PLANT BIOLOGY

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COLLEGE OF SCIENCE

Anterola, Aldwin M., Assistant Professor, Ph.D., Washington State University, 2001; 2005.
Ashby, **William C**., Professor, *Emeritus,* Ph.D., University of Chicago, 1950, 1960.
Baer, Sara, Assistant Professor, Ph.D., Kansas State University, 2001; 2004. Ecosystem ecology, nutrient cycling, restoration ecology, experimental design.
Battaglia, Loretta, Assistant Professor, Ph.D., University of Georgia, 1998; 2003. Landscape and community ecology of wetlands; legacies of natural and anthropogenic disturbances in wetland forests; environmental heterogeneity.
Bozzola, **John J**., Professor and *Director*, SIU Integrated Microscopy and Graphics Expertise (IMAGE), Ph.D., Southern Illinois University Carbondale, 1975; 1983. Electron microscopy; cytology; microbiology.
Crandall-Stotler, **Barbara**, Professor, *Emerita*, Ph.D., University of Cincinnati, 1968; 1970.
Ebbs, Stephen, Associate Professor, Ph.D., Cornell University, 1997; 1999. Plant physiology. toxicology, phytoremediation.
Fralish, **James S**., Associate Professor, *Emeritus*, Ph.D., University of Wisconsin, 1970; 1969.
Geisler, J.B. Matthew, Assistant Professor, Ph.D., The Ohio State University, 1999; 2006.
Gibson, **David J**., Professor, Ph.D., University of Wales, 1984; 1992. Plant population and community ecology, grassland and dune ecology, multivariate methods.
Klubeck, **Brian P**., Professor, Ph.D., Utah State University, 1977; 1978. Soil microbiology and biochemistry; microbial ecology.
Lightfoot, **David A**., Professor, Ph.D., University of Leeds, 1985; 1991. Biotechnology (molecular); nitrogen assimilation; genetics and development.
Matten, **Lawrence C**., Professor, *Emeritus*, Ph.D., Cornell University, 1965; 1965.
Mohlenbrock, **Robert H**., Distinguished Professor, *Emeritus,* Ph.D., Washington University, 1957; 1957.
Nickrent, **Daniel L**., Professor, Ph.D., Miami University (Ohio), 1984; 1990. Plant systematics and molecular evolution; biology of parasitic flowering plants.
Pappelis, **Aristotel J**., Professor, *Emeritus*, Ph.D., Iowa State University, 1957; 1960.
Preece, **John E**., Professor, Ph.D., University of Minnesota, 1980; 1980. Woody plant biotechnology including tissue culture; genetic transformation; DNA polymorphism; biofuels.
Renzaglia, Karen, Assistant Professor, Ph.D., Southern Illinois University Carbondale, 1981; 2003. Morphology, anatomy, ultrastructures, and systematics of bryophytes and pteridophytes.
Richardson, **John A**., Associate Professor, *Emeritus,* M.F.A., Ohio University, 1969; 1969.
Robertson, **Philip A**., Professor, *Emeritus*, Ph.D., Colorado State University, 1968; 1970.
Sipes, Sedonia D., Assistant Professor, Ph.D., Utah State University, 2001; 2001. Plant reproductive biology, pollination ecology, molecular phylogenetics, conservation biology.
Stotler, **Raymond E**., Professor, *Emeritus*, Ph.D., University of Cincinnati, 1968; 1969.
Sundberg, **Walter J**., Professor, *Emeritus*, Ph.D., University of California at Davis, 1971; 1972.
Tindall, **Donald R**., Professor, *Emeritus*, Ph.D., University of Louisville, 1966; 1966.
Ugent, **Donald**, Professor, *Emeritus*, Ph.D., University of Wisconsin, 1966; 1968.
Vitt, Dale H., Professor and *Chair*, Ph.D., University of Michigan, 1970; 2000. Peatland ecology, boreal forest ecology, landscape pattern, ecology and systematics of mosses.
Wood, **Andrew J**., Professor, Ph.D., Purdue University, 1994; 1996. Stress physiology; molecular mechanisms of desiccation-tolerance; posttranscriptional gene control.
Yopp, **John H**., Professor, *Emeritus*, Ph.D., University of Louisville, 1969; 1970

The Department of Plant Biology offers a graduate program leading to the degrees of Master of Science, Master of Science in Biological Sciences, Master of Science in Education in the Biological Sciences, and the Doctor of Philosophy. The first master's degree was granted in 1948, and the first Ph.D. degree in 1965.

