematodes and their relationship with plant diseases. Prerequisites: BIOL 103, 104 or 110, 111.

PL PA 800: Advanced Plant Pathology, 3 cr. (3 and 0) F (odd numbered years)
Economic and social significance and history of plant pathology, host-parasite interactions (host defense mechanisms, myco toxins, pathotoxins, mycoplasmas), ecology (mycorrhizae, pollution, soilborne plant pathogens), and disease loss and appraisal. Selected pathogens illustrate concepts and principles. Outside assignments introduce topics not covered in class. Prerequisite: PL PA 401.

PL PA 801: Epidemiology and Control of Plant Diseases, 3 cr. (3 and 0) S (even numbered years)
Epidemiology and control of plant diseases including practical and theoretical coverage of chemical, physical and biological means of plant disease control. Prerequisites: PL PA 401 and organic chemistry.

PL PA 802: Selected Topics, 1-3 cr. (1-3 and 0-6)
Current advances in phytopathology and physiology, diseases of specific crops and specialized laboratory protocol. May be repeated for credit. Prerequisite: Permission of instructor.

PL PA 803: Fungal Plant Pathogens, 3 cr. (1 and 6) S (odd numbered years)
Plant pathogenic fungi including recognition of fungus disease symptoms, isolation of fungi that cause diseases, cultural features of fungi, morphological characteristics, physiological reactions to environment, disease cycles and management of pathogens and diseases. Prerequisites: BIOL 104 or equivalent, PL PA 401 and BIOCS 425/625.

PL PA 804: Plant-Microbe Interactions, 3 cr. (3 and 0) F (even numbered years)
Physiology, biochemistry and genetics of plant-microbe interactions; molecular mechanisms involved in plant-microbe communication, plant colonization and penetration; development of the microbe within the plant; induction of plant defense responses. Prerequisites: BIOCS 401/601 and 402/602 or PL PA 310 or permission of instructor.

PL PA 805: Special Problems in Plant Pathology, credit to be arranged
Research not related to a thesis. Prerequisites: PL PA 411/611 or equivalent, and permission of instructor.

PL PA 807: Seminar, 1 cr. (1 and 0) F, S
Areas of plant pathology and plant physiology not covered by formal courses. Relevant literature is reviewed. Material is organized and presented by students. Graded on a pass/fail basis.

PL PA 809: Physiological Techniques in Plant Pathology, 2 cr. (1 and 3) S (odd numbered years)
Techniques in separation science; qualitative and quantitative analysis of concern to students in plant pathology and plant physiology. Prerequisite: Organic chemistry or permission of instructor.

PL PA 810: Fungal and Bacterial Plant Pathogens, 4 cr. (3 and 3) S
Biological and molecular biology of plant pathogenic fungi and bacteria; principles of taxonomy, evolution, morphological structures, life cycles, population biology, ecology, control and genetic manipulation of representative fungal and bacterial pathogens encountered by plant pathologists. Prerequisites: PL PA 310, MICRO 305 or equivalent.

PL PA 811: Plant Viruses and Plant Parasitic Nematodes, 4 cr. (3 and 3)
Biological and molecular biology of plant viruses and plant parasitic nematodes; taxonomy, evolution, life cycles, population biology, ecology, control and genetic manipulation of representative viruses and plant parasitic nematodes encountered by plant pathologists. Prerequisite: PL PA 310 or equivalent.

PL PA 856: Plant Virology, 3 cr. (2 and 3)
Plant viruses; their morphology, biochemistry, purification and transmission; symptoms resulting from virus infection; virus vector relationships; serological and nucleic acid hybridization procedures; diagnosis of viral diseases and the identification of causal agents; replication of plant viruses; the interaction between viral host and plant genome.
PL PA 891: Master’s Thesis Research, credit to be arranged
PL PA 991: Doctoral Dissertation Research, credit to be arranged

**Plant Physiology**
N. Dwight Camper, Program Coordinator, Department of Plant Pathology and Physiology

Advanced degrees in plant physiology are not awarded. Students interested in plant physiology should enroll in a degree program in plant and environmental sciences (M.S. or Ph.D.) with a concentration in the area of plant physiology.

The following courses offered by various departments represent possible electives for the student with a concentration in plant physiology.

**BIOSC 618 (MICRO 618) (GEN 618): Biotechnology I: Nucleic Acids Techniques, 4 cr. (2 and 4) N**
Basic training in the manipulation of genetic information using recombinant DNA technology; techniques in molecular cloning, Southern and Northern analyses, clone library construction. Prerequisite: BIOCH 210 or 301, MICRO 305 or permission of instructor.

