191A. Workshop on Food System Sustainability (3) Lecture—2 hours; laboratory—3 hours. Prerequisite: upper-division standing; Plant Sciences 121, Agricultural and Resource Economics 121, Plant Sciences 150 or consent of the instructor. Priority enrollment for seniors in the sustainable agriculture and food systems major, limited to 25 students per section. First in a two-quarter senior capstone course sequence. Identify projects addressing specific problems and opportunities of sustainable agriculture and food systems, form multidisciplinary teams, and identify and consult with key stakeholders to understand their needs and concerns. GE credit: SciEng | SE = Writing Experience (F.) Tomich

191B. Workshop on Food System Sustainability (3) Lecture—2 hours; laboratory—3 hours. Prerequisite: course 191A. Enrollment for seniors in the sustainable agriculture and food systems major, limited to 25 students per section. Continuation of course 191A. Student teams conduct analyses of a specific issue in sustainable agriculture or food systems, prepare a critical assessment of technological, economic, environmental, and social dimensions of options for action and present their results to stakeholders. GE credit: SciEng | SE = W. (F.) Tomich

192. Internship (1-12) Internship—3-36 hours. Prerequisite: completion of 84 units and consent of instructor. Work experience off and on campus in all subject areas offered in the College of Agricultural and Environmental Sciences. Internship supervised by a member of the faculty. (P/NP grading only.)—F, W, S, F, W, S

197T. Tutoring in Environmental Science and Policy (1-5) Tutorial—2-6 hours. Prerequisite: upper division standing and consent of instructor. Experience in teaching under guidance of faculty member. (P/NP grading only.)—F, W, S, F, W, S

198. Directed Group Study (1-5) (P/NP grading only.)—F, W, S, F, W, S

199. Special Study for Advanced Undergraduates (1-5) Prerequisite: consent of instructor. (P/NP grading only.)—F, W, S, F, W, S

Graduate

212A. Environmental Policy Process (4) Lecture—3 hours; discussion—1 hour. Prerequisite: course in public policy (e.g., Environmental Science and Policy 160); environmental law (e.g., Environmental Science and Policy 161); course in bureaucratic theory (e.g., Political Science 187 or Environmental Science and Policy 166); course in statistics (e.g., Sociology 106 or Agricultural and Resource Economics 106). Introduction to selected topics in the policy process, applications to the field of environmental policy. Develops critical reading skills, understanding of framewrok concepts and political behavior, and an ability to apply multiple frameworks to the same phenomena. Offered in alternate years. (Same course as Ecology 212A.)—S. Anderson

212B. Environmental Policy Evaluation (4) Lecture—1 hour; discussion—1 hour; seminar—2 hours. Prerequisite: intermediate microeconomics (e.g., Economics 100); Statistics 108 or Agricultural and Resource Economics 106; policy analysis (e.g., Environmental Science and Policy 168A or the equivalent); Agricultural and Resource Economics 176. Methods and practices of policy analysis; philosophical and intellectual bases of policy analysis and the political role of policy analysis. (Same course as Ecology 212B.) Offered in alternate years. (S.) Springborn

220. Tropical Ecology (3) Lecture—2 hours; discussion—1 hour. Prerequisite: advanced introductory ecology course—course 100, Evolution and Ecology 101, 117; Evolution and Ecology 138 recommended. Open to graduate and undergraduate students who meet requirements subject to consent of instructor. An overview of present status of knowledge on structure and processes of major tropical ecosystems and similarities among tropical and temperate systems stressed. Offered in alternate years. (S.) Rejmanova

228. Advanced Simulation Modeling (3) Lecture—2 hours; discussion—1 hour. Prerequisite: courses 128-128L; Statistics 108 or Agricultural and Resource Economics 106. Advanced techniques in simulation modeling; optimization and simulation, dynamic parameter estimation, linear models, error propagation, and sensitivity testing. Latter half of course will introduce model evaluation in ecological and social system models. 252. Sustainable Transportation Technology and Policy (3) Lecture—2 hours; discussion—1 hour. Prerequisite: course 160 or the equivalent. Role of technical fixes and demand management in creating a sustainable transportation system. Options on transportation modes, including alternative fuels, electric propulsion, and IVHS. Analysis of market demand and travel behavior, environmental impacts, economics, and policies. (Same course as Civil and Environmental Engineering 252.)—S. Sperling

