COLLEGE OF AGRICULTURE, HUMAN AND NATURAL SCIENCES

Chandra Reddy, Ph.D., Dean
Office: 213 Agricultural Biotechnology Building
(615) 963-7561
creddy@tnstate.edu

DEPARTMENT OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES

Samuel Nahashon, Ph.D.,
Interim Department Chair
Office: 108 Lawson Hall (615) 963-5829 or 5431
snahashon@tnstate.edu

MAJOR: **AGRICULTURAL SCIENCES**
DEGREE: **MASTER OF SCIENCE (M.S.)**
OPTIONS: **Thesis, Non-Thesis**

CONCENTRATIONS:
I. Agribusiness Management and Analysis
II. Food Supply Chain Management
III. Agricultural Education
IV. Animal Science
V. Plant Science

OBJECTIVES

The master's program in Agricultural Sciences is designed to:

1. Prepare research scholars in the increasingly complex scientific field of agriculture and related areas;
2. Prepare scholars for rewarding careers in government, the agricultural industry, and higher education;
3. Prepare scholars for leadership roles in professional agriculture;
4. Prepare professionals with a set of critical and analytical business skills to fulfill the unique demands of the food and agribusiness industry;
5. Prepare scholars for further training in doctoral programs; and
6. Provide advanced training in agricultural education for graduates working in secondary schools and vocational agriculture; and
7. Provide advanced training in the application of Geospatial Information Systems and Global Positioning Systems

OVERVIEW

The Master of Science in Agricultural Sciences is offered with five concentrations: Agribusiness Management and Analysis, Food Supply Chain Management, Agricultural Education, Animal Science, and Plant Science. The degree is offered with two options, thesis or non-thesis.

The thesis option in Agribusiness Management and Analysis, and Food Supply Chain Management concentrations requires a minimum of twenty-nine (29) credit hours of course work and a thesis of four (4) credit hours. The candidate for the degree in these two concentrations must complete twelve (12) credit hours of core courses: AGSC 5060, AGSC 5110, AGSC 5120, AGSC 5610-5620; twelve (12) credit hours minimum of required courses in the selected concentration; and nine (9) hours maximum of electives. The thesis option in Agricultural Education, Animal Science, and Plant science concentrations requires a minimum of twenty-six (26) credit hours of course work and a thesis of four (4) credit hours. The candidate for the degree in these three concentrations must complete twelve (12) credit hours of core courses: AGSC 5060, AGSC 5110, AGSC 5120, AGSC 5610-5620; twelve (12) credit hours minimum of required courses in the selected concentration; and six (6) hours maximum of electives. The non-thesis option in all the five concentrations requires a minimum of thirty-five (35) credit hours of course work. The candidate for the degree must complete eleven (11) credit hours of core courses: AGSC 5060, AGSC 5110, AGSC 5350, AGSC 5610-5620; fifteen (15) credit hours minimum of required courses in the selected concentration; and nine (9) hours maximum of electives. These courses must be approved by the advisor and department head.

The College of Agriculture, Human and Natural Sciences at Tennessee State University is partnering with Peace Corps Master's International program to offer students the opportunity to earn credits toward a Master's of Science degree in Agricultural Sciences while serving as Peace Corps Volunteers. This partnership is a part of the Peace Corps Master's International program, which allows volunteers to combine Peace Corps service with a master's degree program and receive credit for Peace Corps service abroad.

Under this program, students may earn up to six graduate credit hours for Peace Corps service to fulfill up to six hours of requirements for the MS degree in Agricultural Sciences. Participants must apply to Peace Corps and Tennessee State University separately. Please contact the Department of Agricultural and Environmental Sciences for details and requirements for the degree program. Further information on Master's International program is available at www.peacecorps.gov/masters.

Admission Requirements: M.S. Program

An applicant may also be recommended for conditional admission if he or she has a 2.25-2.49 GPA and a minimum pre-admission test score of 294 on the GRE or 383 on the MAT or 2.00-2.24 GPA and a minimum pre-admission test score of 297 on the GRE or 394 on the MAT. Candidates having a Master's degree from an accredited institution may be exempted from GRE Score requirements.

Program of Study/Admission to Candidacy: M.S. Program

The degree candidate must file a program of study after completing at least nine semester hours of graduate credit, but before completing fifteen hours of graduate credit. The program lists the courses which will be used to satisfy degree requirements, as well as detailing how other requirements will be met. The student may later change the program of study with the written approval of the Department and the Graduate School.

When the candidate files the program of study, he or she must also apply for admission to candidacy. The candidate must have a grade point average of 3.0 or above to be eligible for admission to candidacy.

Degree Requirements: M.S. Program

Thesis Option

Each student must pass Research Methods (AGSC 5110), must have a thesis guidance committee appointed, and must be advanced to candidacy before enrolling in Thesis Writing (AGSC 5120).

The candidate must submit a thesis on a topic approved by the major advisor. Upon completion of the thesis, the candidate must satisfactorily pass an oral examination conducted by the Thesis Examination Committee. Students choosing this option in Agribusiness Management and Analysis, and Food Supply Chain Management concentrations will require 33 hours of coursework which will include four (4) credit hours of thesis research. But students choosing the Agricultural Education, Animal Science, and Plant science concentrations will require 30 hours of course work which will include four (4) credit hours of thesis research.

Non-Thesis Option

The option is for students who would like to focus on training in specialized areas to meet the needs of employers in agricultural product processing, marketing organizations, input supply firms, teaching, agricultural extension services, and various state and federal government agencies. This program is not recommended for students who have any aspirations toward pursuing a Ph.D. degree.
Students choosing the non-thesis option will be required to take a minimum of 35 hours of course work which will include AGSC 5350 Independent Study of Contemporary Issues and Problems. The graduate student, with guidance from their major advisor will identify a need area in agriculture, research the area and write a paper.

Comprehensive Examination

Upon completion of AGSC 5350 and during the semester of graduation, students choosing the non-thesis option must take a comprehensive written and oral examination administered by the student's advisory committee and other faculty members representing appropriate subject matter areas. The student's major advisor will serve as chairperson of the committee conducting the examination.
If a student fails the comprehensive examination, one retake will be allowed. Should the student again fail, a third and final examination may be taken upon completion of additional course work (minimum of 6 hrs) to be selected by the student's advisory committee.

PROGRAMS OF STUDY

Core Courses, All Concentrations - Thesis 12 hours, or Non-Thesis 11 hrs.

AGSC 5060	Statistics for Res. Workers	3
AGSC 5110	Research Methods	3
AGSC 5120	Thesis Writing	4
or AGSC 5350	Independent Study	3
AGSC 5610-5620	Seminar	1, 1

CONCENTRATION I: AGRIBUSINESS MANAGEMENT AND ANALYSIS 12 HRS. MINIMUM, THESIS OR 15 HRS. MINIMUM NON-THESIS

AGSC5080	Agribusiness Management and Market Analysis	3
AGSC5090	Food and Fiber Industry Economics and Policy	3
AGSC5100	Environmental, Resource Economics and Management	3
AGSC 5300	Decision-Making in Agribusiness Quantitative Appl.	3
AGSC 5310	International Agricultural Trade and Marketing	3
AGSC 5330	Agribusiness Strategy	3
AGSC 5014	Food Marketing and Retail management	3

Electives - 9hrs. Maximum each for Thesis or Non-Thesis option with the approval of the advisor and department head.

ECON 6110	Managerial Economics	3
MGMT 6020	Behavior in Organizations	3
BISI 6131	Management and Evaluation of Information Systems	3
ACCT 5000	Foundations in Accounting	3
AGSC 5040	Program Planning and Evaluation in Ag. & Ext. Ed.	3
AGSC 5050	Curriculum for Ag. STEM Ed.	3

CONCENTRATION II: FOOD SUPPLY CHAIN MANAGEMENT 12 HRS. MINIMUM, THESIS OR 15 HRS. MINIMUM NON-THESIS

AGSC 5080	Agribusiness Management and Market Analysis	3
AGSC 5300	Decision Making in Agriculture – Quantitative Applications	3
AGSC 5310	International Agricultural Trade and Marketing	3
AGSC 5012	Food Supply and value Chain Management	3
AGSC 5090	Food Industry Economics, Regulations and Policy	3
AGSC 5100	Environmental Resource Economics and Management	3
MGMT 6100	Logistics	3

Electives - 9 hrs. maximum each for Thesis or Non-Thesis option with the approval of the advisor and department head.

ECON 6110	Managerial Economics	3
MGMT 6020	Behavior in Organizations	3
BISI 6131	Management and Evaluation of Information systems	3
ACCT 5000	Foundations in Accounting	3
AGSC 5040	Program Planning and Evaluation in Ag. & Ext.Ed.	3
MGMT 6220	Procurement Management	3
AGSC 5330	Agribusiness Strategy	3

CONCENTRATION III: AGRICULTURAL EDUCATION - 12 HRS. MINIMUM, THESIS OR 15 HRS. MINIMUM NON-THESIS

AGSC 5010	Foundation of Agricultural & Extension Education	3
AGSC 5020	Curriculum Development for Formal & Non-Formal Agricultural & Extension Education	3

AGSC 5030	Instructional Design in Agricultural & Extension Education	3
AGSC 5040	Program Planning and Evaluation in Ag. .& Ext. Ed.	3
AGSC 5050	Curriculum for Agriculture STEM Ed.	3

Electives - 6 hrs. maximum, Thesis or 9 hrs. maximum, Non-Thesis with the approval of the advisor and department head.

AGSC 5080	Agribusiness Management and Market Analysis	3
AGSC 5090	Food and Fiber Industry	3
AGSC 5100	Environmental Resource Economics	3
AGSC 5140	Special Problems in Animal and Poultry Science	3
AGSC 5150	Livestock Management	3
AGSC 5220	Plant Growth Substances	3
AGSC 5260	Soil and Plant Analysis	3
EDCI 5260	Philosophy of Education	3
EDCI 5270	Advanced Social Studies	3
PSYC 5430	Advanced Educational Psychology	3

CONCENTRATION IV: ANIMAL SCIENCE - 12 HRS. MINIMUM, THESIS OR 15 HRS. MINIMUM NON-THESIS

AGSC 5130	Animal Nutrition	3
AGSC 5140	Special Problems in Animal and Poultry Science	3
AGSC 5150	Livestock Management	3
AGSC 5160	Animal Genetics and Breeding	3
AGSC 5170	Advanced Poultry Production and Management	3

Electives - 6 hrs. maximum, Thesis or 9 hrs. maximum, Non-Thesis with the approval of the advisor and department head.