An advisory committee of faculty members from plant biology as well as other departments help design individualized programs to meet the specific educational goals and career aspirations of each student. The broadly diversified faculty of the department provide research emphases in ecology and environmental science, systematics and biodiversity, and molecular biology and physiology. Graduate degrees in plant biology will be awarded to students in recognition of their ability to do independent research as evidenced by the acceptance of a thesis or dissertation and the demonstration of competent scholastic ability.

The Department of Plant Biology is housed in various major teaching and research facilities on the campus of Southern Illinois University Carbondale (SIUC) including Life Science II, Life Science III and Forest Science as well as the Electron Microscopy Building. Faculty members provide research and laboratory facilities for students. The department supplies centralized facilities including laboratories for basic computing, Geographic Information Systems (GIS), and molecular biology, as well as herbaria, growth chambers, field research centers and greenhouses. Excellent cooperative research arrangements are available for activities including electron microscopy, chemical analyses and research photography. Southern Illinois University is strategically located in the transition zones of several North American biomes and is within a one hour drive to spectacular natural

areas including Pine Hills Research Natural Area, Cypress Creek Bioreserve, Garden of the Gods, and Little Grand Canyon.

Admission

Applications should be sent to the Director of Graduate Studies of the department and must include a completed application form, three letters of recommendation, official transcripts of all institutions of higher learning attended, GRE scores including the verbal, quantitative and analytical portions of the examination and grade point average. Students must meet both Graduate School and Departmental admission requirements. Financial assistance is available on a competitive basis. To be considered for financial support a financial assistance form must also be submitted. Acceptance to the department is contingent on availability of faculty to advise the student and research space and facilities. International students whose native language is not English must have a minimum of 550 or the equivalent electronic score on the TOEFL test.

This program requires a nonrefundable $45.00 application fee that must be submitted with the application for Admissions to Graduate Study in Plant Biology. Applicants may pay this fee by credit card if applying electronically. Applicants submitting a paper application must pay by personal check, cashier's check, or money order made out to SIU, and payable to a U.S. Bank. Applicants for the Master's degree must have a Bachelor Degree (or equivalent) in a life science, and have had a course in genetics. A student who does not meet these requirements may petition for admission to the department, or register as a regular nondeclared graduate student. Either prior to admission or during their programs, students must complete a course in each of the following categories: 1) plant systematics or plant diversity, 2) plant physiology, cell biology or molecular biology, and 3) plant ecology or environmental science. A course in plant morphology or plant anatomy is strongly recommended.

Applicants to the Ph.D. program must have a plant sciences related Master's degree (or equivalent). Exceptions to this rule include Direct Entry or Accelerated Entry options described below. Criteria for admission include GPA (3.25 or higher), GRE scores, letters of recommendation, transcripts and availability of faculty, space and facilities. To be admitted into the program, at least one faculty member must be willing to serve as major advisor or coadvisor if the student desires to work in the Forestry or Plant, Soil and Agricultural Systems departments.

Students desiring financial assistance should note that the deadline for fellowship and assistantship applications is February 1. Application forms are available from the Director of Graduate studies in the Department of Plant Biology.

Accelerated Entry into the Doctoral Program

A student who enters a master's program in plant biology may, if deemed capable, be permitted to apply to be accelerated into a program leading directly to a Ph.D. degree, subject to the following conditions and specifications. In order to qualify for consideration, each endorsed student must: (a) have been in the SIUC plant biology graduate program no less than one or more than two academic terms when proposed, (b) have a graduate grade point average of 3.75 or better, (c) have no grade in any course (conditional or otherwise) in his/her graduate record of less than *B* and (d) be deemed by the Evaluation and Awards Committee as having superior capabilities.

Once advanced into the doctoral program by the Graduate School, the student shall be eligible to qualify for graduate assistance totaling no more than 60 months. Once in the doctoral program, the student is subject to all of the academic, retention, and exit requirements for a regular doctoral program.

If for any reason, a student who has been admitted into the accelerated entry program fails to complete the doctoral program successfully that student shall not automatically be re-admitted into the master's program. Instead, the student may (if so desired) make formal application for admission into the master's program in plant biology.

Direct Entry into Ph.D. Degree Program

Students with outstanding academic preparation and a baccalaureate degree in the plant sciences or related field may be admitted directly into the doctoral program prior to beginning their program at SIUC. Students admitted under this option will take a written comprehensive diagnostic examination prior to the first week in the program. The examination is constructed by a committee of faculty members from the student's department and is administered by the Departmental Director of Graduate Studies. A student deemed to have deficiencies based on the outcome of this diagnostic qualifying exam must satisfy these deficiencies by taking appropriate courses within the first year of study following the first meeting of his/her graduate advisory committee. When admitted to the doctoral program the student will be eligible to qualify for graduate assistance totaling no more than 60 months. In the event of failure of the diagnostic examination, the student has the option of entering the department's master's degree program.

