

COLLEGE OF AGRICULTURE, FORESTRY, AND LIFE SCIENCES

The College of Agriculture, Forestry, and Life Sciences offers graduate programs in 17 traditional disciplines in agriculture, forestry, and a wide variety of biological sciences, from the fundamental to the applied. The college awards the MS and PhD degrees as well as the Master of Agricultural Education and Master of Forest Resources professional degrees. These postbaccalaureate degree programs are designed primarily to provide continuing education for individuals whose interests lie outside a research-oriented profession.

The program in Applied Economics is a cooperative effort between the Department of Applied Economics and Statistics and the Department of Economics in the College of Business and Behavioral Science. The programs in Biosystems Engineering and Environmental Toxicology are jointly administered with the College of Engineering and Science.

Through cooperative programs with state, federal, and private agencies, students can extend their research off campus to the Greenwood Genetics Center, research and education centers spanning South Carolina, and state and national forests of the Savannah River Basin. Proximity to the Blue Ridge Mountains provides access to one of the most biologically diverse regions of the world. Courses also are offered in experimental statistics agricultural mechanization, community and rural development, and rural sociology.

AGRICULTURAL EDUCATION

Master of Agricultural Education

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 and extension education, agricultural communications, youth development, or technology transfer. Graduates hold positions as agriculture 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 plan an individual program of study in consultation with the major advisor and graduate committee; complete a minimum of three credit hours in adult education, three hours in research methods, and three hours in statistics; complete a minimum of 12 credit hours in the major field; and complete a minimum of six credit hours in an area of concentration outside the major field.

A minimum of 30 credit hours is required for the professional degree. At least one-half of these credit hours must be selected from courses numbered 700 or above. The student's program of study must be approved by the advisory committee.

Admission Requirements

Students must complete all University applications, submit undergraduate overall grade averages and GRE scores, participate in an interview with a department graduate committee, and submit a written sample on a topic assigned by the interview committee. Desirable scores include an undergraduate overall grade-point ratio near 3.0 and GRE scores of 450/450/3.0. Acceptance will be based on an evaluation involving all of the above as well as appropriate recommendations. Provisional acceptance may be awarded and additional undergraduate coursework may be required for marginally qualified students, students without undergraduate Agricultural Education degrees, and for those seeking teacher certification.

ANIMAL AND VETERINARY SCIENCES

Master of Science

Doctor of Philosophy

Applicants to the Animal and Veterinary Sciences programs should have a strong background in the animal, biological, and physical sciences. Students with deficiencies in these sciences may be admitted provided they correct these deficiencies during the first year of the program of study.

Students enrolled in the MS program are required to complete coursework 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, immunology, digestion, and environmental factors. A thesis or dissertation is required.

The PhD degree program does not have formal coursework requirements, but it is recognized that students will have individual deficiencies; therefore, it is the responsibility of the student and his/her major advisor, in consultation with the graduate advisory committee, to prescribe coursework to correct these deficiencies. All students majoring in Animal and Veterinary Sciences are required to complete AN PH 851.

The following courses offered by various departments represent possible electives for students in Animal and Veterinary Sciences: AVS 600, 653, 655, 661, 803, 825, BIOCH 606, 623, 633, 634, 815, BIOSC 632, 633, 659, 660, 661, 668, 670, 671, 672, 675, 676, 677, (AVS) 680, ENT (BIOSC) 636, EX ST 801, 803, 805, MICRO (AVS, BIOSC) 614, 811.

APPLIED ECONOMICS

Doctor of Philosophy

The graduate program in Applied Economics utilizes the facilities and faculty of the Department of Applied Economics and Statistics and those of 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.

Applicants to the PhD program should have a strong background in economic theory and statistics. Core requirements of the program include microeconomics, macroeconomics, and an econometrics course sequence. Students choose two additional concentrations from agribusiness, applied statistics, community and economic development, environmental economics, financial economics, industrial organization, labor economics, monetary economics, and public sector economics.

APPLIED ECONOMICS AND STATISTICS

Master of Science

Graduate work in Applied Economics and Statistics enables students to add to their understanding of principles of economics, econometric methods, environmetrics, and statistical techniques. Instructional focus is on applied problem solving and relevant case studies and projects.