AGSC 5090	Food and Fiber Industry	3
BIOL 5180	Cell Biology	3
AGSC 5280	Advanced Poultry Nutrition and Biotechnology	3
CHEM 5410	Advanced Biochemistry I	3
CHEM 5420	Advanced Biochemistry II	3

CONCENTRATION V: PLANT SCIENCE - 12 HRS. MINIMUM, THESIS OR 15 HRS. MINIMUM NON-THESIS

AGSC 5180	Soil Classification	3
AGSC 5190	Plant Breeding	3
AGSC 5220	Plant Growth Substances	3
AGSC 5230	Advanced Propagation of Horticultural Plants	3
AGSC 5240	Advanced Pomology	3
AGSC 5260	Soil and Plant Analysis	3

Electives - 6 hrs. maximum, Thesis or 9 hrs. maximum, Non-Thesis with the approval of the advisor and department head.

AGSC 5090	Food and Fiber Industry	3
AGSC 5100	Environmental Resource Economics	3
BIOL 5180	Cell Biology	3
CHEM 5410	Advanced Biochemistry I	3
CHEM 5420	Advanced Biochemistry II	3

MAJOR: APPLIED GEOSPATIAL INFORMATION SYSTEMS

DEGREE: PROFESSIONAL SCIENCE MASTER'S OVERVIEW

The Professional Science Master's (PSM) Degree Program with a concentration in Applied Geospatial Information Sciences (GIS) is newly established program to expand our existing online Graduate Certificate Program in Applied Geospatial Information Systems (GIS).The program offers students with opportunities to study a PSM Degree with a concentration in Applied GIS. Courses in this program are delivered online with an on-ground required internship. The program is designed for individuals who wish to pursue careers in professional settings other than research or academia, and who do not wish to pursue additional educational opportunities at the doctoral level. The PSM Degree Program with a concentration in Applied GIS is a non-thesis offering and requires completion of 36 semester credit hours. Students will be trained in real-world situations through internships and theoretical principles through online courses. Students will acquire on-the-job experience with at least 300 internship hours under immediate supervision of an Applied GIS practitioner.

The Graduate Certificate in Applied Geospatial Information Systems (GIS) is an online stand-alone credential designed for degree-holding individuals who wish to develop their knowledge and skills in GIS for enhancement of their professional careers. The program will prepare individuals to meet the rapidly increasing need for graduates highly qualified in the application and use of GIS. Certificate courses are designed and taught with a practical and applied orientation. The Certificate program requires the completion of six courses (18 semester credit hours) in GIS and Global Positioning Systems (GPS), and can be completed by a part-time student within twelve months.

The Ph.D. in Biological Sciences is an interdepartmental degree program offered by the Department of Biological Sciences and the Department of Agricultural and Environmental Sciences in the College of Agriculture, Human and Natural Sciences. Admissions procedures for the Ph.D. program are outlined under the Department of Biological Sciences. The major advisor will be appointed by the department offering the student's primary emphasis. Course descriptions are listed under the respective department.

Admission Requirements: PSM Program

Applicants must fulfill the following requirements for admission into the PSM Degree Program in Applied GIS:

- A baccalaureate degree from an accredited institution in a STEM or STEM-related field with transcripts from all institutions attended; with a grade point average of 2.75 on a 4.00 point scale;
- A minimum score of 3 or higher on the Graduate Record Examination (GRE) analytical writing and a score of 290 or higher on the GRE (verbal and quantitative) or rank 30th percentile or higher on the GRE (verbal and quantitative);
- A one-page statement describing personal interests, career goals, and previous academic preparation (such as math, statistics, and/or critical thinking) that will help in evaluating the candidate's overall fit within the program;
- Two letters of recommendations from professional or academic contacts conveying the applicant's ability for success in the program; and

- Test of English as a Foreign Language (TOEFL)—for international applicants from non-English speaking countries.

Program of Study: PSM Program

The PSM Degree Program with concentration in Applied GIS is an online offering with an on-ground required internship. The program consists a total of 36 semester credit hours. Should a student from the Graduate Certificate Program in Applied GIS satisfy the above admission requirement to the PSM Degree Program with a concentration in Applied GIS, all the 18 credit hours of her/his courses in the certificate program will be transferrable towards his/her PSM program of study. Similarly, a student who has been admitted to the PSM Degree Program with a concentration in Applied GIS can request a Graduate Certificate in Applied GIS after completing the required 18 credit hours.

Degree Requirements: PMS Program

A total of 36 semester credit hours are required for completion of the PSM degree Program. Other requirements for its completion are similar to those of a traditional Master's of Science degree, with two major distinctions: 1) students will complete at least 300 internship hours instead of a thesis; and 2) students will complete a set of multidisciplinary courses of study expanded to include graduate business, economics, management, and public service. A full-time student should be able to complete the degree requirements in two years. Part-time students taking two courses (6 credit hours) per semester and four courses (12 credit hours) per academic year should be able to complete the degree requirements in three years. A cumulative grade point average of "B" (3.00 quality points) in all graduate courses taken at TSU is required for graduation. Guidelines on probation, suspension, and readmission into the program after suspension are the same as those published in this Graduate Catalog for other graduate programs.

PROGRAMS OF STUDY

1. Major Field Core: Total credits: 15

BISI 6550	Project Management	3
MGMT 5000	Survey of Management and Marketing	3
Or	or	
AGSC 5080	Agribusiness Management and Market Analysis	
PRST 5040	Human Resources Management	3
PRST 5100	Issues and Ethics	3
PRST 5310	Leadership in Organization	3

2. **Concentrations Total Credits 21**

PSMA 6510	**Geospatial Information Systems**	
PSMA 6520	Advanced Spatial Analysis	3
PSMA 6525	Remote Sensing and Image Analysis	3
Or	or	
PSMA 6560	Global Positioning Systems*	
PSMA 6530	Advanced Geospatial Metadata	3
PSMA 6540	Advanced Spatial Database Design and Management	3
PSMA 6550	Advanced Geospatial Information Systems Application and Design	3
PSMA 6585	Internship in Applied Geospatial Sciences	3

***** Only eligible for students within driving commuting distance of TSU.

CERTIFICATE: APPLIED GEOSPATIAL INFORMATION SYSTEMS

Admission Process

Applicants for the Certificate must hold a baccalaureate degree from an accredited institution of higher education and must meet the Graduate School requirements for non-degree admission and retention as published in the University catalog. Requests for application forms and materials should be directed to the School of Graduate Studies and Research.

Certificate Requirements

To earn the Graduate Certificate in Applied Geospatial Information Systems, students must satisfactorily complete the following courses:

PSMA 6510	Advanced Geospatial Information Systems
PSMA 6520	Advanced Spatial Analysis
PSMA 6530	Advanced Geospatial Metadata
PSMA 6540	Advanced Spatial Database Design and Management
PSMA 6550	Advanced Geospatial Information Systems Application and Design
PSMA 6560	Advanced Global Positioning Systems

The Certificate is awarded upon the successful completion of the six courses (18 semester credit hours).

MAJOR: BIOLOGICAL SCIENCES
DEGREE: DOCTOR OF PHILOSOPHY (Ph.D.)

Admission Requirements: Ph.D. Program

See admission requirements under Ph.D. Program - Department of Biological Sciences

Program of Study

The degree candidate must file a program of study after completing nine semester hours of graduate work, but before completing fifteen hours of graduate work. The program lists the courses which will be used to satisfy degree requirements, as well as detailing how other requirements will be met. The student may later change the program of study with the written approval of the Department and the Graduate School.

Admission to Candidacy

The student must apply for admission to candidacy after completing the 24-hour core of required courses (See Degree Requirements: Ph.D. Program, below.) With an average of B (3.0) or better, passing the comprehensive examination, and gaining approval of the dissertation proposal.

Degree Requirements

Degree candidates must complete the core of required graduate courses (24 hours) with a grade of B or better in each course, pass the comprehensive examination, and gain approval of their dissertation proposal prior to obtaining admission to candidacy for the doctoral degree.

After gaining admission to candidacy the student must complete an approved curriculum (24 hours minimum of electives set by the student's research advisory committee), enroll in Graduate Seminar (BIO 5010, 5020) or the Seminar in Biology every semester (BIO 7010, 7020), complete a dissertation (24 hours), and successfully defend the dissertation prior to gaining the Ph.D. degree.

Required Courses: 24 Hours

To be completed prior to Admission to Candidacy

BIOL 5100	Literature and Methods in Research	3
BIOL 5180	Cell Biology	3
BIOL 6100	Frontiers in Molecular Science	3
BIOL 7120	Molecular Biology	3
CHEM 5410, 5420	Advanced Biochemistry I, II	6
CHEM 5600	Spectroscopic Methods in Chemistry	3
STAT 5210	Statistical Methods I	3

After Admission to Candidacy: 52 Hours

Electives		24
BIOL 5010, 5020	Graduate Seminar I, II	1, 1
BIOL 7010, 7020	Seminar in Biology I, II	1, 1
BIOL 8110	Dissertation Research	24

Graduate Elective Courses

AGSC 5160	Animal Genetics and Breeding	3
AGSC 5280	Advanced Poultry Nutrition and Biotechnology	3
AGSC 5190	Plant Breeding	3
AGSC 7010	Advancements In Agricultural Biotechnology	3
AGSC 7020	Economic, Regulatory and Ethical Issues in Biotechnology	3
AGSC 7030	Gene Expression and Regulation In Higher Plants	3
AGSC 7040	Plant Tissue Culture Methods and Applications	
AGSC 7050	Biotechnology in Animal Reproduction	3
AGSC 7060	Advanced Soil Technology	3
AGSC 7070	Molecular Genetics Ecology	3

COURSE DESCRIPTION

AGSC 5010. FOUNDATION OF AGRICULTURAL AND EXTENSION EDUCATION. (3) The historical development of legislative efforts toward the encouragement of a national structure of vocational education, educational and societal needs pertinent to legislative consideration; program development resulting from legislative guidelines.

