Plant Biology Graduate Course Descriptions

PB 503 **Systematic Botany** *4(3-3-0) F*

Preq: PB 200, PB 250, BIO 183, or equivalent; Senior standing

J. Xiang (co-taught with PB403)

This course covers basic and contemporary systematic principles and methods as applied to vascular plants, including classification, identification skills, phylogenetics, molecular approaches, and surveys of important families of major groups of flowering plants via lectures and lab practice. Students are expected to achieve the following objectives after successfully completing the course: describe a plant using botanical terms, identify a plant using the key mechanics, name and publish a new species, recognize large and common families of flowering plants, interpret plant relationships depicted on phylogenetic trees with proper terms, exhibit basic knowledge in molecular approaches applied to systematics, demonstrate knowledge in the current understanding of angiosperm phylogeny and evolution. PB 503 students will carry out a term project in molecular systematics involving project design, data acquiring from Genbank, and phylogenetic analyses. Evaluation of students will be based on exams (4 on lecture and 3 on lab), collection project, field trips, and term paper (for PB 503 students).

PB 544 **Plant Geography** *3(3-0-0) S, (Alt Yr. Even)*

Preq: PB 403, PB (ZO) 360, GN 411 or equivalents

J. Mickle

This is a course in plant geography that emphasizes what grows where and why. Historical and ecological approaches are emphasized, and discussions include climatological, pedological, historical, paleobotanical, and more recent approached to understanding the present distribution of plants. A field trip to Green Swamp and Jones Lake to see some more unusual ecosystems is included.

PB 545 **Paleobotany** *4(3-3-0) S, (Alt Yr. Odd)*

Preq: PB 400, 403, 413, 544, MEA 423 or equivalent

J. Mickle

This course is a dual-listed undergraduate/graduate course in paleobotany. Emphasis is on vascular plants. The course includes early fossils and discussions of taphonomy (formation of fossils), biogeography as related to fossil floras, and palynology. Field trips have been to Kaolin mines in Georgia for Eocene fossil plants and to the Triassic age fossil plant locality near Sanford, NC.

PB 565 **Plant Community Ecology** *4(3-3-0) S*

Preq: PB 360 or ZO 260 or equivalent

T. Wentworth

This course covers the structure and function of plant communities, with emphasis on both classical and recent research. Through a lecture/laboratory format, the course introduces students to four major areas of emphasis in plant community ecology. The first of these focuses on definition of the plant community, sampling approaches, measurement and description of community properties, and analysis of community data, with coverage of gradient analysis and classification. Lectures on vegetation of the world and vegetation of North Carolina are included. The second area of emphasis is the influence of environmental characteristics (particularly climate, topography, substrate and soils, and fire) on the nature and spatial distribution of communities. The third area of emphasis is community dynamics, with coverage of disturbance, succession, and modeling of vegetation change through time. Lectures on plant geography and paleobotany are included. The fourth area of emphasis is community organization and function, with coverage of modern theoretical treatments and their predictions; much of this last portion of the course focuses on patterns and processes related to the diversity of species in the plant community. The laboratory is field-oriented and introduces students to natural communities of Wake County (eastern North Carolina Piedmont) and their distribution across the landscape. An introduction to methods of inventory for vegetation and environment is included. In addition to the regular weekly laboratory meetings, there are also two extended field laboratories (three or four days each), one to the mountains, and the other to the coastal plain and coastal fringe. Participation in at least one of these longer laboratories is mandatory.

PB (MB,PP) 575 **Introduction to Mycology** *4(3-3-0) F, (Alt. Yr.)*

Preq: BIO 125 or BIO 181 & 182 or PB 200 or PP 315 or PP 318

L. Grand (Plant Pathology)

Course is a survey of the fungal kingdom in context of phyla and classes. Systematics, ecology, biology and utilization are included. Laboratory includes illustrative material, field trips, and cultural techniques. A collection and paper are required.

