

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 6890 (R) every fall and spring semester during their training.

Curriculum

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

TOX 5010	Principles of Toxicology	3
TOX 5020	Toxicology Methods	3
TOX 5040	Toxicology Seminar (taken twice)	1
7 additional credits in approved toxicology courses		7
BBMB 4050	Biochemistry II (2 additional credits of biochemistry courses)	
BBMB 4040	Biochemistry I	
2 additional credits of upper level BBMB coursework. 3 credits in physiology, histology, pathology, neuroscience, immunobiology or cellular and molecular biology.		2 and 3
STAT 5710	Introduction to Experimental Design	3
STAT 5870	Statistical Methods for Research Workers	4
GRST 5650	Responsible Conduct of Research in Science and Engineering (or)	1
VPTH 5540	Ethics in Scientific Research and Writing	1

M.S. students take a core of:

TOX 5010	Principles of Toxicology	3
TOX 5020	Toxicology Methods	3
TOX 5040	Toxicology Seminar	1
3 additional credits in approved toxicology courses		3
BBMB 4040	Biochemistry I	3
BBMB 4050	Biochemistry II	3
STAT 5870	Statistical Methods for Research Workers	4
Additional coursework is selected to meet departmental requirements and to satisfy individual student research interests		
GRST 5650	Responsible Conduct of Research in Science and Engineering (or)	1
VPTH 5540	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 6890 and:

TOX 5040	Toxicology Seminar	1
TOX 5010	Principles of Toxicology	3
3 credits in other approved toxicology courses		3

A minor at the Ph.D. level includes one semester of TOX 6890 and:

TOX 5040	Toxicology Seminar	1
TOX 5010	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 4010: Principles of Toxicology

(Dual-listed with TOX 5010).

Credits: 3. Contact Hours: Lecture 3.

Prereq: BBMB 4040

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. (Typically Offered: Fall)

TOX 4190: Foodborne Hazards

(Cross-listed with MICRO 4190/ FSHN 4190).

Credits: 3. Contact Hours: Lecture 3.

Prereq: MICRO 2010 or MICRO 3020; 3 credits in BBMB

Pathogenesis of human microbiological foodborne infections and intoxications, principles of toxicology, major classes of toxicants in the food supply, governmental regulation of foodborne hazards. Assessed service-learning component. Offered even-numbered years. Graduation Restriction: Only one of FSHN 4190 and FSHN 5190 may count toward graduation. (Typically Offered: Spring)

TOX 4200: Food Microbiology

(Cross-listed with MICRO 4200/ FSHN 4200).

Credits: 3. Contact Hours: Lecture 3.

Prereq: MICRO 2010 or MICRO 3020

Effects of microbial growth in foods. Methods to control, detect, and enumerate microorganisms in food and water. Foodborne infections and intoxications. (Typically Offered: Fall)

TOX 4260: Veterinary Toxicology

(Dual-listed with VDPAM 5260/ TOX 5260). (Cross-listed with VDPAM 4260).

Credits: 3. Contact Hours: Lecture 3.

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. (Typically Offered: Spring)

TOX 4500: Pesticides in the Environment

(Dual-listed with ENT 5500/ TOX 5500). (Cross-listed with ENT 4500).

Credits: 3. Contact Hours: Lecture 3.

Prereq: 6 credits of BIOL or Permission of Instructor

Fate and significance of pesticides in soil, water, plants, animals, and the atmosphere. (Typically Offered: Spring)

TOX 4900: Independent Study

Credits: 1-2. Repeatable.

Prereq: Instructor Permission for Course

Independent study with a faculty mentor. Intended for students enrolled in the Pharmacology and Toxicology minor. Graduation Restriction: Students in the Pharmacology and Toxicology minor may use no more than 9 credits of university-wide 4900 credits towards the total of 120 credits required for graduation. (Typically Offered: Fall, Spring, Summer)

TOX 4990: Undergraduate Research

Credits: 1-3. Repeatable, maximum of 3 credits.

Prereq: Instructor Permission for Course

Independent research under faculty guidance. Intended for students enrolled in the Pharmacology and Toxicology minor. Graduation Restriction: Students may use no more than 9 credits of university-wide 4990 credits towards the total of 120 credits required for graduation. Offered on a satisfactory-fail basis only. (Typically Offered: Fall, Spring, Summer)

Courses primarily for graduate students, open to qualified undergraduates:

TOX 5010: Principles of Toxicology

(Dual-listed with TOX 4010).

Credits: 3. Contact Hours: Lecture 3.

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. (Typically Offered: Fall)

TOX 5020: Toxicology Methods

Credits: 3.

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. Offered even-numbered years. (Typically Offered: Spring)

TOX 5040: Toxicology Seminar

Credits: 1. Contact Hours: Lecture 1.

Repeatable, maximum of 2 credits.

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. Graduate student speakers will meet with the instructor at least one week prior to their formal presentation. (Typically Offered: Fall, Spring, Summer)

TOX 5150: Regulatory Toxicology

Credits: 2. Contact Hours: Lecture 2.

A survey course on risk analysis approaches used by toxicologists and other life and social scientists in government, industry and non-governmental organizations to inform regulatory policies and decisions under U.S. Federal statutes, including the Federal Food Drug and Cosmetic Act; the Food Quality Protection Act; the Federal Fungicide, Insecticide and Rodenticide Act; the Endangered Species Act; the Plant Protection Act; the National Environmental Policy Act; and the Toxic Substances Control Act. Topics covered include an overview of the roles and responsibilities of different U.S. Government Departments and Agencies in analyzing human; livestock and companion animal; and/or environmental risks and benefits of food products and food additives, cosmetics, drugs, pesticides, and consumer and industrial products. Offered odd-numbered years. (Typically Offered: Fall)

TOX 5260: Veterinary Toxicology

(Dual-listed with VDPAM 4260/ TOX 4260). (Cross-listed with VDPAM 5260).