**BOT 821: Inorganic Plant Metabolism, 3 cr. (3 and 0) F (odd numbered years)**
Plant, soil, water and nutrient relations; permeability; uptake and translocation; transpiration; mineral nutrition. Prerequisites: BIOSC 401/601 and 402/602 or permission of instructor.

**BOT 822: Organic Plant Metabolism, 3 cr. (3 and 0) S (even numbered years)**
Respiration and photosynthesis; synthesis, translocation, storage, transformation and degradation of organic materials, fats, carbohydrates, proteins, pigments and nucleic acids. Prerequisites: BIOSC 601 and 602 and BIOCH 623 or permission of instructor.

**BOT 823: Plant Growth and Development, 3 cr. (3 and 0) F (even numbered years)**
Vegetative and reproductive growth and development from seed to maturity, flowering, fruiting and senescence; natural and synthetic growth regulators; morphogenesis. Prerequisites: BIOSC 401/601 and 402/602, organic chemistry or permission of instructor.

**BOT 824: Mode of Action of Growth Substances, 4 cr. (3 and 3) S (odd numbered years)**
Physiology and biochemistry of both natural and synthetic growth regulators, hormones, growth retardants, herbicides and other inhibitors; methodology and mechanisms of action. Prerequisites: BIOSC 401/601 and 402/602 and general biochemistry, or BOT 822 or permission of instructor.

**BOT 850: Plant Tissue and Cell Culture, 3 cr. (2 and 3) F (odd numbered years)**
Methods and principles of plant tissue and cell culture: cloning, embryogenesis, protoplast fusion, plant regeneration, potential of plant genetic engineering. Prerequisite: Introductory plant physiology or permission of instructor.

**BOT 861: Plant Cell Biology, 3 cr. (3 and 0) F (odd numbered years)**
Structure, development and activities of plant cells; ultrastructural organization uniquely associated with dynamics of cellular growth and development in plants. Prerequisites: BIOSC 401/601 and 402/602 or permission of instructor.

**BOT 921 (HORT 921): Plant Physiology Colloquium, 1 cr. (1 and 0)**
Topics from current plant physiology literature provide a forum for criticizing research, conceiving new research ideas, developing research outlines and proposals, and integrating knowledge from various subdisciplines of plant physiology. May be repeated for credit. Prerequisites: BIOSC 401/601 and 402/602 or permission of instructor.

**CS ENV 690: Beneficial Soil Organisms in Plant Growth, 3 cr. (3 and 0) F (odd numbered years)**
Aspects of biological nitrogen fixation, mycorrhizal fungi, microbial-pesticide interactions, bioremediation, nutrient cycles and biological pest control related to plant growth, soil/environmental quality; sustainable agriculture. Students who desire laboratory experience in these topics can register for CS ENV 406 after consultation with instructor. Prerequisites: CS ENV 202, MICRO 305, PL PA 401 or permission of instructor.

**CS ENV 801: Crop Physiology and Nutrition, 3 cr. (3 and 0) F (odd numbered years)**
Basic concepts and physiologic aspects of growth and culture applied to crop management practices. Prerequisites: BIOSC 401/601 and 402/602 or equivalent.

**CS ENV 812: Crop Ecology and Land Use, 3 cr. (3 and 0) F (even numbered years)**
Concepts and factors affecting adaptation and distribution of crop plants; microclimate and crop response to environmental factors with modifications of microclimate by agricultural operations; interactions among crop plants and between weeds and crop plants under field conditions. Prerequisite: BIOSC 401/601 and 402/602 or equivalent.

**CS ENV 991: Doctoral Dissertation Research, credit to be arranged**

**FOR 806: Advanced Silviculture — Forest Tree Growth and Development, 3 cr. (3 and 0) F (odd numbered years)**
Growth and development of economically important forest tree species; structure, function, phenology and wood formation related under forest stand conditions, emphasizing manipulation of forest tree growth by cultural practice; current research in growth and culture of forest trees and stands. Prerequisites: BIOSC 401/601 and 402/602 or permission of instructor.

**FOR 825: Wood Chemistry, 3 cr. (2 and 3) F (even numbered years)**
Chemical composition of wood and related lignocellulosic substances and the chemistry of individual wood components; chemical reactions and applications of cellulose, hemicelluloses, lignin and extractives.

**FOR 991: Doctoral Dissertation Research, credit to be arranged**

**HORT 800: Topics in Horticultural Science, 1 cr. (1 and 0)**
Timely topics in horticultural science. May be repeated for a total of four credits, as topics and instructors vary. Prerequisite: Permission of instructor.

**HORT 802: Research Systems in Horticulture, 3 cr. (2 and 3) F (even numbered years)**
Current trends, developments and techniques in horticultural research. Prerequisites: CH 223 and 227, or CH 201 and PHYS 207, or BIOCH 210.