Advisement

Following admission to the department and before registration for course work, the student must consult a staff member representing the field of major interest or, if this is unknown, the Director of Graduate Studies of the

department, for assistance in planning the first registration. At registration, deficiencies and specific departmental requirements must be considered first.

Within the first semester of the program, the student must select a faculty member who is willing to serve as the major adviser. The major adviser in consultation with the student will then select appropriate faculty members to comprise the advisory committee. For the master's degree program, a minimum of three people shall make up the advisory committee, two of whom must be voting members of the Plant Biology Department. The advisory committee for the Ph.D. degree program will be composed of at least five people, three of whom must be voting members of the plant biology faculty and one who must be from outside the department. The Director of Graduate Studies is an ex-officio member of each graduate advisory committee. The duties of the advisory committee are to:

(1) plan, approve and file with the Director of Graduate Studies the program of study, and advise the student on his/her research program especially during the first semester of the student's program;
(2) read, evaluate and file with the Director of Graduate Studies the student's research prospectus by the end of second semester of the student's program;
(3) monitor the student's progress and make any necessary changes in the program, while providing advice and direction on the student's research problem;
(4) annually assess the student's progress and file recommendations as to retention or dismissal from the program with the Evaluation and Awards Committee;
(5) participate in and grade the written and oral preliminary examinations for the Ph.D. degree;
(6) read and evaluate the student's thesis or dissertation and make suggestions for improvement; and
(7) administer the defense and final examination of the thesis or dissertation.

In either degree program, following establishment of the advisory committee and before advance registration for the second term, the student must meet with the advisory committee to discuss the program of courses for the degree and plans for research. In this regard, the committee is empowered to require work in areas with which the student's interests are allied. The advisory committee will advise the student on the selection of readings on general and historical topics of importance that may not be encountered in formal courses. Copies of the approved program of courses and the plans for research must be placed in the departmental files by the beginning of the second semester of study. An approved research prospectus must be completed and filed with the Director of Graduate Studies by the end of the second semester.

Research and Training Assignments. Research is required of each student in the program. In addition, each term the student must be engaged in a training assignment which supplements formal course work through professional activities such as research or teaching. The assignment varies according to the needs, professional goals, and competencies of the student, and increases in responsibility as the student progresses. The assignments require from ten to twenty hours of service per week.

Academic Retention

The general regulations of the Graduate School with respect to academic retention shall be followed. In addition, no course in which the grade is below *C* shall count toward the degree or fulfillment of any requirement, but the grade will be included in the grade point average. No more than five hours of *C* work in graduate courses will count toward the degree.

All students are subject to regular review by the department's Evaluation and Awards committee. Those not attaining the minimum acceptable academic standards or who in any way fail to meet any other scheduled requirements or standards may be dropped from the program.

Program and Course Requirements

All master's degree students must earn a minimum of 3 hours credit in graduate seminars (PLB 580, 589, 554 or equivalent), at least 1 of which must be in departmental seminar (PLB 580). All Ph.D. students must earn a minimum of 2 credit hours in graduate seminar (PLB 580, 589, 554 or equivalent) each year of residence, at least 1 of which must be in departmental seminar (PLB 580). Additional seminar requirements can be mandated, if determined to be appropriate, by a student's Advisory Committee.

Appeals

Appeals for variations from the departmental graduate program must be presented in writing to the plant biology graduate faculty meeting as a committee of the whole. Appeals must receive approval from a majority of the total plant biology graduate faculty.

Appeals for changes in the student's graduate advisory committee or changes in the original program must be approved in the following order: (1) approval from adviser, (2) approval from remaining members of the student's advisory committee.

Student appeals for change of major adviser must be presented in writing to the plant biology graduate faculty meeting as a committee of the whole. Appeals must receive approval from the Evaluation and Awards Committee.

The Master's Degree

A minimum of 30 hours of graduate credit is required beyond the bachelor's degree, including no less than 22 hours of plant biology courses, 9 of which may be individualized instruction courses, including 3 hours of seminar, and up to 6 (minimum of 3) hours of thesis. A graduate minor of at least 10 graduate hours may or may not be required; this is to be determined by the student and the advisory committee. At the time of completion of the thesis, the student must schedule a public seminar presentation of the thesis material and a comprehensive examination over the thesis and related subject matter.

The Ph.D. Degree

Course work for the degree shall consist of a minimum of 20 semester hours at the 400 and 500 levels in the plant biology program or related disciplines, excluding seminar, readings, research, dissertation, and research tool requirements. Students will take either prior to or during their program, courses in all of the following categories: 1) plant systematics, 2) plant physiology or plant molecular biology, and 3) ecology or environmental science. Courses in plant anatomy and genetics are strongly recommended.