Special emphasis is placed on the economics of agricultural production and marketing, issues in agribusiness, economic development, and analysis of government programs and policies. Similar emphasis is given to the use of statistical techniques in research design, survey design, and data analysis as well as for solution of business, management, and institutional problems. Additional emphasis is in the natural resource arena, where environmetric techniques, ecological statistics, and economic analysis of issues and policies are presented and discussed.

Both thesis and nonthesis options are available. The curriculum for both options includes recommended courses in applied economics and experimental statistics. Flexibility is achieved through choice of elective courses and, for the thesis option, in the selection of a master's thesis topic. There is no foreign language requirement.

The department encourages applications from students with baccalaureate degrees in Agricultural or Applied Economics, Economics, Statistics, Mathematics, in natural resource areas such as Forestry or Wildlife Biology, and other majors.

Additional information about emphasis areas, recommended courses, and departmental policies is available at appliedeconstat.clemson.edu.

BIOCHEMISTRY AND MOLECULAR BIOLOGY

Master of Science

Doctor of Philosophy

Enrollment in the Biochemistry and Molecular Biology 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. Research activities include bioinformatics, functional genomics, microbial and plant biochemistry, molecular biology, proteins, and signal transduction.

Degree Requirements

For the MS degree, 26 credit hours are required; for the PhD, 30 credit hours are required. Both programs require the following core courses: BIOCH (GEN) 805, (GEN) 810, 814, GEN (BIOCH) 820.

The student, with the guidance of the advisory committee, will select elective courses (nine hours for the MS degree, 12 hours for the PhD degree) from the following: BIOCH 643, 816, 818, 821, 822, 828, 832, 890, GEN 640, 650, 670, 801, 803, 815, 830, 890.

MS candidates will present seminars (BIOCH (GEN) 851) twice, PhD candidates three times. All graduate students are required to attend GEN (BIOCH) 825 or deliver seminars (BIOCH (GEN) 851) every semester they are enrolled.

A minimum of six credit hours of research, culminating in a thesis, is required of master's candidates. Successful completion of written and oral comprehensive examinations will admit the doctoral students to candidacy for the PhD degree.

BIOSYSTEMS ENGINEERING

Master of Science

Doctor of Philosophy

This program is administered jointly with the College of Engineering and Science. See page 59 for program details.

ENTOMOLOGY

Master of Science

Doctor of Philosophy

The Entomology graduate programs of the Department of Entomology, Soils, and Plant Sciences are dedicated to providing leadership in environmental entomology. Research programs fall into four emphasis areas: arthropod biodiversity, agricultural entomology, genetics and biotechnology, and urban entomology. Facilities of the South Carolina 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 laborato-

ries; controlled and ambient temperature insect-rearing facilities; a free-flight butterfly facility; and greenhouses. Candidates for the MS degree must complete 30 hours of graduate credit, including six hours of research, and write a thesis. Candidates for the PhD degree must complete 18 hours of dissertation research and write a dissertation.

ENVIRONMENTAL TOXICOLOGY

Master of Science

Doctor of Philosophy

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. Emphases include the metabolism of contaminants, their decomposition, fate, and effects in aquatic and terrestrial environments. This interdisciplinary program provides a strong background in fundamental environmental toxicology and ecotoxicology. The program is administered jointly with the College of Engineering and Science.

Students with baccalaureate degrees 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/her professional goals.

Candidates for the MS degree must complete 30 hours of graduate credit, including six hours of research, and write a thesis. Candidates for the PhD 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.

FOOD, NUTRITION, AND CULINARY SCIENCES

Master of Science

Detailed information is available from the Department of Food Science and Human Nutrition or at www.clemson.edu/foodscience/.

Admission Requirements

Students admitted to the MS program in Food, Nutrition, and Culinary Sciences must meet the following criteria. Students not meeting the minimum admission requirements may be admitted in a provisional status with the approval of the graduate faculty.