PB 595 **Special Topics in Botany** *1-4, F, S, Sum*

PB 595A - Environmental Issues in Aquatic Ecology
J. Burkholder

Expanding population growth near lakes, rivers, estuaries, and coastal oceans is effectively shrinking the quality and quantity of freshwater and marine resources worldwide. A general understanding of the scientific basis of impacts from nutrient pollution, toxic chemicals, acidification, global warming, overfishing, and related stresses, and the overarching policy/political controls, is critically needed to restore and optimally manage these systems, and to protect the health of humans who depend upon them for potable water supplies and fish resources. This course fills a gap in available curricula by providing students with a working scientific knowledge of water quality issues, related to cultural solutions where applicable. The course is designed for practical use by both science and non-science majors, and for college and high school teachers as well as college students. These are issues that all citizens need to understand; they quietly affect each of us in everyday living.

PB/BIT 595C - Confocal Microscopy
N. Allen

The purpose of the course is to enable students to thoroughly understand the theory behind confocal laser scanning microscopy imaging as well as get hands-on experience with the Leica confocal microscope located in CMIF. The course starts with an introduction to basic microscopy followed by an introduction to phase, POL, DIC and fluorescence imaging. There are three imaging assignments and a final confocal project. Students prepare digital images and print these using photoshop. Students learn how to collect optical sections and make 3D reconstructions. At the end of the course, students should be able to use the Leica confocal microscope independently.

PB/BIT 595D – Computational Biology
H. Sederoff
Computational biology merges biology, computer science, and information technology to form a single discipline. The enormous progress in high-throughput technology has led to the generation of large public databases as a rich source of information for every biologist. Statisticians and bioinformaticians have developed many different and useful tools to mine these databases. This course (1h lecture, 1h lab) is designed to give biologists an overview of the information publicly available in networking databases. We discuss how this information is generated and deposited in databases and which tools can be applied to retrieve and analyze this information. This course will not only explore the use of bioinformatics software but enable the students to apply it beyond the “default” settings by focusing on the underlying algorithms and matrices. Topics

span the entire field from a single nucleotide sequence to its functional integration in whole organism modeling and structural visualization.

PB 595E - Plant Functional Ecology
W. Hoffmann

The traits possessed by a plant will determine its response to the environment as well as its influence on the environment. Therefore this course examines the role of plant traits in plant population ecology, physiological ecology, and ecosystem ecology. An evolutionary and comparative focus is central to the theme of this course. This course is required for all graduate students in the Plant Biology Department, but is open to graduate students of other departments.

PB 595I Current Issues in Plant Community Ecology *2(2-0-0) S (Alt. Yr. Even)*
T. Wentworth

The scientific literature covering plant community ecology (also known as vegetation science) has grown rapidly in recent decades, recording substantial development in both theoretical and applied areas. This course, developed jointly by Dr. Wentworth and a Plant Biology doctoral student, Ms. Kristen Rosenfeld, introduces students to current primary literature in a seminar-style format. Both faculty and students select specific topics to be considered during the semester, and discussion of each topic is moderated by a member of the class. Moderators select papers to be read in advance by the entire class, and each member of the class completes a "topic analysis" synthesizing the key points raised in each week's discussion. Recent topics covered include: species-time-area relationship, the metacommunity concept, phylogenetics in community ecology, competition, biological invasions, community assembly, tritrophic interactions, community classification, diversity-stability theory, plant protection, niche theory, and neutral theory.

PB 595K - Aquatic Plant Ecology
J. Burkholder

Aquatic ecosystems and their inhabitants are usually considered as either freshwater or marine. Yet there are many analogies in the behavioral and physiological mechanisms used by plants – both primitive plantlike alga and rooted vascular plants - for survival and success across freshwater, brackish and marine systems. This course emphasizes analogies between freshwater and marine ecosystems and aquatic plant communities in a real-world approach that encourages experimental design and synthesis in interpreting information. The course first presents a general overview of freshwater and marine habitats and plant types, then focuses on principles of aquatic plant ecology as influenced by physical, chemical and biological variables. Plant survival and success in aquatic ecosystems will be considered across gradients of salinity, water motion, light, nutrient supplies and grazing pressure. The importance of allelopathy and symbiosis as competitive strategies will also be explored. This course is broadly designed for aquatic ecologists and, more generally, for graduate students in Plant Biology and other biological sciences.