The student may select a secondary specialization once the major area has been declared. A secondary specialization is comprised of courses taken from departments or programs other than Plant Biology and may not count towards the 20 semester hours required for the degree. A program of study, including courses contributing to the secondary specialization, must be approved by the student's advisory committee and be submitted to the Director of Graduate Studies by the end of the first semester of the student's program. Changes made after the first semester of the student's program must be approved by the student's advisory committee.

The student shall demonstrate knowledge in two research tools approved by the student's advisory committee. A tool is defined as training in laboratory (or field) methods, instrumentation, technology, or communication skills including languages that are integral to the pursuance of research. Specific tool requirements will be determined by the student's advisory committee. Courses used to satisfy tools requirements shall not be applied toward the total number of hours required for the degree.

The foreign language requirement can be met by earning a grade of *B* or better in an appropriate 400 level course (Latin, French, German, Spanish or Russian). The requirement can also be met by passing an Educational Testing Service (ETS) examination in French, German, Spanish or Russian. The ETS passing level for French and German is 465 and for Russian and Spanish it is 440.

A statistical tool requirement can be satisfied by earning a *B* or better in one or more graduate level statistics courses. Course recommendations for statistical tools include Quantitative Plant Ecology (PLB 444), Biostatistics (PLB 557), Advanced Biostatistics (PLB 558). Other courses can be used to satisfy a statistical tool requirement if deemed acceptable by the student's advisory committee. Tool requirements other than language or statistics may be completed by earning a *B* or better in courses on file with the Director of Graduate Studies. With the approval of the student's advisory committee, courses not on the official list can also be used to satisfy a tool requirement.

Preliminary Examination. The preliminary examination will consist of two parts, a written examination and an oral examination. The written and oral examinations shall emphasize competence in:

(1) general plant science,
(2) the student's designated area of specialization, and
(3) the student's designated secondary specialization (minor) and/or tools

These three components of the written examination will be administered as separate entities. Subject matter covered in the two specialization examinations may be excluded from the general component.

The student, with the approval of his/her graduate advisory committee, will register with the Director of Graduate Studies to take the examination. The Director of Graduate Studies will then appoint a faculty member who is not on the student's advisory committee to chair the examination committee and administer both the written and oral examination. The Chair of the examination committee will solicit questions from the student's advisory committee and from the faculty at large. Upon receipt of these questions, the Chair of the examination committee will call the committee together to construct and plan the written part of the examination. The student will be allocated one eight-hour block of time to complete each of the three components of the examination. The student may request additional time.

The student must pass all parts of the written examination to proceed to the oral examination. Pass means that the student has demonstrated through clear written statements a good understanding of the topics presented in the written examination. A vote of the EC to pass or fail must be taken immediately following the grading of the written examination. Passing of the written examination will be determined by simple majority vote of the EC. If the student fails one or more of the three components of the examination, he/she must be reexamined on the failed components. If the student fails any part(s) of the general examination, he or she must be reexamined on the failed part(s). In consultation with the advisory committee, the EC chair will schedule and administer the reexamination. The reexamination may not be taken during the same academic term. The student must pass the written examination by the second attempt to continue in the program.

Following passage of the written portion of the examination, the EC chair will schedule and administer the oral portion of the examination. The oral examination must be scheduled not sooner than 10 working days nor

more than 30 working days from the completion date of the written examination. The Chair will not participate in the questioning of the student and does not have a vote regarding the proceedings. The oral preliminary examination must be announced at least 10 working days before the examination is to be given. The examination may only be scheduled when classes are in session, including finals week. The examination shall last at least two hours and not more than four hours and should be scheduled to allow attendance of a maximum number of faculty members from the student's department and all of the preliminary examination committee members. The student's answers to the written examination will be made available to the graduate faculty (upon request) before the oral part of the preliminary examination. All attending graduate faculty members will be given the opportunity to express their opinion on the examination. A vote on performance in the oral examination must be taken immediately following completion of the examination. A pass requires a vote with no more than one dissenting member of the preliminary examination committee, and may have conditions. If the vote is pass, then two levels may be recognized: Pass and Pass with Distinction. A student will be allowed two attempts to pass the oral preliminary examination. Should a student fail a second attempt to pass the preliminary examination, he/she will be dropped from the program. Doctoral students entering the program with a master's degree must take the preliminary exam by the end of 30 months and must pass the preliminary examination and be admitted to candidacy by the end of 36 calendar months after first registering in the doctoral program.