275. Economic Analysis of Resource and Environmental Policies (4) Lecture/discussion—4 hours. Prerequisite: Agricultural and Resource Economics 204/Economics 204. Development of externality theory, market failure concepts, welfare economics, theory of renewable and non-renewable resource use, and political economic models. Applications to policy issues regarding the agricultural/environment interface and managing resources in the public domain. (Same course as Agricultural and Resource Economics 275.)—S. Sperling

278. Research Methods in Environmental Policy (3) Lecture/discussion—3 hours. Prerequisite: Agricultural and Resource Economics 106 or the equivalent. Introduction to scientific research in environmental policy. Major issues in the philosophy of the social sciences. How to design research that acknowledges theoretical assumptions and that is likely to produce evidence in an intersubjectively reliable fashion with explicit recognition of its uncertainties.

298. Directed Group Study (1-5) 299. Research (1-12) Prerequisite: graduate standing. (S/U grading only.)

Environmental Sciences

Environmental Toxicology

(Physiological and intellectual bases of policy analysis

Environmental Science and Policy 168A or the equivalent. Role of technical fixes and demand management in creating a sustainable transportation system. Options on transportation modes, including alternative fuels, electric propulsion, and IVHS. Analysis of market demand and travel behavior, environmental impacts, economics, and policies. (Same course as Civil and Environmental Engineering 252.)—S. Sperling

275. Economic Analysis of Resource and Environmental Policies (4) Lecture/discussion—4 hours. Prerequisite: Agricultural and Resource Economics 204/Economics 204. Development of externality theory, market failure concepts, welfare economics, theory of renewable and non-renewable resource use, and political economic models. Applications to policy issues regarding the agricultural/environment interface and managing resources in the public domain. (Same course as Agricultural and Resource Economics 275.)—S. Sperling

278. Research Methods in Environmental Policy (3) Lecture/discussion—3 hours. Prerequisite: Agricultural and Resource Economics 106 or the equivalent. Introduction to scientific research in environmental policy. Major issues in the philosophy of the social sciences. How to design research that acknowledges theoretical assumptions and that is likely to produce evidence in an intersubjectively reliable fashion with explicit recognition of its uncertainties.

298. Directed Group Study (1-5) 299. Research (1-12) Prerequisite: graduate standing. (S/U grading only.)

Environmental Sciences

See Atmospheric Science, on page 184; Environmental and Resource Sciences, on page 184; Environmental Horticulture and Urban Forestry, on page 324; Environmental Policy Analysis and Planning, on page 324; Environmental Toxicology, on page 330; Hydrology, on page 376; Landscape Architecture, on page 392; and Wildlife, Fish, and Conservation Biology, on page 587.
Environmental Toxicology

Minor Program Requirements:

<table>
<thead>
<tr>
<th>COURSES</th>
<th>UNITS</th>
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<tbody>
<tr>
<td>Environmental Toxicology</td>
<td>18-26</td>
</tr>
<tr>
<td>Environmental Toxicology 101, 102A, 103A</td>
<td>12</td>
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<tr>
<td>Completion of upper division</td>
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<tr>
<td>Environmental Toxicology elective courses</td>
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<tr>
<td>six units minimum, selected from the following list: Environmental Toxicology 104, 120, 127, 128, 136, 138, 139, and 146</td>
<td>6-14</td>
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<tr>
<td>Minor Adviser</td>
<td>Qi Zhang</td>
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<tr>
<td>Graduate Study</td>
<td>Programs of study leading to M.S. and Ph.D. degrees are available through related Graduate Groups such as Pharmacology and Toxicology, Biochemistry, Molecular, Cellular, and Developmental Biology, Agricultural and Environmental Chemistry; and the Forensic Science Master’s Degree Program. For information on graduate study, contact your Advising Office or the appropriate graduate adviser.</td>
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Courses in Environmental Toxicology (ETX)