AGSC 5012 FOOD SUPPLY AND VALUE CHAIN MANAGEMENT. (3) The course provides a graduate-level premise to food production, systems approaches and supply chain management strategies and applications. It focuses on methods involved in food products supply chain systems from farm to fork; environmentally, technologically, economically and socially. The course emphasizes on integrated animal and crop-based food supply system(s) of the United States and internationally.

AGSC 5014 FOOD MARKETING AND RETAIL MANAGEMENT. (3) This course introduces students to the principles and methods of agribusiness marketing: marketing process, strategic planning, market research, consumer behavior, segmentation or targeting or positioning, product or service design and branding, pricing decisions and strategies, retailing and value-delivery channels, promotions/advertising, and holistic and sustainable marketing. The course takes an analytical and practical approach: providing analytical methods, real-life examples and case studies, and engaging students in applications and analyses.

AGSC 5020. CURRICULUM DEVELOPMENT FOR FORMAL AGRICULTURAL AND EXTENSION EDUCATION. (3) Study of procedures and practices for determining manpower needs; analysis of occupational clusters; study of identification and development of manpower sources.

AGSC 5030. INSTRUCTIONAL DESIGN IN AGRICULTURAL AND EXTENSION EDUCATION. (3) Study of the organization of vocational and occupational programs; study of principles and concepts of program management; study of the techniques and procedures for program development.

AGSC 5040. PROGRAM PLANNING AND EVALUATION IN VOCATIONAL EDUCATION. (3) Concepts and principles of planning vocational and technical programs at the local, regional, and state level; utilization of advisory councils and citizen committees; study of the administrative structure and legislative mandates, principles and techniques of program evaluation.

AGSC 5050. SPECIAL PROBLEMS IN VOCATIONAL EDUCATION. (3) Students will be allowed to select a problem of interest, conduct and exhaustive literature search and present findings in written form. Discussion of progress will prevail during class periods.

AGSC 5060. STATISTICS FOR RESEARCH WORKERS. (3) Training and skills in research design, analyzing data, presentation of data, and drawing conclusions, with special emphasis on descriptive inferences.

AGSC 5080. AGRIBUSINESS MANAGEMENT AND MARKET ANALYSIS. (3) Introduction to and growth of the U.S. agribusiness industry, its scope and composition. Evolution and composition of basic managerial principles, organization, operation, and administration of agribusiness firms especially under situation of risk and uncertainty. Managerial Methodology Application of economic theory and Statistical methods, the analysis of prices, and marketing of agribusiness products.

AGSC 5090. FOOD AND FIBER INDUSTRY: ECONOMICS & POLICY. (3) The economics of production, competition, markets, and policy for the food and fiber sector of the economy. While the course stresses functional relationships and theoretical principles, descriptive material is included to enhance one's understanding of current problems and the interrelationships between agricultural and general economy, identification of relevant issues, review of criteria for evaluating program development of policies.

AGSC 5100. ENVIRONMENTAL, RESOURCE ECONOMICS AND MANAGEMENT. (3) The course analyzes major environmental and resource issues in relation to operations of agribusinesses using economic principles and alternative management scenarios. Market and non-market approaches to valuation of environmental and natural resources will be discussed in conjunction with the regulatory framework and management institutions.

AGSC 5110. RESEARCH METHODS. (3) The objectives of this course are: (1) to develop an understanding of research philosophies, methods, and procedures; (2) to gain experience in developing and designing research projects, organizing and analyzing research data.

AGSC 5120. THESIS WRITING. (4) This course is designed to provide instruction that will enable the student to adequately prepare a thesis from his or her on-going thesis research under the direction of the major advisor and guidance committee. The format of the thesis must conform to that of the subject matter area and the requirements of the Graduate School.

AGSC 5130. ANIMAL NUTRITION. (3) Devoted to the study of nutrients and their metabolism; studies of recent developments in animal nutrition, experimental procedures and application in commercial feeding.

AGSC 5140. SPECIAL PROBLEMS IN ANIMAL AND POULTRY SCIENCE. (3) Students will be allowed to select a problem of interest, conduct an exhaustive literature search and present findings in written form. Discussions on progress will prevail during class periods.

AGSC 5150. LIVESTOCK MANAGEMENT. (3) Provides an opportunity for the student to receive advanced training in the care and management of purebred herds, commercial herds, and herd development.

AGSC 5160. ANIMAL GENETICS AND BREEDING. (3) A study of the principles of genetics with emphasis on breed improvement involving change of gene frequency, role of selection, selection table of contents, importance of pedigree and methods of estimating heritability.

AGSC 5170. ADVANCED POULTRY PRODUCTION AND MANAGEMENT. (3) Devoted to studying the principles and current practices in production, management and marketing of eggs, broilers, and turkeys; recognition of field problems, and how to solve such problems economically.

AGSC 5180. SOIL CLASSIFICATION. (3) A study of the basis of soil classification, genesis and morphology of zonal soils of the United States. Emphasis placed on the important series of Tennessee. Prerequisites: AGSC 2200, 4230. Two lectures and one laboratory.

AGSC 5190. PLANT BREEDING. (3) A study of the methods, principles and results of plant improvement work, hereditary variation and the general principles of plant breeding. Prerequisite: AGSC 1200.

AGSC 5220. PLANT GROWTH SUBSTANCES. (3) A general study of the organic substances which affect plant growth and development. Special emphasis will be placed on the auxins and cytokinins**.**

AGSC 5230. ADVANCED PROPAGATION OF HORTICULTURAL PLANTS. (3) A study of the methods of propagating horticultural plants, including seedage, cuttage, and grafting of both economic and ornamental plants. Two lectures and one laboratory period.

AGSC 5240. ADVANCED POMOLOGY. (3) A study of the development and performance of fruit plants as influenced by inheritance and environment. Two field trips required. Two lectures and one laboratory period.

AGSC 5260. SOIL AND PLANT ANALYSIS. (3) Fundamental principles involved in analyzing soils and plants. Current techniques and methods of interpretation of soil testing and plant analysis.

AGSC 5280 ADVANCED POULTRY NUTRITION AND BIOTECHNOLOGY (3). This course will provide students with an opportunity to develop knowledge of principles of Poultry Nutrition and feeding. Topics include nutrient requirements of poultry, metabolic processes and the role of nutrients on performance, health and nutritional deficiency diseases of poultry, feed and drug regulations, common feed ingredients, additives, and supplements used in the poultry industry. The course will also address the application of biotechnology in poultry feeds and feeding, common feed ingredients used in poultry feeding and least cost feed formulation. The course will also emphasize practical feeding of poultry with emphasis on specific nutrient requirements. Prerequisites: AGSC 1410

AGSC 5300. DECISION-MAKING IN AGRIBUSINESS: QUANTITATIVE APPLICATIONS. (3) This course develops expertise in quantitative problem-solving techniques necessary for decision-making in agribusiness with extensive use of computers. Introduction to the concepts and methods of applying econometric analyses to problems of economic research. Emphasis will be placed on the formulation and solution of business problems using selected quantitative tools such as linear programming, simulation, game theory, and inventory models.

AGSC 5310. INTERNATIONAL AGRICULTURAL TRADE AND MARKETING. (3) The course emphasizes economic development, trade theory, and its application to agricultural trade. Review of the fundamental trade theory, changing structure of international trade markets, U.S. trade policies for agriculture, and the role of international commodity trading agreement.

AGSC 5330. AGRIBUSINESS STRATEGY. (3) The course is designed to enhance learning through presentations of case studies and analyses of relevant issues by students and guest speakers from agribusinesses. Topics to be covered include but are not limited to location of business, supply of inputs, and international marketing tools.

AGSC 5350. INDEPENDENT STUDY-CONTEMPORARY ISSUES AND PROBLEMS. (3) A required course for students choosing the non-thesis option for a Master of Science Degree in Agricultural Sciences. Individual Study and Research under faculty guidance, resulting in a substantial piece of writing. The intent of this course is to broaden students understanding of theory and methods and apply them to analyze selected issues and problems in a broader context in various areas of agriculture. The students will apply (synthesize) knowledge gained in various courses in presenting issues and problems and integrating the materials learned so as to apply them in his/her area of interest or problem at hand. The course will reflect students' ability to analyze, explore, and synthesize knowledge and skill as well as communication skills.

AGSC 5610-5620. GRADUATE SEMINAR IN AGRICULTURAL SCIENCES. (1-1) Critical review of current literature in Agricultural Sciences. Required of all M.S. graduate students.

PSMA 6510 GEOSPATIAL INFORMATION SYSTEMS (3). An introduction to geospatial information systems (GIS) principles and technologies. Upon successful completion of this course, students will have the knowledge and skillset to demonstrate how to use GIS to predict and solve real-world problems related to spatial data. Students will be able to: differentiate between GIS terminology and concepts; evaluate spatial data through its structure and organization; comprehend the representation of spatial data; develop a foundation for creating, editing, querying and presenting geospatial data; and evaluate laboratory exercises using a hands-on to learn GIS software and hardware. 3 credit hours.

