COLLEGE OF AGRICULTURE, FORESTRY AND LIFE SCIENCES

The College of Agriculture, Forestry and Life Sciences is to provide teaching, research and service in agriculture, forestry and life sciences that will benefit the citizens of South Carolina and the nation. The College of Agriculture, Forestry and Life Sciences serves more than 2,700 graduate and undergraduate students.

The ability to understand and manipulate the molecular structure of biological systems, while at the same time understanding their practical management, offers immense potential to improve our world, whether it is to improve foods, building products, the environment, or our health. The College of Agriculture, Forestry and Life Sciences is using the same expertise to produce more food on a shrinking globe, grow better foods that will help prevent heart disease and fight breast cancer, package environmentally sound products, increase dairy production, increase timber production and provide new fuels, and develop businesses and promote a “green” society.

The College of Agriculture, Forestry and Life Sciences offers 15 Masters and 11 Doctoral degree programs in disciplines in agriculture, forestry, 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.

Cooperative programs with state, federal and private agencies allow students to 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.

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 a program of study in consultation with the major advisor and graduate committee and complete a minimum of three credit hours in adult education, three hours in research methods and three hours in statistics; a minimum of 12 credit hours in the major field; and 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 writing 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 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.

MS students are required to complete coursework in an area of interest approved by their graduate advisory committee. MS students may select a thesis or non-thesis option. Students in the thesis option must complete a minimum of 30 hours of graduate coursework, including six credits of thesis research. Students in the non-thesis option must complete a minimum of 30 hours of coursework and a comprehensive oral examination.

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 major advisor, in consultation with the graduate advisory committee, to prescribe coursework to correct these deficiencies. A dissertation is required.

All students in Animal and Veterinary Sciences are required to complete AVS 820.


BIOCHEMISTRY AND MOLECULAR BIOLOGY

Doctor of Philosophy

Enrollment in the Biochemistry and Molecular Biology program is open to students with appropriate 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

The PhD program requires GEN 814 and BIOC 814 during a student’s first semester; and BIOC 805 and 890 during a student’s second semester. In addition, PhD students are required to attend BIOC 825 every semester they are enrolled. Students beyond their first year are required to do one oral presentation every year in BIOC 825.

A student’s dissertation committee will determine whether the student should take courses in addition to the required courses.

A dissertation, consisting of 18 credits of doctoral research (BIOC 991), exclusive of any research credits earned at the master’s level, is required of PhD students. Successful completion of written and oral comprehensive examinations will admit doctoral students to candidacy for the PhD degree.

BIOLOGICAL SCIENCES

Master of Science

Doctor of Philosophy

The MS and PhD degree programs in Biological Sciences 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 Biological Sciences 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, biology, plant and animal diversity, genetics, and evolutionary biology. 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.

MICRO (AVS, BIOSC) 614, 811.
Non-Thesis Option
The non-thesis option of the MS is designed specifically for K-12 teachers and others interested in biological sciences education. Candidates must complete a total of 30 semester hours of graduate coursework. At least 18 of the 30 hours must be at the 800-level. All courses are offered online. A research proposal and project whose results are presented in written form is also a requirement. The scope of the research project is not as extensive as the thesis required in the traditional MS program; however, it is expected that students will conduct original scientific research and write a document of the caliber of a manuscript suitable for submission to a peer-reviewed journal. The student and the student’s graduate committee will determine the subject of the research project.

Admission to the non-thesis option of the MS program requires a suitable undergraduate education, two letters of recommendation, a resume, and suitable GRE scores. (GRE scores are not required for teachers with one or more years of teaching experience.) Students do not need an undergraduate degree in biology to be considered for admission.

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.

BIOTECHNOLOGY
Master of Science
The MS degree in Biotechnology is administered by the Department of Genetics and Biochemistry. This nonthesis degree (usually used as part of a five-year Combined Bachelor’s/Master’s Program) prepares students for research associate positions in the growing biotechnology and pharmaceutical industries. Students acquire a solid foundation in biotechnology theory plus knowledge of industry-oriented Good Laboratory Practices and Good Manufacturing Practices. The degree has options in Molecular Biology and in Bioprocessing.

Admission Requirements
Entering students must have a Bachelor of Science degree in a life science, agricultural, chemistry, or bioengineering field. Students entering the BS/MS program must have completed their junior year (minimum 89 credit hours) in one of these majors with a minimum grade-point ratio of 3.40. Students must have taken basic undergraduate courses in biochemistry, genetics and microbiology. A mathematics course on modeling with differential equations is recommended for the Molecular Biology Option but required for the Bioprocessing Option. Students will be given conditional admission to the master’s program pending completion of their bachelor’s degree and submission of satisfactory GRE scores.

Degree Requirements
Both options require 30 credit hours, including the following core courses: B E 835, BIOCH 633, BIOCH (GEN) 805, BIOCH (GEN) 810, BIOCH (GEN) 851 (or an equivalent seminar course in the student’s major), EX ST 801, GEN (BIOCH) 825. In addition, students in the Molecular Biology Option must take three credits of GEN 491 (or an equivalent research course in the student’s major), GEN 640, and GEN (BIOCH) 820. Students in the Bioprocessing Option must take B E (CH E) 628, B E 638, 901 (or an equivalent research course in the student’s major), and MICRO 613.

