

Toxicology

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(Interdepartmental Graduate Major)

Toxicology is the science of studying the adverse effects of substances on living organisms. Students observe, gather data and predict risks and outcomes in populations. Whole organism research and cellular and molecular approaches are used to determine toxicant exposure and mechanisms. Work is offered for the degrees doctor of philosophy and master of science. Students majoring in toxicology will be affiliated with one of the following cooperating departments: Agricultural and Biosystems Engineering; Animal Science; Biochemistry, Biophysics and Molecular Biology; Biomedical Sciences; Chemistry; Entomology; Food Science and Human Nutrition; Genetics, Development and Cell Biology; Geological and Atmospheric Sciences; Natural Resource Ecology and Management; Physics; Plant Pathology and Microbiology; Veterinary Diagnostic and Production Animal Medicine; Veterinary Microbiology and Preventive Medicine; and Veterinary Pathology.

The prerequisites for entrance into the graduate toxicology major include an undergraduate degree in a relevant area of study; for example, chemical engineering, biology, biochemistry, chemistry, ecology, entomology, food science and technology, microbiology, nutritional science, zoology, or veterinary medicine. Minimum undergraduate coursework should include the following or their equivalent:

- 1 year of college mathematics, including calculus
- 1 year of inorganic chemistry with quantitative analysis
- 1 course in physics
- 1 year of organic chemistry
- 2 years of biological sciences including 1 course in physiology

Other courses that are considered desirable in undergraduate preparation include: biochemistry, physical chemistry, qualitative analysis, and some specialized courses such as histology or advanced physiology.

Facilities and faculty are available for fundamental research in such areas as agricultural toxicology, drug discovery and prevention, ecotoxicology, environmental fate and effects of chemicals, insect toxicology, aquatic toxicology, food safety, nutritional toxicology, mycotoxins, neurotoxicology, cellular and molecular toxicology, reproductive toxicology, and veterinary toxicology.

Ph.D. and M.S. Students should register for TOX 689X (R) every fall and spring semester during their training.

Students majoring in toxicology will be affiliated with a cooperating department. All Ph.D. students take a core curriculum consisting of:

TOX 501	Principles of Toxicology	3
TOX 502	Toxicology Methods	3
TOX 504	Toxicology Seminar (taken twice)	1
7 additional credits in approved toxicology courses		7
8 credits in biochemistry from courses listed below		8
BBMB 404	Biochemistry I	
BBMB 405	Biochemistry II	
BBMB 420	Physiological Chemistry	
BBMB 542	Introduction to Molecular Biology Techniques	
3 credits in physiology, histology, pathology, neuroscience, immunobiology or cellular and molecular biology		3
STAT 401	Statistical Methods for Research Workers	4
STAT 402	Statistical Design and the Analysis of Experiments	3
GR ST 565	Responsible Conduct of Research in Science and Engineering (or)	1
V PTH 554	Ethics in Scientific Research and Writing	1

M.S. students take a core of:

TOX 501	Principles of Toxicology	3
TOX 502	Toxicology Methods	3
TOX 504	Toxicology Seminar	1
3 additional credits in approved toxicology courses		3
BBMB 404	Biochemistry I	3
BBMB 405	Biochemistry II	3
STAT 401	Statistical Methods for Research Workers	4

Additional coursework is selected to meet departmental requirements and to satisfy individual student research interests

GR ST 565	Responsible Conduct of Research in Science and Engineering (or)	1
V PTH 554	Ethics in Scientific Research and Writing	1

A graduate minor in toxicology is available for students enrolled in other majors.

A minor for an M.S. degree includes one semester of TOX 689X and:

TOX 504	Toxicology Seminar	1
TOX 501	Principles of Toxicology	3
3 credits in other approved toxicology courses		3

A minor at the Ph.D. level includes one semester of TOX 689X and:

TOX 504	Toxicology Seminar	1
TOX 501	Principles of Toxicology	3
6 credits in other approved toxicology course work		6

One member of the student's program of study committee will be a member of the toxicology faculty.

Most students awarded doctoral degrees continue their training as postdoctoral associates at major research institutions in the U.S. or abroad in preparation for research and/or teaching positions in academia, industry, the military, veterinary research, or government environmental and public health institutions. A few go directly to permanent research positions in industry. Many students awarded master's degrees continue their training as doctoral students; however, some choose research support positions (i.e., technician, chemist, research associate) in academia, industry, or government. A more thorough list of outcomes is available at our Web site.

Graduates of the Toxicology major will be able to carefully design, execute and analyze experiments that extend the knowledge of toxicology and closely related sciences. They will be able to clearly communicate research findings, and thoroughly evaluate the literature of toxicology, contributing significantly to the advancement of the field.

Courses primarily for undergraduates:

TOX 354. General Pharmacology.