AGSC 6520 ADVANCED SPATIAL ANALYSIS (3). Evaluates the concepts and analytical procedures used to extract and simplify complex systems using geospatial information systems (GIS). This course analyzes geometric, coincidence, and adjacency models as applied to surface analysis, linear analysis, raster analysis, topological overlay, and contiguity analysis. Spatial modeling will be used to analyze, simulate, predict, and resolve real-world problems and issues. Upon successful completion of Advanced Spatial Analysis, students will have the knowledge and skills to develop and differentiate between advanced spatial statistical models needed to predict and solve real-world problems correlated to geospatial data. Students should be able to: apply the terminology and concepts of spatial analysis and modeling; apply specific forms of three-dimensional spatial data and their structure, organization, and analysis; differentiate between methodologies used in spatial analysis; interpret the representation of three-dimensional spatial data through spatial statistics; and apply concepts of planning used in the spatial analysis decision- making processes Systems. **Prerequisites or co-requisites: PSMA 6510.**

PSMA 6525 REMOTE SENSING AND IMAGE ANALYSIS (3). This course evaluates the concepts and analytical procedures used to extract and simplify complex systems using geospatial information systems (GIS). This course analyzes geometric, coincidence, and adjacency models as applied to surface analysis, linear analysis, raster analysis, topological overlay, and contiguity analysis. Spatial modeling will be used to analyze, simulate, predict, and resolve real-world problems and issues. Upon successful completion of Advanced Spatial Analysis, students will have the knowledge and skills to develop and differentiate between advanced spatial statistical models needed to predict and solve real-world problems correlated to geospatial data. Students should be able to: apply the terminology and concepts of spatial analysis and modeling; apply specific forms of three-dimensional spatial data and their structure, organization, and analysis; differentiate between methodologies used in spatial analysis; interpret the representation of three-dimensional spatial data through spatial statistics; and apply concepts of planning used in the spatial analysis decision- making processes

PSMA 6530 ADVANCED GEOSPATIAL METADATA (3). An examination of geospatial data that make up the most expensive component of a geospatial information system (GIS) and accounts for billions of dollars of expenditures annually. Upon successful completion of Advanced Geospatial Metadata, students will demonstrate knowledge about metadata through the evaluation of background data correlated to the various types of GIS data. Students should be able to: differentiate between critical information attached to metadata; differentiate between different procedures used to create and maintain metadata; evaluate metadata and its components; and demonstrate to GIS users the how and why there are needs for documenting their data.. **Prerequisite or corequisites: PSMA 6510.**

PSMA 6540 ADVANCED SPATIAL DATABASE DESIGN AND MANAGEMENT (3). An examination and demonstration of the accuracy and usability of data that determines the analysis, output, and cost of any geospatial information system (GIS) using techniques that include python programming. Upon successful completion of Advanced Spatial Database Design and Management, students should be able to evaluate and differentiate between geodatabase and database design; editing; and management within a GIS . **Prerequisite or corequisites: PSMA 6510; PSMA 6520.**

PSMA 6550 ADVANCED GEOSPATIAL INFORMATION SYSTEMS APPLICATION AND DESIGN (3). Concepts and procedures used to successfully assess needs, evaluate requirements, design, and implement geospatial information systems (GIS). Upon successful completion of Advanced Geospatial Information Systems Application and Design, students will be able to develop, evaluate, and differentiate between data and technology needed to produce desired information products. Students should also be able to: demonstrate cost benefit analysis and project proposal development. **Prerequisites or co-requisites: PSMA 6510, PSMA 6520.**

PSMA 6560 ADVANCED GLOBAL POSITIONING SYSTEMS (3). Principles, technology, and use of Global Positioning Systems (GPS). Upon successful completion of GPS, students will have the knowledge and skills to evaluate and differentiate between the principles of navigation and positioning. Students should be able to: evaluate and differentiate between GPS instrumentation; evaluate and differentiate between the collection and processing of data; and evaluate and differentiate between the integration of GPS with geospatial information systems (GIS). *Please note that this course is only eligible for students within driving commuting distance of TSU. Prerequisites: None.

PSMA 6585: INTERNSHIP IN APPLIED GEOSPATIAL SCIENCES (3). This is not an online course and has an on-ground requirement lasting 13 weeks over the summer term. It provides on-the-job experience enabling students to perform adequately in a professional business setting and requires at least 300 hours of participation in an assigned and approved professional setting under a practitioner's guidance with at least one standardized national AGS certification. Students must complete PSMA 6510 and PSMA 6525 or PSMA 6560 before they enroll in internship course. Students can take other courses concurrently **Prerequisites: PSMA 6510 and PSMA 6525 or PSMA 6560**.

AGSC 7010. ADVANCEMENT IN AGRICULTURAL BIOTECHNOLOGY (3). A review of recent advances in biotechnology in agriculture with emphasis on experimental techniques and application in improvement of livestock and crop production**. Prerequisite: Animal and Plant Genetics (AGSC 3400).**

AGSC 7020. ECONOMIC, REGULATORY AND ETHICAL ISSUES IN BIOTECHNOLOGY. (3). This course will analyze factors affecting the development of biotechnology using economic principles and discuss regulatory and ethical issues as they relate to plant and animal products and by-products. Prerequisites: At least 6 credits in economics courses, of which 3 credits should be in intermediate level economic theory.

AGSC 7030. GENE EXPRESSION AND REGULATION IN HIGHER PLANTS. (3). A study of gene structure in higher plants, and gene expression and its regulation in plant growth development, morphogenesis, reproduction, response to environmental stress and defense mechanism. Special topics such as transposable elements, Arabidopsis, molecular plant breeding will be included. **Prerequisites: AGSC 5190 or BIO 5110.**

AGSC 7040. PLANT TISSUE CULTURE METHODS AND APPLICATIONS. (3). Emphasis on hands-on laboratory procedures. Application of tissue culture techniques for the improvement of economic plants will be emphasized. Prerequisite: An introductory course in botany and plant physiology.

AGSC 7050. BIOTECHNOLOGY IN ANIMAL REPRODUCTION. (3). Discussion on the various advances in techniques used to enhance animal reproduction and livestock productivity. Basic concepts of mammalian reproductive function will be studied. However, students should have a working knowledge of reproductive physiology. Methods such as artificial insemination, embryo transfer, in vitro fertilization, and embryo manipulation will be covered. Topics will be viewed from basic and applied perspectives. A comprehensive review of current literature will be included as a part of all discussions. Laboratory time in connection with this course will provide hands-on experience with some practices associated with reproductive biology. Prerequisite: Previous course in Reproductive.

AGSC 7060. SOIL TECHNOLOGY. (3). Evaluation of soil utilizing most recent advances in physical-chemical properties, soil structure, metric potential, water management/conservation techniques, and irrigation systems and pollution abatement. **Prerequisites: AGSC 2200, 4230; Basic Chemistry and Calculus.**

AGSC 7070. MOLECULAR GENETIC ECOLOGY. (3). This course will explore and explain the underlying sources of genetic variation in populations, how this variation can be detected and analyzed, and how to interpret observed variation. Also covered will be examples of the applications of molecular genetics in behavioral ecology and population genetics drawn from current literature. Emphasis will be placed on applying these principles in agricultural research. Prerequisites: Undergraduate or Graduate Genetics.

AGRICULTURAL SCIENCES FACULTY

Ahmad N. Aziz, Associate Professor
B.S., 1988, Barani Agricultural College; M. Phil, 1991, Quaid-e-Azam University; Ph.D., 1998, University of New Brunswick

Karla Addesso, Assistant Professor
B.S. 2002, The College of New Jersey; Ph.D., 2007, University of Florida

Richard Browning, Jr., Professor
B.S., 1989 Prairie View A&M University; M.S. 1992, Ph.D., 1994; Texas A & M University

Fitzroy D. Bullock, Professor
B.S., 1973, Loma Linda University; M.S., 1975, Tennessee State University; Ph.D., 1980, University of Tennessee-Knoxville

Arvazena Clardy, Assistant Professor
B.S., 1989, Tennessee State University; M.S., 1993, Tennessee State University; Ph.D., 1999, Alabama A & M University

Fur-Chi Chen, Associate Professor
B.S., 1987, Chung Shan Medical & Dental College, Taiwan; M.S., 1994, University of Wisconsin-Stout; Ph.D., 1998, Auburn University

Agnes Kilonzo-Nthenge, Assistant Professor
B. S., 1992, University of Eastern Africa, Kenya; M.S. 1997, Tuskegee University; Ph.D., 2003, Auburn University

Jason P. de Koff, Assistant Professor
B.S., 2000, Ithaca College; M.S., 2004, UC Riverside; Ph.D., 2008, Purdue University

Sam O. Dennis, Associate Professor
B.S., 1978, Middle Tennessee State University; M.S., 1980, Tennessee State University; Ph.D., 1999, Alabama A&M University

Charles Korsi Dumenyo, Assistant Professor
B.S., 1990, University of Ghana – Legon; M.S., 1994, Tuskegee University; Ph.D., 2000, University of Missouri

Desh Duseja, Professor
B.S., 1961, M.S., 1963, Punjab Agriculture University, Ludhiana, Pb., India; Ph.D., 1972, Utah State University

Emmanuel Kudjo Dzantor, Associate Professor
B.S., 1974, University of Science and Technology, Kumasi, Ghana; MS, 1978; PhD 1980, University of Wisconsin

Enefiok Ekanem, Professor
B.S., 1981, Ohio University, M. A., 1983, Ohio University, M. A., 1986, Ohio University, M. S. 1987, Ohio University, Ph. D. 1992, University of Minnesota