1. The Aptitude Test of the Graduate Record Examination (GRE General Test) must be taken by all applicants. A minimum total GRE score of 1000

on the two-component exam is required. In some cases, other tests administered for students applying for postbaccalaureate degrees may be accepted in lieu of the GRE (e.g., MCAT).

2. A strong background in food science; human nutrition; physical, chemical, or biological sciences; or engineering is highly desirable.

3. Proficiency in food science must be demonstrated by satisfactory completion of coursework in the following areas: food chemistry, food microbiology, food processing, and biochemistry. Background course requirements will normally be satisfied with completion of a BS degree in Food Science from an accredited institution. Students deficient in any of these areas will be required to complete coursework to fulfill these background course requirements.

4. Acceptance is based upon academic transcripts with a minimum undergraduate grade-point ratio of 3.0, three letters of recommendation, a statement of objectives and professional experience.

5. International students must have a minimum Test of English as a Foreign Language (TOEFL) score of 575. International applicants must also submit documentation of adequate financial support for their studies.

6. An additional requirement for admission is identification of a research advisor prepared to accept the applicant as an advisee.

Financial Aid

A limited number of research assistantships are available from grant funds, with the student assisting in the research supported under the grant. This research often may be applicable to the thesis or dissertation. Interested applicants should contact individual faculty for research assistantships. Applicants whose files are completed prior to February 15, 2007, will be given preferential consideration for research assistantships offered beginning fall semester 2007.

Transfer of Credits

With preapproval, up to eight graduate credits may be transferred into the MS program. A grade of B or better is required in each course transferred.

Course Requirements

A minimum of 24 credit hours of coursework and six credit hours of thesis research (FD SC 891) is required for the graduate degree. Only 600-level courses and higher may be used for graduate credit, and at least one-half of the 24 hours of coursework must be at the 800 level or higher.

The following courses are required: EX ST 801 or equivalent, FD SC 851 (one-credit hour seminar each spring), 18 credit hours of advanced-level courses (may include courses in food science or in areas such as chemistry, nutrition, biochemistry, animal and veterinary sciences, microbiology, statistics, or cell biology, as required by the student's Graduate Advisory Committee), and six credit hours of thesis research (FD SC 891).

In addition, a minimum grade-point ratio of 3.0 is required to maintain good academic standing and for graduation.

Combined Bachelor of Science in Food Science/Master of Science in Food, Nutrition, and Culinary Sciences

Under this plan, students may reduce the time necessary to earn both degrees by applying graduate credits to both undergraduate and graduate program requirements. Enrollment guidelines and procedures can be found under *Academic Regulations* in this catalog. Consult the Department of Food Science and Human Nutrition for details.

FOOD TECHNOLOGY

Doctor of Philosophy

There are no set course requirements for the doctorate in Food Technology. It is expected that each PhD graduate will have a comprehensive understanding of the principles of food science with an expanded knowledge covering their focused research area. The PhD candidate's research committee will have final approval on all coursework. PhD candidates must pass both written and oral examinations given by the student's advisory committee. The successful student must also write a research dissertation and defend that dissertation to the satisfaction of the advisory committee.

PhD students are required to pass a written and oral qualifying exam administered by the advisory committee. PhD students are also required to pass a final oral dissertation defense.

Dissertations

Dissertations are usually longer and also normally contain a review of the literature. PhD students should expect to publish a minimum of two refereed research manuscripts from their dissertations.

FOREST RESOURCES

Master of Forest Resources

Master of Science

Doctor of Philosophy

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 credit hours of graduate coursework with at least 18 of the required hours selected 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 credit hours of coursework and six hours of research. The Doctor of Philosophy degree requires a minimum of 16 credit hours of coursework and 18 hours of research. For both degrees, one-half of the semester hours must be selected from courses numbered 800 and above.

GENETICS

Master of Science

Doctor of Philosophy

The MS and PhD degrees in Genetics are administered by the Department of Genetics and Biochemistry. Research activities include biochemical, biometrical, molecular, and population genetics, as well as bioinformatics, cytogenetics, and structural and functional genomics through arrangements with other participating disciplines and with the Greenwood Genetics Center.