Final Examination (Dissertation Defense). The final examination will be oral. It must be preceded during that semester by a public seminar on the student's research findings. The student's advisory committee will notify the Director of Graduate Studies of its recommendation for the date of the final examination at least two weeks prior to the seminar. The seminar and examination must be announced at least 10 working days before the seminar and examination. The seminar and examination must be held when classes are in session, including finals week. The final examination shall last for no more than 3 hours. It is to cover the dissertation and related subject matter. Passage of the final oral examination should be construed to mean there shall be no more than one dissenting vote of the advisory committee. Should a student fail a second attempt to pass the final examination, she/he will be dropped from the program.

Certificate in Plant Ecology

The Department of Plant Biology participates in the Certificate in Plant Ecology to prepare candidates for the Ecological Society of America's Associate Ecologist Certification. For more information on the Certificate program, please see the section on Certificate Programs in Chapter 1.

Certificate in Systematic Biology

The Department of Plant Biology participates in the Certificate in Systematic Biology interdisciplinary program and offers two classes, PLB 554 Systematic Biology Seminar and PLB 556 Computer Techniques in Systematic Biology, which are Certificate requirements. For more information on the Certificate program, please see the section on Certificate Programs in Chapter 1.

Courses (PLB)

For all field courses in plant biology, students will be assessed a transportation fee. In addition, certain courses may require the purchase of additional materials and supplies, generally $1 to $5 in total cost.

400-4 Plant Anatomy. An introduction to the differentiation, diversification and structure of plant tissues and organs, with emphasis on the organization of seed plants. Laboratory will include instruction in the techniques of microscopy used in the study of plant structure. Two lectures and two laboratories per week. Lab fee: $15. Prerequisite: Biology 200b or Plant Biology 200.

404-4 The Algae. A phylogenetic approach to the study of algae with emphasis on comparative cytology, morphology and ecology. Laboratories include a detailed survey of freshwater algae and a general treatment of representative marine forms. Two lectures and two two-hour laboratories per week. Prerequisite: 204 or consent of instructor.

405-4 The Fungi. A survey of the fungi — their structure, development, relationships, ecological roles and economic importance. Two lectures and two laboratories. Lab fee: $15. Prerequisite: Biology 200b or Plant Biology 200 or equivalent; Plant Biology 300 or equivalent recommended.

406-3 Bryology. An introduction to the biology of mosses, liverworts, and hornworts, with emphasis on structure, development, and phylogeny, but also including the study of their genetics, biochemistry, and physiology. Two lectures and one laboratory per week. Lab fee: $15. Prerequisite: 300.

409-3 Field Mycology. The taxonomy, ecology, and distribution of fungi in southern Illinois and environs with emphasis on techniques of specimen collection, preservation, identification, and recognition. This is a field-based course wherein field trips are made most weeks. Also microscopic examination of living specimens is required. Lab fees are needed for travel and microscope supplies. Prerequisite: Biology 200b or Plant Biology 200; Plant Biology 300 recommended.

410-4 Ecology of Bryophytes. A field-based focus on learning identification of the local flora. Interactions of bryophytes to their environment are examined through lectures, laboratories, and field study. Importance of

mosses and liverworts to ecosystems, community analysis, and population interactions are emphasized. Two lecture/laboratories/field trips per week. Lab fee: $15. Prerequisite: A 300 level course in plant biology or permission of the instructor.

415-5 Morphology of Vascular Plants. The study of external form, internal structure and relationships of vascular plants. Three lectures and two laboratories per week. Prerequisite: PLB 300; PLB 400 recommended. Lab fee: $15.

416-3 Limnology. (Same as Zoology 415) Lakes and inland waters; the organisms living in them, and the factors affecting these organisms. Two lectures per week and one four-hour laboratory alternate weeks. Offered Fall term. Prerequisite: Zoology 220a.

419-3 Plant Molecular Biology. (Same as Plant Soil and Agricultural Systems 419, Plant and Soil Science 419) A survey of molecular phenomena unique to plant systems. Topics will include: genome organization and synteny between plant genomes, transcriptional and post-transcriptional control of gene expression, signal transduction, epigenetics, plant-pathogen interactions and responses to biotic- and abiotic-stresses. Prerequisite: junior standing and Biology 305 or Plant and Soil Science 305.

420-3 Techniques in Molecular Biology. Students will gain hands-on experience with current molecular techniques being applied to questions in the plant sciences. These include isozyme electrophoresis, DNA and RNA extraction, restriction endonuclease digestions, Northern blotting, Southern blotting, PCR (polymerase chain reaction) and gene cloning. Students will gain experience in the use of computers in manipulating and analyzing molecular data. Lab fee: $15. Prerequisite: either Biology 200b or Plant Biology 200, and junior standing or consent of instructor.