Solomon Haile, Assistant Professor
B.S., 1993, Alemaya Agricultural University; M.S., 1997, Wageningen University; Ph.D., 2007, University of Florida
John L. Hall, Assistant Professor
B.S. 2001, University of Florida; MAB 2002, University of Florida; Ph.D., 2010, Texas A&M University
Makonnen Lema, Associate Professor
B.S., 1977 Haile Selassie University; M.S., 1980, Addis Ababa University; Ph.D., 1994, Oklahoma State University
Jianwei Li, Assistant Professor
B.S. 2001, China Agricultural University; Ph.D., 2009, Duke University
Lan Li, Assistant Professor
B.S.,1998, Tianjin Polytechnic University; M.S., 2001, China Agricultural University; Ph.D., 2007, University of California, Davis.
Lim, Kar Ho, Assistant Professor
B.S. 2004, University of Kentucky; M.S., 2009, University of Kentucky; PhD., 2012, University of Kentucky.
Prabodh Illukpitiya, Assistant Professor
BS, University of Peradeniya, Sri Lanka; MS, Norwegian University of Life Sciences; Ph.D. University of Hawai'i at Manoa.
Margaret T. Mmbaga, Professor
B.S., 1974; M.S., 1976, University of Dar es Salaam, Tanzania; Ph.D., 1980, University of Wisconsin, Madison
Dilip Nandwani. Assistant Professor
B.S. 1985, University of Jodhpur; MS, 1987, University of Jodhpur; PhD, 1991, University of Jodhpur
Samuel Nahashon, Professor
B.S., 1987, Andrews University; M.S., 1990, Tuskegee University; Ph.D., 1994, Oregon State University
Jason Oliver, Associate Professor
B.S., 1987, M.S., 1990, University of Tennessee; Ph.D., 1999, Auburn University.
Ankit Patras, Assistant Professor
B.S. 2002, Allahabad Agriculture Institute; India; MS, 2004, University College Dublin, Ireland; PhD, 2009, University College Dublin, Ireland; Post-Doctoral Training. 2013, Trojan Technologies & University of Guelph, Canada.
Dharma S. Pitchay, Assistant Professor
B.Ag.Sc. 1981, Malaysia Agriculture University, M.S., 1997, West Virginia University, Ph.D., 2002, North Carolina State University
Sudipta Rakshit, Assistant Professor
BSc., 1997, University of Calcutta; MSc., 1999, University of Calcutta; M.S., 2002, University of Iowa; Ph.D., 2006, University of Kentucky.
John Ricketts, Associate Professor
B.S. 1996, Middle Tennessee State University; M.V.T.E., Middle Tennessee State University; Ph.D., University of Florida
Chandra Reddy, Professor, Dean and Director of Land Grant Programs
B.S. (Ag). –Andhra Pradesh Agricultural University; M.Sc (Ag). - Andhra Pradesh Agricultural University; Ph.D. University of Florida
Dalia Abbas Saleh, Research Assistant Professor
B.A., 1995, Ain Shams University; M.A., 2000, University of Sussex; Ph.D., 2007, University of Minnesota
Roger J. Sauve, Research Professor
B.S., 1970, M.S.,1972, Ph.D., 1978, University of Florida
George Smith, Assistant Professor
B.L.A., 1975, University of Toronto; M.A. (Planning), 1990, University of Waterloo; PhD, 2001, University of Guelph (Canada)
Susan M. Speight, Assistant Professor
B. S., 2003; M.S., 2007; University of Kentucky; Ph.D., 2010, Virginia Polytechnic Institute and State University
Fisseha Tegegne, Professor
B.A. 1973, Haile Selassie I University; M.S., 1977, University of Strathclyde; Ph.D. , 1990, Michigan State University
William Sutton, Assistant Professor
B.S. 2002, Wheeling Jesuit University; M.S., 2004, Marshall University, Ph.D., 2010, Alabama A&M University.
Ali Taheri, Assistant Professor
MSc in Horticulture, 2000, University of Tehran, Tehran, Iran; PhD in Plant Molecular Biology 2009, University of Guelph, Ontario, Canada
De'Etra Young, Assistant Professor
B.S. 2004, Southern University and A&M College; MS, 2006, Texas A&M University; PhD, 2010, Texas A&M University
Ying Wu, Assistant Professor
B. S., 1991, Inner Mongolia Agricultural University (P.R. China); M.S., 1994, Inner Mongolia Agricultural University (P.R. China); M.S., 2000, University of Guelph (Canada); Ph.D., 2010, University of Guelph (Canada)
Suping Zhou, Professor
B.S., 1985, Hebei Agricultural University, M.S., 1988, Shandong Agricultural University; Ph.D., 1998, Naijing Agricultural University

DEPARTMENT OF BIOLOGICAL SCIENCES

Terrance L. Johnson, Ph.D., Head
110 McCord Hall
615-963-5681
615-963-5548 (Fax)
tjohnson@tnstate.edu

MAJOR: **BIOLOGY**
DEGREE: **MASTER OF SCIENCE (M.S.)**
THESIS OPTION, NON-THESIS
OPTION
MAJOR: **BIOLOGICAL SCIENCE**
DEGREE: **DOCTOR OF PHILOSOPHY**

Michael Ivy, Ph.D., Graduate Coordinator

The Department of Biological Sciences offers graduate programs leading to the Master of Science (M.S.) degree in Biology and the Doctor of Philosophy (Ph.D.) degree in Biological Science. Both curricula are designed to prepare scholars for the pursuit of research careers in academia, government, and industry, and to improve the level of competency of high school, college, and university teachers.
The Ph.D. in Biological Science is a degree program offered by the Department of Biological Sciences and the Department of Agricultural and Environmental Sciences in the College of Agriculture, Human, and Natural Sciences. Programs of study involve cellular and molecular biology, plant and environmental Sciences and biochemistry. The emphasis of this program is to train scientists in biological research who will be highly competent to teach in higher education and who can work in industry and with other biologists, biochemists, engineers, agricultural scientists, and others to develop solutions to problems that have an impact on our quality of life. Admissions procedures for the Ph.D. program are outlined under the Department of Biological Sciences. The major advisor will be appointed by the department offering the student's primary emphasis. Course descriptions are listed under the respective departments.

Admission Requirements: M.S. Program

Unconditional admission to the M.S. program requires the applicant to have a bachelor's degree from an accredited four-year college or university, a minimal score of 800 calculated from the GPA multiplied by 200 and added to the GRE combined verbal and quantitative scores, two letters of recommendation and a personal statement. Also required is that the student will have accumulated a minimum of 24 acceptable semester hours in biology plus a minimum of four semester hours of biochemistry. The Departmental Admissions Committee will base admission upon these materials and additionally, will evaluate the applicant's science course GPA and may request a personal interview to determine the applicant's potential for success in the program.

Conditional admission may be granted to applicants prior to the completion of the 24 semester hours of biology and four semester hours of biochemistry, but the student must complete these courses with a GPA of 3.0 or better. The student must remove conditional status by earning at least a B (3.0) average in the first nine hours of graduate courses; failure to achieve this average will result in withdrawal from the program.

Degree Requirements: M.S. Program

The Department offers both thesis and non-thesis options in the master of science degree program. A minimum of 36 semester hours of approved courses is required for the M.S. degree under the thesis option, and a minimum of 39 semester hours is required under the non-thesis option. Students who choose the non-thesis option must pass a comprehensive examination (passing score 70% or above) taken no earlier than the term in which they complete their course work. Students interested in pursuing research careers in academia, government or industry are highly encouraged to take the thesis option.

Required Courses: 23 hours in thesis option, 19 hours in non-thesis option

BIOL 5010, 5020	Graduate Seminar I, II	1,1
BIOL 5100	Literature and Methods in Research	3
BIOL 5110	Research in Biology	2
BIOL 5120	Thesis Writing (required only in thesis option)	4
BIOL 5180	Cell Biology	3
CHEM 5410, 5420	Advanced Biochemistry I, II	6
AGSC 5060	Statistics for Research Workers or Equivalent	3

Elective Courses: 13 hours in thesis option, 20 hours in non-thesis option

Selection of elective courses must be made in consultation with the student's thesis committee or non-thesis advisor. Often, depending on the career direction or research interest of the student, a student may be advised to take elective courses in other departments or at other institutions. Included in the elective courses must be a physiology and a genetics course. In addition, only three (3) semester hours of Special Problems courses will be credited toward the M.S. degree.

Program of Study: M.S. Program

The degree candidate must file a program of study after completing at least nine semester hours of graduate credit, but before completing fifteen hours of graduate credit.

The program lists the courses which will be used to satisfy degree requirements, and details how other requirements will be met. The student may later change the program of study with the written approval of the Department and the Graduate School.

Admission to Candidacy: M.S. Program

When the candidate files the program of study, he or she must also apply for admission to candidacy. The candidate must have a grade point average of 3.0 or above to be eligible for admission to candidacy and must have a grade of B or better in all required courses.

Admission Requirements: Ph.D. Program

Applicants to the Ph.D. program must submit a completed application form, a personal statement describing interest in the program and professional goals, and three letters of recommendation from persons familiar with the applicant's academic work. The Departmental admissions committee will base admission upon these materials and interviews with selected applicants.

Admission requires that the applicant have a bachelor's degree from a fully accredited four-year college or university, a minimal score of 900 calculated from the GPA multiplied by 200 and added to the GRE combined verbal and quantitative scores. Students admitted to the program must take a Departmental diagnostic examination that will be used by the admissions committee to design a curriculum to eliminate any identified weaknesses. After passing the recommended courses with a grade of B or better in each, the student will begin the Ph.D. curriculum.

Degree Requirements: Ph.D. Program

Degree candidates must complete the core of required graduate courses (24 hours) with a grade of B or better in each course, pass the comprehensive examination, and gain approval of their dissertation proposal prior to obtaining admission to candidacy for the doctoral degree. Students may have a "C" grade in no more than two courses (6 credit hours), neither of which can be a core course. No "D" or "F" grades are acceptable. A student who receives a grade of "C" in excess of six credits must repeat this course and achieve at least a "B".

After gaining admission to candidacy the student must complete an approved curriculum (24 hours minimum of electives set by the student's research advisory committee), enroll in Graduate Seminar (BIOL 7010, 7020), complete a dissertation (24 hours), and successfully defend the dissertation prior to gaining the Ph.D. degree (Please refer to Biological Sciences Graduate Student Handbook for specific dissertation requirements). A student entering with a Master's degree may have applicable hours transferred toward the Ph.D. program, as determined by the Advisory Committee. The total number hours required is 76.