Degree Requirements

For the MS degree, 26 credit hours are required; for the PhD, 30 credit hours are required. Both programs require the following core courses: BIOCH (GEN) 805, (GEN) 810, GEN 814, GEN (BIOCH) 820.

The student, with the guidance of the advisory committee, will select elective courses (nine hours for the MS degree, 12 hours for the PhD degree) from the following: BIOCH 643, 816, 818, 821, 822, 828, 832, 890, GEN 640, 650, 670, 801, 803, 815, 830, 890.

MS candidates will present seminars (BIOCH (GEN) 851) twice, PhD candidates three times. All graduate students are required to attend GEN (BIOCH) 825 or deliver seminars (BIOCH (GEN) 851) every semester they are enrolled.

A minimum of six credit hours of research, culminating in a thesis, is required of master's candidates. Successful completion of written and oral comprehensive examinations will admit the doctoral students to candidacy for the PhD degree.

MICROBIOLOGY

Master of Science

Doctor of Philosophy

The Department of Biological Sciences administers the MS and PhD degree programs in Microbiology. The Microbiology graduate programs include a wide variety of disciplines with three major emphasis areas: Cellular and Physiological Microbiology, Microbial Genetics and Molecular Microbiology, and Environmental Microbiology.

Applicants to the graduate degree programs in Microbiology must have a bachelor's or master's degree and a background of training in biology (botany, microbiology, or zoology), chemistry, or in one of the agricultural sciences. Undergraduate work in bacteriology or microbiology is desirable but not necessary. All students are expected to have completed inorganic and organic chemistry, physics, calculus, general biology, and genetics. Deficiencies (less than 18 hours total) may be remedied through appropriate coursework completed during the graduate program. Graduate credit is not normally awarded for remedial coursework. Students with more than 18 hours of deficiencies including those with degrees outside of biology, chemistry, or agricultural sciences are encouraged to contact the Department of Biological Sciences to discuss options for fulfilling coursework requirements in preparation for application to the MS and PhD programs.

Candidates for the MS degree must complete 30 hours of graduate credit, including 24 credits of coursework, six credits of thesis research, an acceptable thesis based on original research, and satisfactory performance in a final oral examination. The 30 credits of graduate coursework will include courses from each of the following areas: cellular and physiological microbiology, microbial genetics and molecular microbiology, and environmental microbiology.

Candidates for the PhD program must complete written and oral comprehensive examinations, 18 credits of dissertation research, an acceptable dissertation based on original research, and satisfactory performance in a final oral examination. Although there is no required number of credits of coursework for the doctorate beyond the 18 credits of dissertation research, a core of graduate coursework including courses from each of the following areas is expected of each candidate: cellular and physiological microbiology, microbial genetics and molecular microbiology, and environmental microbiology.

PACKAGING SCIENCE

Master of Science

The MS degree program in Packaging Science prepares graduates to work independently in the research, development, and application of new packaging materials and processes. Students may be accepted with backgrounds relating to chemistry, physics, mathematics, biology, or engineering. Students with backgrounds in business or graphic communications or other disciplines may also be accepted after completing courses equivalent to the basic science and mathematics courses in the department's undergraduate curriculum. Each degree program is designed individually to augment the student's background to provide a broad understanding of packaging science and specialized knowledge in the area of the student's research.

The MS degree in Packaging Science requires 30 hours of coursework, six of which are thesis research, and the completion of an acceptable MS thesis. In addition to PKGSC 891, students register for at least one credit of PKGSC 851.

The following courses offered by various departments represent possible electives for the student in packaging science: CME 815, CHE 612, 804, EX ST 801, 802, FD SC 601, 602, 604, 606, 608, 810, 811, 812, GC 606, 607, 648, MKT 627, 630.

PLANT AND ENVIRONMENTAL SCIENCES

Master of Science

Doctor of Philosophy

The degree programs in Plant and Environmental Sciences are offered through an interdisciplinary program comprised of faculty from disciplines including biological sciences, botany, crop science, entomology, genetics, horticulture, plant pathology, plant physiology, and soil science.

Candidates for the program in Plant and Environmental Sciences should have a strong undergraduate background in the biological, agricultural, and/or physical sciences as appropriate to their focus areas. 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 the graduate program.