(Dual-listed with TOX 554). (Cross-listed with B M S). (3-0) Cr. 3. S. Prereq: B M S 549 and B M S 552; BBMB 404, BBMB 405

General principles; drug disposition; drugs acting on the nervous, cardiovascular, renal, gastrointestinal, and endocrine systems.

TOX 419. Foodborne Hazards.

(Cross-listed with MICRO, FS HN). (3-0) Cr. 3. Alt. S., offered 2012. Prereq: MICRO 201 or MICRO 302, a course in biochemistry

Pathogenesis of human microbiological foodborne infections and intoxications, principles of toxicology, major classes of toxicants in the food supply, governmental regulation of foodborne hazards. Nonmajor graduate credit. Only one of FS HN 419 and FS HN 519 may count toward graduation.

TOX 420. Food Microbiology.

(Cross-listed with MICRO, FS HN). (3-0) Cr. 3. F. Prereq: MICRO 201 or MICRO 302

Effects of microbial growth in foods. Methods to control, detect, and enumerate microorganisms in food and water. Foodborne infections and intoxications. Nonmajor graduate credit.

TOX 429. Foodborne Toxicants.

(Dual-listed with TOX 529). (Cross-listed with FS HN). (2-0) Cr. 2. F. Prereq: A course in biochemistry; enrollment in GP-IDEA Food Safety and Defense Graduate Certificate or permission of instructor.

Mechanisms of action, metabolism, sources, remediation/detoxification, risk assessment of major foodborne toxicants of current interest, design of HACCP plans for use in food industries targeting foodborne toxicants, discussion of toxicants from a food defense perspective. Offered online only.

Courses primarily for graduate students, open to qualified undergraduates:

TOX 501. Principles of Toxicology.

(3-0) Cr. 3. F. Prereq: BBMB 404 or equivalent

Principles of toxicology governing entry, fate, and effects of toxicants on living systems. Includes toxicokinetics and foreign compound metabolism relative to toxification or detoxification. Fundamentals of foreign compound effects on metabolism, physiology, and morphology of different cell types, tissues, and organ systems.

TOX 502. Toxicology Methods.(0-6) Cr. 3. Alt. S., offered 2012. *Prereq: TOX 501*

Provides demonstrations or laboratory experience in the application of methods used in toxicology, including safety procedures, calculation and data analysis, teratologic and morphologic evaluation, cellular/molecular toxicological techniques, electrophysiologic measures, in vitro enzyme induction/biotransformation, neural and behavioral toxicology testing.

TOX 504. Toxicology Seminar.(1-0) Cr. 1. Repeatable, maximum of 2 credits. F.S.SS. *Prereq: Permission of instructor required*

Presentation of a seminar about a current topic in toxicology as part of a weekly series of seminars by graduate students, faculty, and guest lecturers from off campus.

TOX 506. Diet and cancer prevention.(Dual-listed with TOX 406). (1-0) Cr. 1. Alt. F., offered 2012. *Prereq: BBMB 404 and BBMB 405 or BBMB 420*

Principles of cancer biology and cancer etiology will be integrated with the impacts of diet on cancer development and prevention. Contributions of research with humans, animals, cultured cells and cell free systems will be included. The importance of dietary contaminants, macronutrients and micronutrients will be examined with an emphasis on the strength of the evidence and mechanisms of action.

TOX 515. Regulatory Toxicology.(Cross-listed with FS HN). (1-0) Cr. 1. Alt. F., offered 2012. *Prereq: BBMB 404 or FSHN 403*

Survey of approaches used by toxicologists in government and industry for generating, enforcing and complying with laws and regulations. Examine policies from multiple regulatory agencies and how risk-based decisions are made. Perform simple risk assessments and suggest ways of dealing with data gaps. Explore new types of data used in risk assessments. Taught online only.

TOX 519. Food Toxicology.(Cross-listed with FS HN, NUTRS). (3-0) Cr. 3. Alt. F., offered 2012. *Prereq: A course in biochemistry*

Basic principles of toxicology. Toxicants in the food supply: modes of action, toxicant defense systems, toxicant and nutrient interactions, risk assessment. Only one of FS HN 419 and FS HN 519 may count toward graduation.

TOX 526. Veterinary Toxicology.(Dual-listed with TOX 426). (3-0) Cr. 3. S. *Prereq: Permission of instructor*

Study of toxicological diseases of animals emphasizing clinical recognition, circumstances of poisoning, differential diagnosis with clinical and laboratory data, therapeutic procedures, preventive management and public health implications. Supplemented with case-based materials.