Required Courses: 24 Hours
To be completed prior to Admission to Candidacy

BIOL 5100	Literature and Methods in Research	3
BIOL 5180	Cell Biology	3
BIOL 6100	Frontiers in Molecular Science	3
BIOL 7120	Molecular Biology	3
CHEM 5410, 5420	Advanced Biochemistry I, II	6
CHEM 5600	Spectroscopic Methods in Chemistry	3
STAT 5210	Statistical Methods I	3

After Admission to Candidacy: 52 Hours

Electives		24
BIOL 5010, 5020	Graduate Seminar I, II	1, 1
BIOL 7010, 7020	Seminar in Biology I, II	1, 1
BIOL 8110	Dissertation Research	24
Total Required Hours		76

Graduate Elective Courses

BIOL 5070, 5080	Methods of Teaching Science in the College/University Setting	6
BIOL 5130	Evolution	3
BIOL 5140, 5150	Special Problems I, II	3, 3
BIOL 5160	Environmental Genetics	3
BIOL 5170	Advanced Genetics	3
BIOL 5180	Cell Biology	3
BIOL 5190	Ecology	3
BIOL 5200	General Physiology	3
BIOL 5210	Embryology	3
BIOL 5220	Advanced Parasitology	3
BIOL 5230	Arthropods and Diseases	3
BIOL 5240	Systemic Physiology	3
BIOL 5300	Plant Physiology	3
BIOL 5400	Microbial Genetics	3
BIOL 5410	Molecular Genetics	3
BIOL 5460	Immunology	3
BIOL 5470	Special Topics in Immunology	3
BIOL 6040	Individual Studies	3
BIOL 6100	Frontiers in Molecular Science	3
BIOL 6110	Individual Research	3
BIOL 6150	Genomics	3
BIOL 6210	Introduction to Neuropharmacology	3
BIOL 6560	Techniques of Electron Microscopy	3
BIOL 7120	Molecular Biology	3
BIOL 7130	Molecular Genetics	3
BIOL 7170	Selected Topics in Molecular Genetics	3
BIOL 7180	Advanced Cell Biology	3
BIOL 7190	Advanced Molecular Biology	3
BIOL 7260	Neurobiology	3
BIOL 7270	Selected Topics in Neurobiology	3
BIOL 7410	Advanced Microbiology	3

Admission to Candidacy: Ph.D. Program

The student must apply for admission to candidacy after completing the 24-hour core of required courses (See Degree Requirements: Ph.D. program, above.) with an average of B (3.0) or better, passing the comprehensive examination, and gaining approval of the dissertation proposal. The student's advisory committee will recommend and approve a program of study which must be filed in the School of Graduate Studies upon admission to candidacy.

MINOR

The Department offers a graduate minor in Biology as a subject field for graduate students seeking advanced degrees in teaching (M.S., M.Ed., or Ed.D.). A minor consists of twelve semester hours of graduate courses approved by the advisor in the major program.

DESCRIPTION OF COURSES

BIOL 5010, 5020. GRADUATE SEMINAR I, II. (1, 1) Current problems in biology. Courses meet weekly during each semester of the regular school year. Both courses are required of all degree candidates in the Department.

BIOL 5070, 5080. METHODS OF TEACHING SCIENCE IN THE COLLEGE/UNIVERSITY SETTING. (3, 3) Teaching methods and techniques suitable for college and university level courses. Instruction in developing course outlines, lectures, and laboratory experiences, and in evaluating student progress is given. Assignment to a faculty mentor for development of teaching skills is a part of this two-semester course. Individual students work in a specific course (upper-division undergraduate or lower-division graduate) and observe classroom teaching and assist with laboratory preparations and operations. The student, under the direction of the faculty mentor, prepares and teaches at least one unit of subject matter. Prerequisite: Permission of major advisor **and faculty mentor.**

BIOL 5100. LITERATURE AND METHODS IN RESEARCH. (3) The methods of literature review, with primary emphasis on methods in biological research and research laboratory rotation. The student is expected to concentrate on literature in the student's proposed area of research and rotate through three research laboratories (4 weeks each) of the student's choice. Required of all degree candidates. Formerly BIOL 5170.

BIOL 5110. RESEARCH IN BIOLOGY. (2) Individual research under the supervision of the research advisor. The student must present a general statement of proposed research and obtain the approval of the guidance committee. Prerequisite: BIOL 5100. Required of all M.S. candidates. Formerly BIOL 5160.

BIOL 5120. THESIS WRITING. (4) The preparation of a thesis over individual research under the supervision of the guidance committee. The format of the thesis must conform to that adopted by the Department of Biological Sciences. Once students have registered for this course they must continue to enroll in it every semester until they complete the thesis and are examined over it. Prerequisite: BIOL 5110. Required of all students who write a thesis.

BIOL 5130. EVOLUTION. (3) Current evolutionary theory including systematics, with an examination of macroevolutionary patterns and microevolutionary processes. Students use computer simulation techniques to construct models illustrating the concepts discussed.

BIOL 5140, 5150. SPECIAL PROBLEMS I, II. (3, 3) Short-term specialized problems in the area of major emphasis of the research investigator. The student is expected to develop and master techniques that are necessary for addressing the assigned problem. Prerequisite: permission of instructor and thesis or graduate advisor. Three laboratory periods.

BIOL 5160. ENVIRONMENTAL GENETICS. (3) The diversity of organisms, populations, and communities. Specific intricacies of the living world are elucidated. Laboratory work includes the study of organisms treated with mutagens. Chromosomal aberrations as well as phenotypic changes are observed. Students who have had at least 12 hours of Biology, including BIOL 2120, 2121 (Principles of Genetics) and BIO 5470 (Special Topics in Immunology) or the equivalents, may elect this course. Prerequisite: permission of instructor. Two lectures and one laboratory period weekly. Formerly BIOL 5100.

BIOL 5170. ADVANCED GENETICS. (3) The nature of the gene, the principles governing genic mutation and change in chromosomal structure, and the results of the operation of these principles. Prerequisite: permission of the instructor. Two lectures and one laboratory period.

BIOL 5180. CELL BIOLOGY. (3) The structure and behavior of the cell and its components with special emphasis on mitosis and meiosis. Prerequisite: permission of instructor. Two lectures and one laboratory period. Required of all degree candidates. (Formerly BIO 518)

BIOL 5190. ECOLOGY. (3) Study of how ecological systems function and the reciprocal relationships between the structure and composition of a system and its pattern of function. Some time is devoted to an examination of that body of theory which deals with ecological models, both experimental and mathematical. Prerequisite: BIOL 4120, 4121 (Principles of Ecology) or permission of instructor. Two lectures and one laboratory period.

BIOL 5200. GENERAL PHYSIOLOGY. (3) The chemical and physical nature of protoplasm. Considered are its chemical constituents and their properties, its colloidal nature, and the bearing of this state on its physical properties and processes. Prerequisite: permission of instructor. Two lectures and one laboratory period.

BIOL 5210. EMBRYOLOGY. (3) The principles and mechanisms of developmental physiology. Prerequisite: BIOL 4210, 4211 (Embryology) or equivalent, or permission of instructor. Two lectures and one laboratory period.

BIOL 5220. ADVANCED PARASITOLOGY. (3) Life histories, taxonomy, morphology, and general importance of the parasitic protozoa and helminths to man and animals. Prerequisite: permission of the instructor. Two lectures and one laboratory period.

BIOL 5230. ARTHROPODS AND DISEASES. (3) Survey of the various orders, classes, genera, and species in the phylum arthropods that act as both ectoparasites and endoparasites in man, food animals, and domesticated animals. The course also explores the hyperparasiticity in which certain genera of arthropods are parasitic to other arthropods belonging to different genera and species. Prerequisite: permission of instructor. One lecture and two laboratory periods.

BIOL 5240. SYSTEMIC PHYSIOLOGY. (3) Functions of different organ systems with emphasis on the human nervous system, muscular system, cardiovascular system, respiratory system, digestive system, urinary system, and endocrine system. Prerequisite: permission of instructor. Two lectures and one two-hour laboratory period.

BIOL 5300. PLANT PHYSIOLOGY. (3) Current topics in plant growth, development, metabolism, nutrition, and water relations. Research papers in plant metabolism and development are written and reviewed. Prerequisite: 8 hours in botany. Two lectures and one laboratory period.

BIOL 5400. MICROBIAL GENETICS. (3) The heredity of viruses, bacteria, molds, yeast, and protozoa, with emphasis on protozoan genetics. Physiologic aspects primarily relating to genetics in these forms are also considered. Prerequisites: BIOL 2120, 2121 (Principles of Genetics) and permission of instructor. In addition, BIOL 5110 is recommended.

BIOL 5410. MOLECULAR GENETICS. (3) The application and utilization of microorganisms, plants and animal systems in biotechnology. Emphasis is placed on the methods and techniques used in these systems.

BIOL 5460. IMMUNOLOGY. (3) Topics concerning all aspects of antigen-antibody reactions. Emphasis is placed on laboratory problems and procedures associated with immunology. Prerequisites: BIO 3400, 3401 (Introduction to Microbial Physiology), 4400, 4401 (Pathogenic Microorganisms), and 4410, 4411 (Immunology and Serology), or permission of instructor. Two lectures and one laboratory period.

BIOL 5470. SPECIAL TOPICS IN IMMUNOLOGY. (3) The study of a variety of sub-disciplines, including host-parasite-environment relations. Recent topics in immunology are presented by students and staff members. Prerequisite: permission of instructor. Two lectures and one laboratory.

BIOL 6040. INDIVIDUAL STUDIES. (3-9) Doctoral individual study under the guidance of the graduate curriculum advisory committee which cannot be credited toward graduate degree programs of the Department of Biology. May be repeated as topics vary. Maximum hours nine (9) with three (3) registrations.

BIOL 6100. FRONTIERS IN MOLECULAR SCIENCE. (3) Survey of current research topics in cellular, developmental, and molecular biology. The use of molecular techniques to study cell structure and function is emphasized. Required of all Ph.D. candidates.

BIOL 6110. INDIVIDUAL RESEARCH. (3-6) Doctoral research of independent nature. May be repeated twice for credit up to six (6) hours. Prerequisite: Candidacy admission to the Ph.D. Program.

BIOL 6150. GENOMICS. (4) This course will provide students with an overview of genomes from viruses to vertebrates, as well as an introduction to genomics approach to fundamental problems in current biology. Specific areas that will be discussed include large scale sequencing projects, genomes structure and variation, comparative genomics, genome-wide analysis of genes and proteins. The course will familiarize student with current methods used in DNA microarrays and proteomic analysis. This course will be literature-lecture based, with lab exercises on microarray and protein 2 D gel separations and dample preparation for mass spectrometry. Prerequisite: permission of instructor.