PB 595M Applied Multivariate Analysis of Community Data *1-3 S (Alt. Yr. Even)*
T. Wentworth

Workers in the area of community ecology typically collect large amounts of data representing the abundances of various organisms across a range of different sites characterized by varied environments. Analysis and interpretation of these complex data are facilitated by a variety of multivariate analytical procedures. However, most general courses on multivariate statistics cover only a small portion of the available procedures. This course, developed jointly by Dr. Wentworth and a Plant Biology doctoral student, Ms. Kristen Rosenfeld, introduces students to a broad suite of multivariate procedures useful in analysis and interpretation of community data. Emphasis is placed on practical application of the procedures, although some coverage of underlying theory is also provided. The course is a "hands-on" computer laboratory that allows students to apply multivariate procedures to widely available data sets or their own data. Methods covered include summarizing data, cluster analysis, comparing group properties, ordination of community data, and related topics, implemented using a variety of readily-available statistical software packages. All students receive one credit hour for participation in a half-semester workshop with weekly meetings. Additional credit (one or two hours) is available for students wishing to pursue independent projects; credit allocated depends on the complexity of the project undertaken.

PB 595T - Modern Herbarium Management and Curation Techniques
A. Krings

In the context of increasing development pressures and habitat changes around the world, the need to deepen our understanding of plant resources is perhaps larger than ever. Herbaria are the fundamental source of information for the identification and classification of plants and represent the backbone of taxonomic knowledge and thus of all disciplines in need of communicating about plants. This course aims to: 1) provide students a broad understanding of the history of herbaria and their role in the context of the taxonomic process; 2) introduce students to the principles and methods of modern herbarium management and collections-based science; and 3) provide students the knowledge and skills to become proficient in curatorial techniques.

PB 595V - Video Microscopy
N. Allen

This course provides an interdisciplinary group of upper level undergraduate and graduate students a thorough understanding of microscopy and optics, cameras and image analysis and their applications to biology and engineering, allowing them to develop marketable skills. A variety of subjects are covered in this course beginning with the traditional physics of light and optics, microscope construction and use, and the various types of microscopy as well as recently developed modes of imaging such as near field scanning, confocal laser scanning, atomic force

and multiphoton microscopy. Through various laboratory exercises and projects, students become proficient with every type of microscopy and many specimen preparation methods.

PB 601 **Botany Seminar** *1(1-0-0) F,S*

W. Hoffmann

PB 620 **Special Problems In Botany** *1-4, F, S, Sum*

Credits Arranged

Staff

Directed research in some phase of botany other than a thesis problem, but designed to provide experience and training in research.

PB 624 **Topical Problems** *1-4 F,S*

Preq: Consent of Instructor

Staff

Discussions and readings on problems of current interest in fields of ecology, anatomy and morphology, taxonomy, plant physiology and cell biology. May be repeated with a change in topic for a maximum of six credits.

PB 624B - Ethics in Plant Biology
T. Wentworth, D. Robertson

This course originated from a graduate student Ethics Fellowship requirement to develop course material related to ethics and has continued to be driven by graduate student interest and active involvement. Guidelines for identifying ethical issues and procedures for addressing them are discussed, using case studies as examples. Topics include plagiarism, intellectual property, copyright protection, mentoring, standards for authorship and review, working with endangered species, and whistleblowing. Students have the option of writing a position paper or preparing a detailed teaching module on a topic of their choosing.