TOX 529. Foodborne Toxicants.(Dual-listed with TOX 429). (Cross-listed with NUTRS). (2-0) Cr. 2. F. *Prereq: A course in biochemistry; enrollment in GP-IDEA Food Safety and Defense Graduate Certificate or permission of instructor.*

Mechanisms of action, metabolism, sources, remediation/detoxification, risk assessment of major foodborne toxicants of current interest, design of HACCP plans for use in food industries targeting foodborne toxicants, discussion of toxicants from a food defense perspective. Offered online only.

TOX 546. Clinical and Diagnostic Toxicology.(Cross-listed with VDPAM). (0-3) Cr. 1-3. Repeatable. F.S.SS. *Prereq: D.V.M. degree or VDPAM 526*

Advanced study of current problems and issues in toxicology. Emphasis on problem solving utilizing clinical, epidemiological, and laboratory resources.

TOX 550. Pesticides in the Environment.(Cross-listed with ENT). (2-0) Cr. 2. S. *Prereq: 9 credits of biological sciences* Coats. Fate and significance of pesticides in soil, water, plants, animals, and the atmosphere.**TOX 554. General Pharmacology.**(Dual-listed with TOX 354). (Cross-listed with B M S). (3-0) Cr. 3. S. *Prereq: B M S 549 and B M S 552; BBMB 404, BBMB 405*

General principles; drug disposition; drugs acting on the nervous, cardiovascular, renal, gastrointestinal, and endocrine systems.

TOX 565. Methods in Biostatistics and Epidemiology.(Cross-listed with STAT). (3-0) Cr. 3. Alt. F., offered 2013. *Prereq: STAT 500 or STAT 401; STAT 543 or STAT 447*

Statistical methods commonly used in epidemiology and human and animal health studies. Overview of cohort studies, case-control studies and randomized clinical trials. Topics include inference procedures for disease risk factors, analysis of time-to-event and survival data, analysis of longitudinal studies of disease progression and health status, approaches to handling missing data, and meta-analysis. Examples will come from recent studies of physical and mental health, nutrition and disease progression in human and animal populations. Use of statistical software: SAS or R.

TOX 570. Risk Assessment for Food, Agriculture and Veterinary Medicine.(Cross-listed with VDPAM, AGRON). (3-0) Cr. 3. F. *Prereq: STAT 104 or consent of instructor*

Wolt, Hurd. Risk assessment principles as applied to biological systems. Exposure and effects characterization in human and animal health and ecological risk assessment. Risk analysis frameworks and regulatory decision-making. Introduction to quantitative methods for risk assessment using epidemiological and distributional analysis. Uncertainty analysis. This course is available on campus and by distance.

TOX 575. Cell Biology.(Cross-listed with B M S). (3-0) Cr. 3. F. *Prereq: 10 credits in biological science and permission of instructor*

A multi-instructor course covering major topics in cell structure and function, including: universal features of prokaryotic and eukaryotic cells, types of utilization and conversion of energy, genetic control of cell shape and functionality, internal organization of cells, communication between cells and their environment, development of multicellular systems. Students have to write a term paper.

TOX 590. Special Topics.

Cr. arr. Repeatable.

Contact individual faculty for special projects or topics. Graded.

Courses for graduate students:**TOX 626. Advanced Food Microbiology.**(Cross-listed with MICRO, FS HN). (3-0) Cr. 3. Alt. S., offered 2013. *Prereq: FS HN 420 or FS HN 421 or FS HN 504*

Topics of current interest in food microbiology, including new foodborne pathogens, rapid identification methods, effect of food properties and new preservation techniques on microbial growth, and mode of action of antimicrobials.

TOX 627. Rapid Methods in Food Microbiology.(Cross-listed with MICRO, FS HN). (2-0) Cr. 2. Alt. S., offered 2012. *Prereq: FS HN 420 or FS HN 421 or FS HN 504*

Provides an overview of rapid microbial detection methods for use in foods. Topics include historical aspects of rapid microbial detection, basic categories of rapid tests (phenotypic, genotypic, whole cell, etc.), existing commercial test formats and kits, automation in testing, sample preparation and "next generation" testing formats now in development.

TOX 656. Cellular and Molecular Pathology II.(Cross-listed with V PTH). (3-0) Cr. 3. Alt. S., offered 2014. *Prereq: Graduate course in biochemistry, genetics, or cell biology*

Cellular and molecular mechanisms of carcinogenesis.

TOX 675. Insecticide Toxicology.(Cross-listed with ENT). (2-3) Cr. 3. Alt. F., offered 2013. *Prereq: ENT 555 or TOX 501*

Coats. Principles of insecticide toxicology; classification, mode of action, metabolism, and environmental effects of insecticides.

TOX 697. Graduate Research Rotation.(0-12) Cr. 1-12. Repeatable, maximum of 3 times. F.S.SS. *Prereq: Admission to Toxicology graduate program*

Graduate research projects performed under the supervision of selected faculty members in the graduate Toxicology major.

TOX 699. Research.

Cr. arr. Repeatable.