BIOL 6210. INTRODUCTION TO NEUROPHARMACOLOGY. (3) Course derived from three areas of pharmacology: 1) general principles, 2) pharmacology of drugs affecting cell growth, and 3) central nervous system pharmacology.

BIOL 6560. TECHNIQUES OF ELECTRON MICROSCOPY. (3) Introduction to electron optics and types of electron microscopes. Techniques of tissue preparation, fixation, embedment, ultramicrotomy, staining, and EM photography are included. Prerequisite: Permission of instructor.

BIOL 7010, 7020. SEMINAR IN BIOLOGY I, II. (1, 1) Topics relevant to biology, biotechnology, and environmental science presented by faculty, visiting scholars and graduate students. Participating graduate students who have achieved candidacy status present one seminar per year. Both courses are required of all Ph.D. candidates in Biological Sciences. Candidates must register for 7010 and 7020 in their first two semesters of residency, unless they have not completed BIOL 5010 and 5020 or the equivalent, in which case they must register for these courses.
Each course may be repeated once for an additional hour of credit. BIOL 5010 and 5020 are prerequisites to 7010, and 7010 is a prerequisite to 7020.

BIOL 7120. MOLECULAR BIOLOGY. (3) A detailed introduction to prokaryotic and eukaryotic molecular biology. Most of the course focuses on the fundamentals of molecular genetics: the structure and function of the gene, genetic organization of chromosomes, the genetic code, the molecular mechanisms of transcription, RNA processing, translation, DNA replication and recombination, and the molecular mechanisms of transcription, RNA processing, translation, DNA replication and recombination, and the molecular mechanisms of regulation of gene expression and enzyme activity. The model systems studied include both prokaryotes (bacteria and bacterial viruses) and simple eukaryotes (yeast, slime molds, and animal viruses). Prerequisites: CHEM 5410, 5420. Required of all Ph.D. candidates.

BIOL 7130. MOLECULAR GENETICS. (3) An examination of the structure and function of gene systems in prokaryotes, eukaryotes and viruses. This course also explores the process of RNA editing and other regulatory circuits, including DNA repair, control of transcription, translation and post-translation events. Prerequisites: CHEM 5410, 5420.

BIOL 7170. SELECTED TOPICS IN MOLECULAR GENETICS. (3-6) Current research interest in the areas of molecular genetics. May be repeated for credit as topics vary for no more than six (6) hours. Prerequisites: Consent of Doctoral Advisory Committee.

BIOL 7180. ADVANCED CELL BIOLOGY. (3) Molecular biology of animal cells with emphasis on assembly of cellular organelles, function and organization of membrane systems receptors, energy mechanisms, and secretion. Properties and functions of microfilaments and microtubules, Golgi apparatus, mitochondria, ribosomes, and the nucleus are considered also. Prerequisites: BIO 5180,CHEM 5410, 5420, or permission of instructor.

BIOL 7190. ADVANCED MOLECULAR BIOLOGY. (3) A review of prokaryotic and eukaryotic molecular biology literature. Discussions involve defining the mechanisms and methods used to solve biological problems. Prerequisite: BIOL 7120.

BIOL 7260. NEUROBIOLOGY. (3) Principles and mechanisms of the nervous system in invertebrate and vertebrate organisms. Topics including neurotransmitters, effector control, integration, inhibition, and localized excitation are considered. A study of the ionic and electrical mechanisms involved in the generation and conduction of nerve impulses is also included. Prerequisite: permission of instructor.

BIOL 7270. SELECTED TOPICS IN NEUROBIOLOGY. (3-6) Current research interest in the field of neurobiology. May be repeated for credit as topics vary for no more than six (6) hours. Prerequisites: Consent of Doctoral Advisory Committee.

BIOL 7410. SELECTED TOPICS IN MICROBIOLOGY. (3-6) Current research interests in the various fields of microbiology. May be repeated for credit as topics vary for no more than six (6) hours. Prerequisite: Consent of Doctoral Advisory Committee.

BIOL 8110. DISSERTATION RESEARCH. (1-9) Individual research under the supervision of the advisor. The candidate must have an approved dissertation proposal. A minimum of three registrations is required with a maximum of nine hours per registration. Dissertation hours must total at least 24. Prerequisites: admission to candidacy and permission of advisor. Required of all Ph.D. candidates.

GRADUATE FACULTY

Mary Ann Asson-Batres, Associate Professor
B.S., 1970, University of Portland; M.A.T., 1971, University of Chicago; M.S., 1982, University of Oregon; Ph.D., 1990, Oregon Health Sciences University
Anthony Ejiofor, Associate Professor
B.S., 1976, Ph.D., 1983 University of Nigeria, Nsukka
Hugh Fentress, Assistant Professor
B.S., 1999, Tennessee State University; Ph.D. 2005, Vanderbilt University
Philip F. Ganter, Associate Professor
B.S., 1973, Glassboro State College; Ph.D., 1981, University of North Carolina, Chapel Hill
Defeng Hui, Assistant Professor
B.S., 1989, Yangzhou University, M.S., 1994, Yangzhou University, University of Oklahoma
Michael Ivy, Associate Professor
B.A., 1978, University of Southern Illinois; Ph.D., 1986, University of Illinois
Terrance L. Johnson, Professor and Department Head
B.S., 1974, M.S., 1976, East Texas State University; Ph.D., 1985, University of North Texas
E. Lewis Myles, Professor
B.S., 1974, M.S., 1976, Tennessee State University; Ph.D., 1985, University of Arizona
Quincy Quick, Assistant Professor
B.S., 1994, Ferrum College, Virginia; M.S.1996, Virginia State University; Ph.D. 2001, New Mexico State University
John T. Robinson, Assistant Professor
B.S., 1985, North Carolina Central University; Ph.D., 1993, University of North Carolina at Chapel Hill
Venkatashwarup Tiriveedhi, Assistant Professor
MBBS., 2002, Osmania Medical College, India; Ph.D. 2007, The University of Southern
Xiaofei Wang, Assistant Professor
B.S., 1983, Sichuan University; M.S., 1987, Sichuan University; Ph.D., 1999, The University of Hong Kong (Hong Kong)
Benny Washington, Jr., Associate Professor
B.S., 1975, M.S., 1979, Tennessee State University; Ph.D., 1985, Atlanta University

DEPARTMENT OF CHEMISTRY

Mohammad Karim, Ph.D., Head
201 Chemistry Building
615-963-5321
615-963-5326 (Fax)
mkarim@tnstate.edu

MAJOR: CHEMISTRY
DEGREE: MASTER OF SCIENCE (M.S.)
CONCENTRATIONS: CHEMISTRY AND BIOCHEMISTRY

The Department of Chemistry offers the Master of Science (M.S.) degree in Chemistry with concentrations in Chemistry and Biochemistry. The objectives of the program include: 1) advancing, interpreting, disseminating, and preserving knowledge of chemistry; 2) engaging in research and publication of new scientific knowledge; 3) educating graduate students to take their proper place in industry, education, and public life. The M.S. degree represents from one to two academic years of full-time study beyond an acceptable bachelor's degree. The candidate must complete a program of study approved by his or her major professor, the Department Head, and the Dean of the Graduate School.

Admission Requirements

Unconditional admission to the M.S. program requires the applicant to have a bachelor's degree from an accredited four-year college or university, an undergraduate cumulative grade point average of 2.5 or better on a 4.0 scale, and a composite score of at least 289 on the Graduate Record Examination. Applicants have the option of taking the subject test in order to bring the combined score to 289 or higher. Applicants with less than a 2.5 undergraduate GPA must submit test scores at the time of application; applicants with a GPA of 2.5 or above may submit test scores in the first semester of attendance, but it is preferable that they submit test scores at the time of original application.

Conditional admission may be gained with a lower grade point average than 2.5, but the GRE score must be correspondingly higher. If the undergraduate GPA is between 2.25 and 2.49, the GRE score must be 293; if the GPA is between 2.0 and 2.24, the GRE score must be 1,000.

The student must remove the conditional status by earning at least a B (3.0) average in the first nine hours of graduate courses; failure to achieve this average will result in withdrawal from the program.

In addition, the applicant must have an undergraduate major in Chemistry, or the equivalent. In some instances, conditional admission may be granted prior to completion of the undergraduate course requirements, but a student must complete these courses before taking any graduate courses.

Degree Requirements

The Department offers both thesis and non-thesis options in the Master of Science degree program. A minimum of 30 semester hours of approved courses are required for the M.S. degree under the thesis option, and a minimum of 35 semester hours are required under the non-thesis option. Students who choose the non-thesis option must pass a comprehensive examination (passing score 70% or above) taken no earlier than the term in which they complete their course work. Students interested in pursuing research careers in the academia, government or industries are highly encouraged to take the thesis option.

There is no foreign language reading requirement for the M.S. degree in Chemistry.

The M.S. (Thesis option) degree requires students to complete and defend a thesis based upon his or her research.