PB 624T - Molecular Systematic Topics
J. Xiang

This is a journal reading and discussion class. It is offered every semester for graduate students who are interested in plant molecular systematics and evolution. The objective is to provide an opportunity for graduate students to learn both theoretical and practical knowledge in plant molecular systematics and evolution, as well as to maintain informed in current advances in these research areas. Each semester, the readings may be focused on a special current topic, a book, or selected journal articles by graduate students that are related to their research. Each

class meeting is led by the instructor or by a student. Key points of the reading and questions/problems to be discussed will be posted beforehand by the leader whenever possible. Other students enrolled in the class are expected to read the selected papers and bring questions in for discussion as well. Evaluation of students (satisfactory vs unsatisfactory) is based on their attendance, participation in discussion, and preparation for leading the discussion.

PB 685 **Master's Supervised Teaching** *1-3 F,S, Sum*

Preq: Master's students

Staff

This course is a teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

PB (GN/MB/PP) 730 **Fungal Genetics and Physiology** *3(3-0-0) S. (Alt. Yr.)*

Preq: BCH 451, PB 575, GN 411 or PP 501

M. Daub
(co-taught with G. Payne, M. Cubeta, Plant Pathology)

This course addresses basic concepts of the genetics and physiology of fungi, with emphasis on saprophytic and plant pathogenic mycelial fungi. The course consists of lectures and reading of current literature. The course is taught in alternate years and is aimed at students with some background in mycology as well as a strong foundation in genetics and molecular biology. Specific topics covered change to stress contemporary areas of interest, but always include evolution and characteristics of the major phyla, cell structure, polar growth, sexual and asexual reproduction and incompatibility systems, gene expression, genetic systems of variability, metabolic pathways and their regulation, and fungal diversity and adaptation. The course is cross-listed and co-taught with faculty in the Department of Plant Pathology.

PB 733 **Plant Growth and Development** *3(3-0-0) S*

Preq: PB(ZO) 414 or PB 421, organic chemistry

D. Robertson
(co-taught with R. Franks, Genetics)

This course is for advanced graduate students with a background in genetics and plant biology. The molecular basis for developmental processes such as germination, flowering, and fruit formation is covered, providing a fundamental basis for understanding these agriculturally important processes. Lectures and student presentations of recent articles are used in addition to on-line, graded discussions using a class blog. Through lectures, students become familiar with forward and reverse genetic approaches to understanding plant growth and development, understand the molecular basis of fate maps and developmental plasticity, and the distinction between cell autonomous and non-autonomous regulation of gene expression. Discussions

speculate on the overall coordination of epigenetic effects, including chromatin structure, miRNA processing, hormones, and environmental signals on plant growth. At the end of the course, students should be able to synthesize experimental data into a working model that can be used to make testable hypotheses for future experiments.

PB 751 **Advanced Plant Physiology** *3(3-0-0) F*

Preq: PB 421 or equivalent

H. Sederoff

The unique abilities of plants for adaptation as sessile organisms are based on their metabolic flexibility and special physiology. This course focuses on the cellular and intercellular mechanisms and regulatory features of plant specific metabolic pathways. We discuss the latest developments and discoveries in understanding the physiology of plants and their underlying experimental approaches such as functional genomics or high-throughput technologies. Topics include photosynthesis, photorespiration, mitochondrial respiration, regulation of carbohydrate metabolism, lipid biosynthesis and membrane biogenesis, cell wall synthesis /modifications, intra- and intercellular transport of metabolites, RNA, and proteins, nitrogen and sulfur metabolism, physiological adaptations, stress response regulation, and plant metabolomics.

PB (MB) 774 **Phycology** *3(1-4-0) S,(Alt Yr. Odd)*

Preq: BIO 125 or PB 200

J. Burkholder

The primitive plant-like organisms known as algae are the foundation of food webs in the aquatic ecosystems that cover most of the Earth. Products made from algae, from food to cosmetics to fillings in teeth and internal sutures, are used by many people in countries throughout the world in everyday living. This course provides an introduction to the taxonomy, morphology, ultrastructure, life histories, ecology and economic importance of the remarkably diverse species included in the algae, with emphasis on the freshwater and marine algae of North Carolina. The course begins with an overview of historical aspects and key characteristics used to differentiate among algae at the phylum level. The major phyla are then discussed in detail, including general features of ecology and economic importance. Field laboratories are required, including one all-day trip to a stream and a reservoir, and a two-day trip to marine habitats on the coast. The course is cross-listed, and targets advanced science education majors as well as undergraduates and graduate students in biological sciences.