421-4 Botanical Microtechnique. Introduction to practical methods of preservation and preparation of plant materials for laboratory and microscopic study. Paraffin and plastic embedding and sectioning techniques, and use of general and histochemical stains stressed. Includes chromosome squashing, whole-mount preparation, photomicrography and other techniques. One lecture and three laboratories per week. Prerequisite: either Biology 200b or Plant Biology 200.

425B-5 Advanced Plant Physiology. (Same as Plant, Soil and General Agriculture 425b.) Physics of plants; membrane phenomena; water relations; mineral nutrition. Lab fee: $15. Prerequisite: 320 and consent of instructor.

427-5 Plant Biochemistry. Exploration of fundamental biochemical pathways in plants with an emphasis upon carbon and nitrogen metabolism. Lab fee: $15. Prerequisite: 320 or consent of instructor.

430-3 Economic Botany. Classification, evolution, domestication, and botanical characteristics of plants useful to people. Every year. Prerequisite: either Biology 200b or Plant Biology 200.

433-4 Introduction to Agricultural Biotechnology. (Same as Plant and Soil Science 433) This course will cover the basic principles of plant and animal biotechnology using current examples; gene mapping in breeding, transgenic approaches to improve crop plants and transgenic approaches to improve animals will be considered. Technology transfer from laboratory to marketplace will be considered. An understanding of gene mapping, cloning, transfer and expression will be derived. Prerequisite: senior standing or consent of instructor.

435-3 Plant-Insect Interactions. (Same as Zoology 435) Plants and insects have played major roles influencing each other's evolutionary diversification. The course will be an evolutionary and ecological examination of the interactions between plants and insects. Topics will include herbivory, pollination, relationships, ant-plant mutualisms, host plant choice, specialized vs. generalization relationships, seed and fruit dispersal, coevolution/cospeciation, and chemical ecology. Prerequisite: Biology 200a and 200b or equivalent, Biology 307 or equivalent.

439-2 Natural Areas and Rare and Endangered Species. Evaluation of the natural area preservation concept with emphasis on how to detect natural areas and methods to preserve them. Emphasis on the rare and endangered species program, its significance and its methodology. Prerequisite: 304, Biology 307.

440-3 Grassland Ecology. A study of grassland structure and function in relation to various biotic and abiotic factors. Laboratory fee: $15. Prerequisite: 304 and Biology 307 or equivalent.

443-3 Restoration Ecology. Ecological restoration tests current understanding of ecosystem assembly and function. This course applies ecological theory to restoration, with an emphasis on factors influencing plant community assembly and evaluating restoration success. Two lectures a week and one four-hour lab alternate weeks. Prerequisite: Biology 307 or equivalent.

444-4 Quantitative Plant Ecology. Includes concepts and methods pertaining to the analysis of ecological data. Approaches will include a variety of methods for analyzing multivariate ecological, diversity, pattern, and spatial data. Laboratory will include the computer application of these concepts and methods to field situations. Laboratory fee: $15. Prerequisite: 360 or equivalent and Biology 307 or equivalent or consent of instructor.

445-4 Wetland Plant Ecology. Provides students with experience in wetland plant ecology with an emphasis in wetland functioning, field sampling and identification of common wetland plants. Lab fee: $20. Prerequisite: 200, 304, Biology 200b, 307, or consent of instructor.

447-2 to 6 Field Studies in Latin America. Two to six weeks of intensive field work to acquaint students with the flora and vegetation in various environments of Latin America and with ecological and taxonomic field techniques. Cost varies with type of study and location. Transportation cost: $80. Prerequisite: advanced standing in one of the biological sciences and consent of instructor.