Once these requirements are met, students, in consultation with the advisor, choose from the following courses to complete the 30 credit hours required in the program: B E (CH E) 628, B E 635, 638, 838, BIO E 849, BIOCH 631, 632, 634, 643, 814, 816, 818, 821, 822, 832, 900, CH E 601, 804, CH E (EE&S) 814, EX ST 805, GEN (BIOCH) 640, 814, 890, GEN 820, MICRO 613.

ENTOMOLOGY
Master of Science
Doctor of Philosophy
The Entomology graduate programs of the School of Agricultural, Forestry, and Environmental Sciences are dedicated to providing leadership in environmental entomology. Research programs fall into three emphasis areas: arthropod biodiversity, agricultural entomology, 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 laboratories; controlled and ambient temperature insect-rearing facilities; a free-flight butterfly facility; and greenhouses. Candidates for the MS degree must complete a minimum of 30 hours of graduate credit, including six hours of research, and write a thesis. Candidates for the PhD degree must complete a minimum of 60 hours of graduate credit beyond the BS/BA degree and 30 beyond the MS degree, including 18 hours of dissertation research and write a dissertation. Candidates for both degrees must satisfy a set of core requirements, some of which may have been satisfied in a previous degree program.

ENVIRONMENTAL TOXICOLOGY
Master of Science
Doctor of Philosophy
These programs are jointly administered with the Graduate School. See requirements under the Graduate School.

FOOD, NUTRITION AND CULINARY SCIENCES
Master of Science
Detailed information is available from the Department of Food, Nutrition and Packaging Sciences 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 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 and 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, will be given preferential consideration for research assistantships offered beginning fall semester.

Transfer of Credits
With pre-approval, 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—Thesis Option
A minimum of 24 credit hours of coursework and six credit hours of thesis research (FD SC 891) is required for the MS 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 year), 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).

Course Requirements—Non-thesis Option
A minimum of 30 hours of coursework as outlined below and a comprehensive, two-day final examination is required for the MS degree. The final examination consists of one day of core material and one day of content selected from departmental courses. Details may be found in the graduate handbook.

The following core courses are required: EX ST 801 or ED F 778; FD SC 810; and NUTR 803.

Students select three out of the five following courses: FD SC 811, 812, 815, NUTR 804, 805.

Students select eight to ten additional credit hours from 600-level or higher courses with approval of the student’s graduate committee.

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

Combined BS in Food Science/MS 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 in the Undergraduate Announcements. Consult the Department of Food, Nutrition and Packaging Sciences for details.

FOOD TECHNOLOGY

Doctor of Philosophy

Students admitted to the PhD program in Food Technology must meet the following criteria. Students not meeting the minimum 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 and 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, will be given preferential consideration for research assistantships offered the beginning fall semester.

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 and defend a dissertation to the satisfaction of the advisory committee. Dissertations usually contain a review of the literature and a detailed description of research in a scientific publication format. 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 MS and PhD degrees. The MS degree requires a minimum of 24 credit hours of coursework and six hours of research. The PhD degree requires a minimum of 16 credit hours of coursework and 18 hours of research beyond the student’s master’s degree coursework. For both degrees, one-half of the semester hours must be selected from courses numbered 800 and above.

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.

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 includes 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 in 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.

GENETICS

Doctor of Philosophy

The PhD degree in Genetics is 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
The PhD program requires GEN 814 and BIOCH 814 during a student’s first semester; and GEN 805 and 890 during a student’s second semester. In addition, PhD students are required to attend GEN 825 every semester they are enrolled. Students beyond their first year are required to do one oral presentation every year in GEN 825.

A student’s dissertation committee will determine whether the student should take courses in addition to the required courses.

A dissertation, consisting of 18 credits of doctoral research (GEN 991) exclusive of any research credits earned at the master’s level, is required of PhD students. Successful completion of written and oral comprehensive examinations will admit the doctoral students to candidacy for the PhD degree.
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 PKGS 851.

The following courses represent possible electives for the student in Packaging Science: C M E 815, CH E 612, 804, EX ST 801, 802, FD SC 601, 602, 604, 606, 608, 810, 811, 812, G C 606, 607, 648, MKT 627, 630.

Combined Bachelor of Science, Master of Science Degree Program

The Department of Food, Nutrition and Packaging Sciences also offers an accelerated five-year combined bachelor’s/master’s program that allows students to count up to twelve hours of graduate credit toward both the BS degree in Packaging Science and the MS degree in Packaging Science. Details are available from the Department of Food, Nutrition and Packaging Sciences or at www.clemson.edu/fnps.

PLANT AND ENVIRONMENTAL SCIENCES

Master of Science

Doctor of Philosophy

The degree programs in Plant and Environmental Sciences are offered through an interdepartmental program comprised of faculty from disciplines including biological sciences, botany, crop science, entomology, genetics, environmental horticulture, plant pathology, plant physiology and soil science.
Research opportunities are enhanced by cooperative programs with the S.C. Department of Natural Resources, U.S. Geological Survey 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 BS/MS in Wildlife and Fisheries Biology**

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 should obtain specific requirements for the dual degree from the School of Agricultural, Forestry and Environmental Sciences as early as possible in their undergraduate program to ensure that all prerequisites are met. Enrollment guidelines and procedures can be found in the Undergraduate Announcements.