PB 780 **Plant Molecular Biology** *3(3-0-0) F, (Alt. Yr.)*

Preq: BCH 451, GN 411

R. Boston

This course is designed as an introduction to the molecular aspects of plant biology and

biotechnology. It emphasizes techniques used in plant molecular biology and ways in which these techniques along with the unique characteristics of plants can be combined for practical applications. Outside reading assignments include review articles (mostly) and primary research papers (occasionally) chosen to provide an overview of a topic by experts in the field. These readings provide the background for specific experiments discussed in class. One-third of the course grade is based on preparation of an original grant proposal involving molecular biology techniques and participation as a review panel member (written reviews of other students' proposals and discussion in a mock grant panel based on NSF format for peer review of research).

PB 795 **Special Topics in Botany** *1-4 F,S*

PB 795F/795G - Plant Form and Function Lecture/Lab
C. Haigler

This course is designed to acquaint plant science graduate students from diverse sub-disciplines with the various levels of control of plant life--cellular, meristematic, biophysical, genetic, biochemical, hormonal, and via signal transduction--through discussion of broad concepts and selected examples based on review articles and research papers. In the laboratory, the students will have a systematic introduction to the essential elements of plant anatomy and adaptations in plant structure. Students will also have the opportunity to conduct independent study on a specific topic of particular interest to them that links plant structure and plant function. After completion of the class through active participation, students will have a broad understanding of how plants organize and conduct their basic life processes.

PB 820 **Special Problems** *1-4*

Credits Arranged

Staff

Directed research in some phase of botany other than a thesis problem, but designed to provide experience and training in research.

PB 824 **Topical Problems** *1-4 F,S*

Preq: Consent of Instructor

Staff

Discussions and readings on problems of current interest in fields of ecology, anatomy and morphology, taxonomy, plant physiology and cell biology. May be repeated with a change in topic for a maximum of six credits.

PB 824C – Colloquium
T. Wentworth, W. Thompson, J. Burkholder, N. Allen

Colloquium is a required course for all graduate students and emphasizes student presentations and discussions about current research frontiers in plant biology. The goal of the course is to bring together students from a variety of backgrounds to stimulate thinking in a wide range of biological topics, to help improve the ability to communicate within and between disciplines, and to foster interdisciplinary interactions among plant biology research groups. Specific objectives include improving communication and presentation skills and providing exposure to a variety of research areas within plant biology. The course emphasizes oral and written presentations, evaluated through critiques by both faculty and student peers. Emphasis is placed on communicating across subdisciplinary boundaries. The need for 'grantsmanship' skills is addressed by guiding students through the preparation and presentation of research proposals describing their M.S. or Ph.D. research project or a hypothetical project in another area of special interest. Students are involved in a broadly based discussion of research frontiers in plant biology, with the object of exposing the students to different ways of thinking about the field, rather than having them focus on just one approach or subdiscipline. Presentations and discussions focus on both experimental and descriptive approaches, and on levels of biological organization ranging from molecular to ecosystem.

PB 824N - Understanding and Manipulating Plant Genome Function
W. Thompson

This is a special topics course offered on an alternate year basis, with a changing focus. Subjects have included: Genome and Chromosome Structure; Replication and Transcription; DNA Methylation and Histone Modification; Gene Transfer Technology; Gene Silencing: Avoiding it and Exploiting it; and Applications: Plant Breeding and Bioengineering. The course usually includes a "journal club" segment in which students review selected research papers pertinent to the themes of the course, as well as a segment in which students present seminar-length oral presentations on topics of their choice. The course has recently included segments on Intellectual Property (IP) and Freedom to Operate.

PB 885 **Doctoral Supervised Teaching** *1-3 F,S, Sum*

Preq: Doctoral student

Staff

This course is a teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.