449-3 Plant Systematics and Evolution. Plant systematic and evolution using traditional and molecular characters. Includes classification methods, phenetics, cladistics, maximum likelihood, and plant molecular evolution. Prerequisite: 304 (or equivalent) or consent of instructor.
450-2 Plant Geography. Plant distributions are examined from both ecological and historical perspectives. Ecological topics include analysis of limiting factors, occurrence of present biomes, and examination of climate/plant interactions. Historical topics include phylogenetic analysis, evolutionary biogeography, and paleo-floras. Two lectures per week.
451-3 Flora of Southern Illinois. Exposure to the major upland and lowland communities of southern Illinois with an emphasis on the identification, distribution and ecology of the natural and introduced floristic components. This is a field-based course wherein the students travel to local areas for plant identification. Each week, 4-8 hours per weekly session is spent in field work and travel to specific field sites is required via a university vehicle. Lab fee: $15. Prerequisite: 304 or consent of instructor.
452-4 Plant Population Ecology. The principles and research techniques of plant population ecology including the spatial, age, size and genetic structures of plant populations. The origin of these different kinds of population structure, their influences upon each other and their temporal dynamics. Laboratory fee: $15. Prerequisite: Biology 307 or consent of instructor.
456-2 Advanced Plant Pathology. A study of the changes occurring in host and pathogen at the host-parasite interface before, during, and after penetration. Control measures will be discussed and emphasis will be on midwest field crops. Two lectures per week. Prerequisite: 356 or consent of instructor.
475-3 Advanced Cell Biology. (Same as Zoology 475.) Cell structure at molecular and cytological levels. Includes discussions of research methods, plasma membrane, cell exterior and recognition, the endomembrane system and related organelles, self-replicating organelles, the cytoskeleton, nuclear structure and function in cell replication, cell differentiation and response, and eukaryotic cell evolution. Prerequisite: Biology 306 or equivalent.
476-2 Advanced Cell Biology Laboratory. (Same as Zoology 476.) Laboratory course to accompany Plant Biology 475. Light and electron microscopy, cell culturing, biochemical methods, and experimental protocols are used to study the structure of cell membranes, intracellular organelles, including the Golgi apparatus, ER, mitochondria, plastids, lysosomes, the cytoskeleton and nucleus. Prerequisite: 475 or concurrent enrollment.
479-3 Plant Variation, Classical and modern plant biosystematics focused at and below the species level. Chromosomal and molecular bases for genetic and phenotypic variation in plants, isolating mechanisms, speciation, hybridization, polyploidy, phlogeography, and conservation genetics will be discussed. Prerequisite: Plan Biology 304 (or equivalent) or consent of instructor.
500-3 Advanced Plant Anatomy. The study of advanced topics in the anatomy of seed plants. Emphasis is on trends in and adaptive nature of evolutionary modifications of anatomical features and the application of anatomical data to plant systematics. Two lectures and one laboratory per week. Prerequisite: 400 and 421 or equivalent.
501-4 (2,2) Research Transmission Electron Microscopy. (See Science 501a, b.)
502-4 (2,2) Research Scanning Electron Microscopy. (See Science 502a, b.)
504-3 Molecular Evolution and Systematics. (Same as Zoology 500) Survey of the theory and processes of organic evolution at the level of protein and DNA in animals. Quantitative analysis of empirical genetic information; methods of phylogenetic inference from molecular data. Three lectures per week. Prerequisite: Zoology 304 or equivalent and Biology 305 or equivalent.
520-3 Plant Growth and Development. (Same as Plant, Soil and Agricultural Systems 520) Physiological control of developmental processes. Emphasis on exogenous growth-regulating compounds and their behavior in plants. Prerequisite: Plant Biology 320 or consent of instructor.
524-2 Advanced Plant Genetics. (Same as Plant, Soil and Agricultural Systems 524) A consideration of incompatibility systems, paramutation, cytoplasmic inheritance, developmental genetics, and other genetic topics as they occur in higher plants. Prerequisite: Biology 305 or equivalent.
525-2 to 16 (2 to 4, 2 to 4, 2 to 4, 2 to 4) Cell Biology Research Techniques. A special techniques course designed for graduate students specializing in cell studies. Provides instrumentation training, with emphasis on application of the method to a research project. **(a)** Quantitative Cytology. **(b)** Immuno-Labelling and Qualitative Histochemistry. **(c)** Deep Etching Techniques in Electron Microscopy. **(d)** Cell Fractionation and Biochemical Techniques.
530-3 Plant Ecophysiology. (Same as Plant, Soil and Agricultural Systems 530) A study of the physiological processes that influence the growth, reproduction, adaptation, and geographic distribution of plants. The ecophysiology of plant stress and plant interactions. Prerequisite: 320 or equivalent and Biology 307 or equivalent.
533-3 Plant Growth and Morphogensis. A study of the role of the environmental variables (light, temperature, etc.) and phytohormones in the growth and morphogensis of intact plants and tissue cultures. The theories of plant organogensis and the synthesis, translocation, regulation and mode of action of the major classes of phytohormones will be treated in light of the most recent literature. Three lectures per week. Prerequisite: 320 or consent of instructor.