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

Candidates for the MS degree must complete 24 credit hours of coursework and six hours of research, and they must present and defend a thesis based on original research. MS students who plan nonresearch-related careers in public gardening, landscape design, extension, consulting, or agribusiness may complete 30 credit hours of coursework 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 PhD degree. There is no specific credit hour requirement; the plan of coursework is based on the student's interests and dissertation emphasis, as determined in consultation with the major advisor and graduate committee.

Individual plans of study include courses from the following areas: biochemistry, biological sciences, botany, crop and soil environmental science, entomology, genetics, horticulture, and plant pathology as well as plant and environmental sciences.

WILDLIFE AND FISHERIES BIOLOGY

Master of Science

Doctor of Philosophy

Those who are interested in pursuing a graduate degree in Wildlife and Fisheries Biology 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 requires acceptance by the University and the Graduate Student Admission Committee of Wildlife and Fisheries Biology. This committee will base its acceptance recommendation to the Graduate Admissions Office on previous coursework, GRE scores, letters of recommendation, undergraduate background, and current research interests. Students are required to have completed a bachelor's degree, preferably in a

natural science, with a minimum of 30 credit hours in natural sciences. In addition, an MS in Natural Resource Biology or related area usually is preferred, but not required, for acceptance into the doctoral program. Students accepted without the appropriate course background will be required to make up these deficiencies as outlined by the Graduate Student Admission Committee and consistent with University admission policies.

Requirements for the MS in Wildlife and Fisheries Biology include 24 credit hours of coursework, six hours of research credits (WFB 891), an acceptable thesis based on original research, and satisfactory performance on a final oral examination. Additional coursework 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 credit hours of postbaccalaureate coursework and 19 hours of doctoral dissertation research for the PhD in Wildlife and Fisheries Biology; however, the student's advisory committee will insist on a rigorous and appropriate program of study and research. Students are 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 participation, or natural resource agency employment. Other course requirements will be identified by the student's advisory committee and will include specific courses 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. Department of Natural Resources, 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 Improvement Eastern Wildlife Program. The graduate program is accredited by the Southeastern Section of the Wildlife Society.

Combined Bachelor's/Master's Plan

Under this plan, students may reduce the time necessary to earn both degrees by applying graduate credits to both undergraduate and graduate program requirements.

Students are encouraged to obtain the specific requirements for the dual degree from the Department of Forestry and Natural Resources as early as possible in their undergraduate program as a number of required courses have prerequisites not normally taken by Wildlife and Fisheries Biology majors. Enrollment guidelines and procedures can be found under *Academic Regulations* in this catalog.

ZOOLOGY

Master of Science

Doctor of Philosophy

The Department of Biological Sciences administers the MS and PhD degrees in Zoology. The Zoology graduate programs encompass a wide variety of disciplines in both plant and animal biology with three major emphasis areas: Ecology and Evolutionary Biology, Cell and Developmental Biology, and Comparative Organismal Biology.

Applicants to the graduate degree programs in Zoology must have a bachelor's or master's degree and a background of training in biology. All students are expected to have completed inorganic and organic chemistry, physics, calculus, introductory biology, plant and animal diversity, genetics, cell or developmental biology, physiology, and ecology. Deficiencies (less than 18 hours total) may be remedied through appropriate coursework completed during the graduate program. Graduate credit is not normally awarded for remedial coursework. Students with more than 18 hours of deficiencies including those with degrees outside of biology are encouraged to contact the Department of Biological Sciences to discuss options for fulfilling coursework requirements in preparation for application to the MS and PhD programs.

Candidates for the MS degree must complete 30 hours of graduate credit, including 24 credits of coursework, six credits of thesis research, an acceptable thesis based on original research, and satisfactory performance in a final oral examination.

Candidates for the PhD degree must complete written and oral comprehensive examinations, 18 credits of dissertation research, an acceptable dissertation based on original research, and satisfactory performance in a final oral examination. Although there is no required coursework for the doctorate beyond the 18 credits of dissertation research, some graduate coursework emphasizing breadth and depth of knowledge in the life sciences is expected of each candidate.