Credits: 3. Contact Hours: Lecture 3.

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. (Typically Offered: Spring)

TOX 5290: Foodborne Toxicants

(Cross-listed with FSHN 5290).

Credits: 2. Contact Hours: Lecture 2.

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. (Typically Offered: Fall, Spring, Summer)

TOX 5440: Aquatic Toxicology

Credits: 2. Contact Hours: Lecture 1, Discussion 1.

An overview of interactions between anthropogenic chemicals and aquatic ecosystems. Topics include history of aquatic toxicology, methods of toxicity testing, and species responses to toxicants. Emphasis is on aquatic pollutants of emerging concern (e.g., nanoparticles, microplastics). Offered odd-numbered years. (Typically Offered: Spring)

TOX 5460: Clinical and Diagnostic Toxicology

(Cross-listed with VDPAM 5460).

Credits: 1-3. Contact Hours: Laboratory 3.

Repeatable.

Advanced study of current problems and issues in veterinary toxicology. Emphasis on problem solving and interpreting clinical cases while utilizing clinical, epidemiological, and laboratory resources. Course consists highly of clinical case based material. (Typically Offered: Fall, Spring, Summer)

TOX 5500: Pesticides in the Environment

(Dual-listed with ENT 4500/ TOX 4500). (Cross-listed with ENT 5500).

Credits: 3. Contact Hours: Lecture 3.

Prereq: 9 credits in BIOL or Graduate Classification

Fate and significance of pesticides in soil, water, plants, animals, and the atmosphere. (Typically Offered: Spring)

TOX 5540: General Pharmacology

(Cross-listed with BMS 5540).

Credits: 3. Contact Hours: Lecture 3.

General principles; drug disposition; drugs acting on the nervous, cardiovascular, renal, gastrointestinal, and endocrine systems. (Typically Offered: Spring)

TOX 5650: Methods in Biostatistics and Epidemiology

(Cross-listed with STAT 5650).

Credits: 3. Contact Hours: Lecture 3.

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, diagnostic test evaluation, 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. Offered even-numbered years. (Typically Offered: Fall)

TOX 5690: Reproductive and Developmental Toxicology

(Cross-listed with ANS 5690).

Credits: 2. Contact Hours: Lecture 2.

Chemical agents that target developmental and reproductive systems in animals and humans, both male and female. The influence that timeline of developmental in utero and what part of reproductive organ have on outcome of environmental exposures will be developed. The physiological changes due to exposure, and mechanistic pathways activated by xenobiotics will be defined and the consequences of these changes will be explored. Offered even-numbered years. (Typically Offered: Fall)

TOX 5700: Risk Assessment for Food, Agriculture and Veterinary Medicine

(Cross-listed with AGRON 5700/ VDPAM 5700).

Credits: 3. Contact Hours: Lecture 3.

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. Offered odd-numbered years. (Typically Offered: Fall)

TOX 5750: Cell Biology

(Cross-listed with BMS 5750).

Credits: 3. Contact Hours: Lecture 3.

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. (Typically Offered: Fall)

TOX 5900: Special Topics

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

Contact individual faculty for special projects or topics. Graded.

Courses for graduate students:**TOX 6260: Advanced Food Microbiology**

(Cross-listed with MICRO 6260/ FSHN 6260).

Credits: 3. Contact Hours: Lecture 3.

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. Offered odd-numbered years. (Typically Offered: Spring)

TOX 6270: Rapid Methods in Food Microbiology

(Cross-listed with MICRO 6270/ FSHN 6270).

Credits: 2. Contact Hours: Lecture 2.

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. (Typically Offered: Fall, Spring, Summer)

TOX 6560: Cellular and Molecular Pathology II

(Cross-listed with VPTH 6560).

Credits: 3. Contact Hours: Lecture 3.

Cellular and molecular mechanisms of carcinogenesis. Offered even-numbered years. (Typically Offered: Spring)

TOX 6750: Insecticide Toxicology

(Cross-listed with ENT 6750).

Credits: 3. Contact Hours: Lecture 2, Laboratory 3.

Prereq: ENT 5550 or TOX 5010 or Graduate Classification

Principles of insecticide toxicology; classification, mode of action, metabolism, and environmental effects of insecticides. Offered even-numbered years. (Typically Offered: Fall)

TOX 6890: Current Topics in Toxicology

Credits: Required. Contact Hours: Lecture 1.

Repeatable.

Lecture and discussion participation on current topics in toxicology.

An 80% attendance is expected to satisfactorily complete the course.

Offered on a satisfactory-fail basis only. (Typically Offered: Fall, Spring)

TOX 6970: Graduate Research Rotation

Credits: 1-12. Contact Hours: Laboratory 12.

Repeatable, maximum of 12 credits.

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

Fall, Spring, Summer)

TOX 6990: Research

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

Research. (Typically Offered: Fall, Spring, Summer)

Courses primarily for professional curriculum students:**TOX 7354: General Pharmacology**

(Cross-listed with BMS 7354).

Credits: 3. Contact Hours: Lecture 3.

General principles; drug disposition; drugs acting on the nervous, cardiovascular, renal, gastrointestinal, and endocrine systems. (Typically Offered: Spring)