**HORT 806: Postharvest Physiology and Handling of Horticultural Crops, 3 cr. (3 and 0) S (even numbered years)**
Principles, developments and research findings dealing with physiological and biochemical changes and processes occurring in horticultural plant organs after harvest; biological aspects of methods and practices relating to harvesting, handling, transportation and storage of horticultural commodities for fresh market. Prerequisites: BIOSC 401/601 and 402/602 or equivalent.

**HORT 813: Photomorphogenesis, 3 cr. (2 and 2)**
Regulatory role of light quality in plant development (photomorphogenesis) and its consequences in and applications for crop production. Prerequisites: BIOSC 401/601 and 402/602 or permission of instructor; BOT 823 preferred.

**HORT 814: Environmental Plant Stress Physiology, 3 cr. (2 and 2)**
Environmental stresses associated with water (drought, waterlogging), temperature, light and air pollution with quantitative treatment of stress effects on plants; mechanisms by which plants may avoid, tolerate or modify stress effects on plant growth and function at the molecular, cellular and whole-plant levels. Prerequisites: BIOSC 401/601 and 402/602 or permission of instructor.
PL PA 804: Plant-Microbe Interactions, 3 cr. (3 and 0) F (even numbered years)
Physiology, biochemistry and genetics of plant-microbe interactions; molecular mechanisms involved in plant-microbe communication, plant colonization and penetration; development of the microbe within the plant; induction of plant defense responses. Prerequisites: BIOSC 401/601 and 402/602 or PL PA 401 or permission of instructor.

PL PA 809: Physiological Techniques in Plant Pathology, 2 cr. (1 and 3) S (odd numbered years)
Techniques in separation science; qualitative and quantitative analysis of concern to students in plant pathology and plant physiology. Prerequisite: Organic chemistry or permission of instructor.

PL PA 856: Plant Virology, 3 cr. (2 and 3)
Morphology, biochemistry, purification and transmission of plant viruses; symptoms resulting from virus infection; virus vector relationships; serological and nucleic acid hybridization procedures; diagnosis of viral diseases and the identification of causal agents; replication of plant viruses, the interaction between viral host and plant genome.

PL PH 991: Doctoral Dissertation Research, credit to be arranged
PL PH 991: Doctoral Dissertation Research, credit to be arranged

ZOOL 803: Population Dynamics, 4 cr. (2 and 6) N
Fundamental mechanisms basic to regulation of natural animal populations. Laboratory research project in population dynamics complements theory.

ZOOL 810: Behavioral Ecology, 3 cr. (3 and 0) N
Behavior of animals and the ecological context in which various behaviors are shown; empirical and theoretical aspects of behavioral ecology at individual, population and community levels. Prerequisites: BIOSC 441/641 and 470/670 or permission of instructor.

ZOOL 812: Seminar, 1 cr. (1 and 0)
Review of current literature in zoology.

ZOOL 815: Physiological Ecology, 4 cr. (2 and 3) N
Physiological and biochemical adaptations of invertebrates and vertebrates toward various natural environmental parameters. Field trips acquaint students with natural macro- and micro-environments of individual species. Field measurements of parameters of the environment are undertaken, and laboratory studies furnish detailed knowledge of various physiological adaptations to these parameters.

ZOOL 816: Advanced Ecosystem Analysis, 4 cr. (3 and 3) N
Description and analysis of ecological systems; biogeochemical, physicochemical and ecological principles emphasizing fundamental unity of ecosystems and their abiotic environment. Laboratory focuses on application of theory to actual field and laboratory research problems. Prerequisites: MTHSC 210 and 605; BIOSC 641 or BOT 846; or permission of instructor.

ZOOL 818: Community Ecology, 4 cr. (3 and 3) N
Structure and function of ecological communities emphasizing description of natural communities and evolutionary rules by which they are organized. Laboratory applies theory to field problems. Prerequisites: MTHSC 108 and 605; BIOSC 641 or BOT 846; or permission of instructor.

ZOOL 835: Interpretive Electron Microscopy, 3 cr. (3 and 0) N
Cell structure as viewed through the electron microscope; characteristic structural features of cells from various tissues and from various organisms at different phylogenetic levels. Prerequisites: AN PH 801/BIOSC 801 or BIOSC 632 and 633 or permission of instructor.

ZOOL 863: Special Problems, 1-4 cr.
Research not related to thesis. Prerequisite: Permission of instructor.

ZOOL 891: Master’s Thesis Research, credit to be arranged
ZOOL 991: Doctoral Dissertation Research, credit to be arranged