1. Major Field Core: Total credits: 11 (thesis option and non-thesis option)

Rubric/Number	**Course Title**	**Credit Hours**
CHEM 5210	Advanced Organic Chemistry I	3
CHEM 5510	Advanced Analytic Chemistry	3
CHEM 5600	Spectroscopic Methods	3
CHEM 6005	Seminar, Part I	1
CHEM 6006	Seminar, Part II	1
	TOTAL	**11**

2. Concentrations(s):

2.1 Chemistry concentration: Hours-13/6 (Thesis/Non-Thesis)

Rubric/Number	**Course Title**	**Credit Hours**
CHEM 5000	Advanced Inorganic Chemistry I	3
CHEM 5310	Advanced Physical Chemistry I	3
CHEM 5110*	Research	5
CHEM 5120*	Thesis	2
	TOTAL	**13**

2.2 Biochemistry concentration: Hours- 16/9 (Thesis/Non-Thesis)

Rubric/Number	Course Title	Credit Hours
CHEM 5410	Advanced Biochemistry I	3
CHEM 5420	Advanced Biochemistry II	3
CHEM 6406	Special Topics in Biochemistry	3
CHEM 5110*	Research	5
CHEM 5120	Thesis	2
TOTAL		**16**

*Not required for non-thesis option

3. Electives: (Include descriptions, directions, or restrictions that may apply.)

3.1 Chemistry concentration: 6 hrs. for thesis and 18 hrs. for non-thesis option.

Select from the list below

Rubric/Number	Course Title	Credit Hours
CHEM 5010	Advanced Biochemistry	3
CHEM 5220	Advanced Topics in Organic Chemistry II	3
CHEM 5320	Advanced Physical Chemistry II	3
CHEM 5410	Advanced Biochemistry I	3
CHEM 5420	Advanced Biochemistry II	3
CHEM 6200	Biochemistry of Cellular Signal Transduction	3
CHEM 6405	Special Topics in Analytical Chemistry	3
CHEM 6406	Special Topics in Biochemistry	3
CHEM 6407	Special Topics in Inorganic Chemistry	3
CHEM 6408	Special Topics in Organic Chemistry	3
CHEM 6409	Special Topics in Physical Chemistry	3
CHEM 6500	Cancer Biochemistry and Biology	3
CHEM 6800	Advanced Pharmacology	3

Or any 5000 or 6000-level courses in Biology, Mathematics, Physics or Engineering would satisfy the elective requirement.

3.2 Biochemistry concentration: 6 hrs. for thesis (one 3 hour course must be chosen in the field of Biochemistry) and 15 hrs. for non-thesis. Students following biochemistry non-thesis option are required to take a minimum of 15 hours of biochemistry courses. Choose the courses from the list above.

CHEM 5000	Advanced Inorganic Chemistry I	3
CHEM 5220	Advanced Organic Chemistry II	3
CHEM 5310	Advanced Physical Chemistry I	3

Program of Study

The degree candidate must file a program of study after completing at least nine semester hours of graduate study but no more than fifteen hours. The program of study lists the courses which will be used to satisfy degree requirements, as well as detailing how other requirements will be met. The student may later change the program of study with the written approval of the Department and the Graduate School.

Admission to Candidacy

The individual must file for admission to candidacy at the same time he or she submits the program of study. The candidate must have a grade point average of 3.0 or above to be eligible for admission to candidacy.

DESCRIPTION OF COURSES

CHEM 5000. ADVANCED INORGANIC CHEMISTRY I. (3) Topics include atomic and molecular structure, bonding theories, molecular symmetry; and group theory, chemistry of transition metals and organometallic complexes, and catalysis. Prerequisites: CHEM 3220 (Physical Chemistry II) and CHEM4200, 4201 (Inorganic Chemistry I). Required of all degree candidates. Offered only in fall.

CHEM 5010. ADVANCED INORGANIC CHEMISTRY II. (3) Spectroscopic characterization of inorganic and organometallic compounds, and reaction mechanisms of inorganic, organometallic, and bioinorganic compounds. Prerequisite: CHEM 4210 (Inorganic Chemistry II) or CHEM 5000. Offered only in spring.

CHEM 5110. RESEARCH. (1-9) A variable-credit course in methods of research and reporting in the field of chemistry. Only five hours is applicable toward degree requirements. Required of all degree candidates. Offered every semester.

CHEM 5120. THESIS WRITING. (2) Research and writing under the supervision of the thesis director. Once students have registered for this class, they must re-enroll in it every semester until they complete the thesis. Required of all degree candidates. Offered every semester.

CHEM 5210. ADVANCED ORGANIC CHEMISTRY I. (3) A critical study of the structural theory of organic chemistry and advanced discussion of reaction mechanism. Prerequisites: **CHEM 2020, 2021** (Organic Chemistry II [formerly **CHEM 212, 212L]**) and CHEM **3220, 3221** (Physical Chemistry II). Required of all degree candidates. Offered only in fall.

CHEM 5220. ADVANCED ORGANIC CHEMISTRY II. (3) Synthesis of natural products. Prerequisite: CHEM 5210, or permission of instructor. Offered only in spring.

CHEM 5310. ADVANCED PHYSICAL CHEMISTRY I. (3) A broad discussion of the laws of thermodynamics, quantum mechanics, spectroscopy, and classical transport processes, as well as an introduction to statistical mechanics. Prerequisites: CHEM 3220, 3221 (Physical Chemistry II). Required of all degree candidates. Offered only in spring.

CHEM 5320. ADVANCED PHYSICAL CHEMISTRY II. (3) A focus on quantum mechanics as it applies to chemistry, including molecular orbital theory and the relationship of quantum mechanics to molecular spectroscopy. Prerequisite: CHEM 5310, or permission of the instructor. Offered only in the fall.

CHEM 5360. CHEMICAL KINETICS. (3) Experimental and theoretical considerations of chemical reaction rates and mechanisms. Prerequisite: CHEM 5310. Offered on demand.

CHEM 5410. ADVANCED BIOCHEMISTRY I. (3) An in-depth study of the chemical and physical properties and biological functions of proteins, carbohydrates, lipids, and nucleic acids. Prerequisites: CHEM 3420, 3421 (General Biochemistry II), or permission of instructor. Offered only in fall.

CHEM 5420. ADVANCED BIOCHEMISTRY II. (3) An in-depth study of the catabolic pathways, including their chemical reactions, energetics, and regulation. Prerequisite: CHEM 5410, or permission of the instructor. Offered only in spring.

CHEM 5510. ADVANCED ANALYTICAL CHEMISTRY. (3) A critical study of recent developments in chemical and instrumental methods of analysis. Prerequisite: CHEM 3220, 3221 (Physical Chemistry II). Required of all degree candidates. Offered only in spring.

CHEM 5600. SPECTROSCOPIC METHODS IN CHEMISTRY. (3) Various spectroscopic methods in chemistry, concentrating on the practical aspect of using spectroscopic techniques to solve structural problems. Techniques include ultraviolet spectroscopy, infrared spectroscopy, nuclear magnetic resonance (NMR) spectroscopy, including "two dimensional" (2D) NMR in solving problems, mass spectrometry (MS). Prerequisites: CHEM 2020, 2021 (Organic Chemistry II) or equivalent. Offered in fall.

CHEM 6005, 6006. SEMINAR I, II. (1, 1) Review and discussion of important current literature in the various areas of chemistry. Both courses required of all degree candidates. CHEM 6005 offered in fall and 6006 in spring.

CHEM 6405, 6406, 6407, 6408, 6409. SPECIAL TOPICS IN ANALYTICAL CHEMISTRY, BIOCHEMISTRY, INORGANIC CHEMISTRY, ORGANIC CHEMISTRY, AND PHYSICAL CHEMISTRY. (3, 3, 3, 3, 3) Faculty-generated lecture courses on selected topics of current interest or student need. Offered on demand.

CHEM 6200. BIOCHEMISTRY OF CELLULAR SIGNAL TRANSDUCTION. (3) Study of the biochemical processes involved in cellular responses to signal molecules, such as hormones. Focus on the mechanisms by which cells transform extracellular signals into changes in cellular function. Pre-requisites: **CHEM 3410**, **CHEM 5410**, or permission of the instructor. Offered in the fall.

CHEM 6500. CANCER BIOCHEMISTRY AND BIOLOGY: (3) An in-depth study of the biochemical and biological basis of cancer. Topics include biochemistry/biology of: cellular oncogenes; growth factor receptors; tumor suppressors; angiogenesis; invasion and metastasis; and cancer treatment. Prerequisites: CHEM5410 or Permission of the instructor. Three hours of lecture per week. Offered only in Spring

CHEM 6800 ADVANCED PHARMACOLOGY. (3) An in-depth discussion of the principles of pharmacology and how it applies to the evaluation and development of drugs. Topics covered include pharmacokinetics, absorption, metabolism, distribution, transport mechanisms and clinical aspects. Prerequisite: CHEM 3410. Offered only in the Fall.

GRADUATE FACULTY

Mohammad Al-Masum, Associate Professor
B.S., 1984, M.S., 1986, Dhaka University (Bangladesh); Ph.D., 1996, Tohoku University (Japan).

Yousef Beni, Assistant Professor
B.S. 1995, M.S. 1997, Sharif University of Technology, Ph.D., 2002, Sharif University of Technology and Justus-Liebig University.

William Y. Boadi, Professor
B.S., 1982, University of Science and Technology (Ghana); M.S., 1988, D.Sc., 1991, Technion-IIT (Israel)

Theodore J. Duello, Assistant Professor
B.S., 1996, Quincy College; Ph.D., 1971, St. Louis University (Missouri).

Sujata Guha, Associate Professor
B.S., 1994, University of Dubuque; M.S., 1997, Purdue University; Ph.D., 2000, Purdue University (Indiana)

Mohammad R. Karim, Professor and Head
B.S., 1978, M.S., 1980, Jahangirnagar University (Bangladesh); Ph.D., 1989, Kent State University (Ohio).

Joshua Moore, Associate Professor
B.S., 1998, University of Pittsburgh at Johnstown; Ph.D., 2003, Vanderbilt University (Tennessee)

Cosmas O. Okoro, Professor
B.S., 1981, M.S., 1986, North Carolina Central University; Ph.D., 1993, Howard University (D.C.)

Nsoki Phambu, Associate Professor
B.S., 1989, Université Denis Diderot, Paris (France); M.S., 1992, Université Henri Poincaré, Nancy I (France); Ph.D., 1996, Université Henri Poincaré, Nancy I (France)

Tasneem Siddiquee, Assistant Professor
B.S., 1993; M.S., 1994, Jahangirnagar University; Ph.D., 2007, University of Wisconsin-Milwaukee (Wisconsin).

Koen P. Vercruysse, Associate Professor
B.S., 1990, University of Ghent; Ph.D., 1995, University of Ghent (Belgium)

Margaret M. Whalen, Professor
B.S., 1979, South Dakota School of Mines and Technology; Ph.D., 1984, University of New Mexico School of Medicine (New Mexico).

Mu Zheng, Assistant Professor
B.S., 1987, M.S. 1990, Zhongshan (Sun Yat-Sen) University (China), D.A. 1997, Middle Tennessee State University, Murfreesboro, TN