Lower Division

10. Introduction to Environmental Toxicology (3)

Lecture—3 hours. Basic principles of forensic science, types of information on which investigations focus, how information is obtained and used in criminal investigations, types of scientific skills required to practice forensic science, guidance on training. Real cases discussed; demonstrations of methods provided. GE credit: SciEng, WrtI, SL, Vl, W. (Wood)

30. Chemical and Drug Use and Abuse (3)

Lecture—3 hours. An overview of chemical use and abuse in our society. The effects of chemicals (therapeutic drugs, pesticides, food additives, herbal remedies, environmental contaminants, and recreational drugs) on humans and other living systems. GE credit: SciEng, SE, SL, W. (Wood)

92. Internship (1-12)

Internship—3-36 hours. Prerequisite: lower division standing and consent of instructor. Work experience off and on campus in all subject areas offered in the College of Agricultural and Environmental Sciences. Internships supervised by faculty of the college. (P/NP grading only.) GE credit: SE.

99. Special Study for Undergraduates (1-5)

Prerequisite: consent of instructor. (P/NP grading only.) GE credit: SE.

Upper Division

101. Principles of Environmental Toxicology (4)

Lecture—3 hours; discussion—1 hour. Prerequisite: Chemistry 8B, 118B, or 128B and Biological Sciences 1A. Principles of toxicology with a focus on environmental, industrial, and natural chemicals. Topics include fate and effects of chemicals in organisms and the environment, air pollutants, insecticides, aquatic toxicology, endocrine disruptors, biomarkers and bioassays, and risk assessment. GE credit. SciEng, SE, SL, Vl, W. (Wood)

102A. Environmental Fate of Toxicants (4)

Lecture—3 hours; discussion—1 hour. Prerequisite: Chemistry 8B, 118B, or 128B; or consent of instructor. Properties of toxic chemicals influencing their distribution and transformation; action of environmental forces affecting chemical behavior, movement, and accumulation; sources and occurrence of major classes of environmental toxicants. Not open for credit to students who have completed course 112A. GE credit. SciEng, QL, SE, SL, Vl, WE. — W. (Wood)

102B. Quantitative Analysis of Environmental Toxicants (5)

Lecture—3 hours; laboratory—3 hours; discussion—1 hour. Prerequisite: course 102A. Sample preparation and instrumental methods for toxicological analytes. Concept and techniques of advanced analytical instrumentation. Interpretation and use of analytical data. Not open for credit to students who have completed courses 112A and 114A. GE credit. SciEng, SE, SL, Vl, W. (Wood)

103A. Biological Effects of Toxicants (4)

Lecture—3 hours; discussion—1 hour. Prerequisite: Biological Sciences 102; course 101 and Neurobiology, Physiology, and Behavior recommended. Biological effects of toxic substances in living organisms. Metabolism, cellular and tissue targets, mechanisms of action, and pathological effects. Not open for credit to students who have completed course 114B. GE credit. SciEng, SE, SL, Vl, W. (Wood)

104. Environmental and Nutritional Factors in Cellular Regulation and Nutritional Toxicants (4)

Lecture—3 hours; discussion—1 hour. Prerequisite: Biological Sciences 10 or the equivalent or consent of instructor; Chemistry 118B recommended. Examination of toxic tragedies, their origins, consequences, and effects on toxic regulation. GE credit. SciEng, WrtI, SE, SL, Vl, WE. — W. (Wood)

111. Introduction to Mass Spectrometry (3)

Lecture—3 hours. Prerequisite: Chemistry 118C. Introduction to mass spectrometry, including ionization techniques, mass analyzers, interpretation of mass spectra, and applications of mass spectrometry. Emphasis on fundamental concepts of mass spectrometry necessary to identify and quantify organic molecules. GE credit: SciEng, SE.