534-2 Techniques in Studies of Plant Growth and Development. Instruction in laboratory techniques used in the study of the role of environment and natural plant growth substances in plant morphogensis. Two two-hour laboratories per week. Prerequisite: 320 or consent of instructor.
545-3 Ecosystem Ecology. Fundamentals of and human modification to atmospheric chemistry and cycling of major nutrients in terrestrial ecosystems are covered in the context of global change. Laboratory exercises provide methodology and analytical approaches to studying ecosystem structure and function. Two lectures a week and one four-hour lab alternate weeks. Lab fee: $15. Prerequisite: one year of general chemistry and general ecology or equivalent.
546-2 Nutrient Cycling Methods. Research in ecosystem ecology requires a basic understanding of biochemistry. Analytical methodology used to study pools and transformations of major nutrients in terrestrial ecosystems, applicable to freshwater systems, will be the focus of this laboratory course. Three hour laboratory every other week. Prerequisites: 545 or concurrent enrollment, inorganic chemistry and general ecology or equivalent.
547-3 to 8 Tropical Studies in Costa Rica. Credit for field courses taken under the jurisdiction of the Organization for Tropical Studies in Costa Rica. Courses and credits will vary. Prerequisite: approval of OTS Advisory Committee at Southern Illinois University Carbondale.
554-1 to 4 Systematic Biology Seminar. (Same as Anthropology 554, Molecular Biology Microbiology and Biochemistry 554, Zoology 554.) Interdisciplinary research topics in systematic biology. Seminar consists of biweekly presentations by visiting or resident researchers, followed by roundtable discussions with seminar participants. Students also participate in a day-long symposium at which they contribute an oral or poster presentation. Graded S/U. Prerequisite: consent of instructor.
556-3 Computer Techniques in Systematic Biology. (Same as Molecular Biology, Microbiology and Biochemistry 556, Anthropology 556 and Zoology 556.) A survey of computational problems and solutions in modern systematic biology. Topics include platform options and limitations, numerical analyses, database management, information dissemination and retrieval, and computer taxonomy. Prerequisite: consent of instructor.
557-4 Biostatistics. (Same as Zoology 557) Basic biostatistical procedures used by researchers in life sciences and related fields. Topics include descriptive statistics, probability and distributions, statistical models, likelihood methods, experimental design, analysis of variance, regression, correlation, and the use of statistical software.
558-4 Advanced Biostatistics. (Same as Zoology 558) Advanced biostatistical procedures used by researchers in life sciences and related fields. Topics include multiple and logistic regression, randomization tests, jackknife and bootstrap. Mantel tests, BACI designs, MANOVA, repeated measures analysis, and the use of statistical software. Prerequisite: 557 or equivalent, Zoology 557,
570-2 to 3 Graduate Readings in Plant Biology. A course of individually assigned readings in botanical literature. Every semester. Prerequisite: consent of instructor. Graded *S*/*U* only.
571-4 Genomics of Eukaryotes. (Same as Plant, Soil and Agricultural Systems 571) Genomics, Proteomics and Bioinformatics are rapidly making important contributions to the life science through biotechnology. An appreciation of the genomic tools is important to all in agriculture and biology. The relationships between plant molecular biology and the biotechnology industry will be explored. Short independent practical projects in genomics, proteomics or bioinformatics will be pursued. Prerequisite: 400 level course in genetics, biotechnology, biochemistry or consent of instructor.
578-3 Population Genetics. (Same as Zoology 578) Genetic structure of populations, factors causing changes and principles governing rate and direction of change. Three lectures per week. Prerequisite: Zoology 304 or equivalent, and Biology 305 or equivalent.
580-1 to 6 Departmental Seminar. Student presentations and critiques of original research, including presentations by occasional invited speakers. Graded *S*/*U* only. Required of all graduate students in residence, when offered.
589-1 to 12 (1 per topic per semester) Seminars in Plant Biology. Discussions of current and historical research and literature in various subject areas of plant biology. **(a)** Ecology, **(b)** Molecular and Biochemical Physiology and **(c)** Systematics and Biodiversity. Graded *S*/*U* only.
590-1 to 3 Introduction to Research. General introduction to research techniques. Techniques to be determined by instructor and students. Summer only. Graded *S*/*U* only. Prerequisite: consent of instructor; consent of department.
591-2 to 9 Research. Assignments involving research and individual problems. **(a)** Anatomy; **(b)** Bryology; **(c)** Ecology; **(d)** Morphology; **(e)** Mycology; **(f)** Paleobotany; **(g)** Pathology; **(h)** Photography; **(i)** Phycology; **(j)** Physiology; **(k)** Systematics. Master's students may use this for their research for their thesis. Summer only. Graded *S*/*U*. Prerequisite: consent of instructor, consent of department.
599-2 to 9 Thesis. Course to be taken in the preparation of the Master's thesis. Every semester. Prerequisite: consent of instructor. Graded *S*/*U* only.
600-1 to 36 (1 to 12 per semester) Dissertation. Course to be taken in the research for and in writing of the doctoral dissertation. Every semester. Graded *S*/*U* only. Prerequisite: consent of instructor.
601-1 per semester Continuing Enrollment. For those graduate students who have not finished their degree programs and who are in the process of working on their dissertation, thesis, or research paper. The student must have completed a minimum of 24 hours of dissertation research, or the minimum thesis, or research hours before being eligible to register for this course. Concurrent enrollment in any other course is not permitted. Graded *S*/*U* or *DEF* only.