120. Perspectives in Aquatic Toxicology (4)

Lecture—3 hours; discussion—1 hour. Prerequisite: Chemistry 88B, 118B, or 128B, Biological Sciences 1A, or consent of instructor. Toxic substances, their fate in marine and freshwater systems, and their effects on aquatic organisms and ecosystems. Emphasis on substances and issues of current concern. Offered in alternate years. GE credit. SciEng, QL, SE, SL, Vl, WE. — W. (Cherr, Tjeerdema, Wood)

127. Environmental Stress and Development in Marine Organisms (10)

Lecture—4 hours; laboratory—12 hours; discussion—2 hours. Prerequisite: course 101 or Biological Sciences 102 or 104; course 114A or Nutrition 114 recommended. Course taught at Bodega Marine Laboratory. Effects of environmental and nutritional stress, including pollutants, on development and function in remotely derived lines of marine organisms. Emphasis on advanced experimental methods. (Same course as Nutrition 127.) GE credit. SciEng, QL, QL, SE, SL, Vl, WE. — S. Chern
128. Food Toxicology (3) Lecture—3 hours. Prerequisite: Biological Sciences 102 and 103. Chemistry and biochemistry of toxins occurring in foods, including plant and animal tox- ins, intentional and unintentional food additives. The assessment of food safety and toxic hazards. (Same course as Food Science and Technology 128.) GE credit: SciEng | OL, SE, SI, VL, W, WC—F, W, S.


131. Environmental Toxicology of Air Pollutants (3) Lecture—3 hours. Prerequisite: Chemistry 88 (may be taken concurrently) or the equivalent; Biological Sciences 102 recommended. Field trip required. Toxicology of air pollutants in the ambient, indoor, and occupational environments. Health effects, sources, environmental fate, pulmonary responses, sampling, analytical techniques, and health criteria and standards. GE credit: SciEng | SE, VL—F, F, F—F, F, F—Kado


136. Legal Aspects of Environmental Toxicology (3) Lecture—3 hours. Prerequisite: course 10 or 101 recommended. Federal and California legislation concerning air and water pollution, pesticide use, food and feed additives, consumer protection, and occupational exposure to toxic substances; roles of federal regulatory agencies; alternatives to govern- ment control. GE credit: SciEng | SE, VL, WE—W—W—Rives

140. Genes and the Environment (3) Lecture/discussion—3 hours. Prerequisite: Biological Science 101 required or permission of instructor; coursework in genetics and molecular biology and/or environmental biology recommended. Evidence of human understanding is greater and disease sus- ceptibility result from complex interactions between genes and the environment. Emphasis on cancer, metabolic, cardiovascular, and neurological health outcomes assessed by genotoxicity and toxico- genomic methods. Offered in alternate years. —F—La Morill

146. Exposure and Dose Assessment (3) Lecture—3 hours. Prerequisite: course 112A; course 135 recommended. The exposure component of risk assessment; specifically, the presence and/or forma- tion of toxic substances in environmental media, their movement within and between contaminated media, and the contacts of human populations with those media. Offered in alternate years. GE credit: SciEng | QL, SE, SI, VL—S—S—Bennett

190. Environmental Toxicology Career Seminar (1) Seminar—1 hour. Careers in environmental toxicology; discussion with graduates from the Department of Environmental Toxicology and other experts in the field. (P/NP grading only.) GE credit: SE—F, F—F.

192. Internship (1-12) Internship—3-36 hours. Prerequisite: completion of 84 units and consent of instructor. Work experience off and on campus in all subject areas offered in the College of Agricultural and Environmental Sciences. Internships supervised by a member of the faculty. (P/NP grading only; deferred grading pending completion of sequence.) GE credit: SciEng | SE—F, W, S—F, W, S.

194HA. Honors Research (3) Discussion—1 hour; laboratory—6 hours. Prereq- site: senior standing; minimum GPA of 3.250; con- sent of instructor. Specific research project conducted under the supervision of a faculty spon- sor. Experience to include experimental design, learning new techniques, data analysis and interpre- tation of findings. (P/NP grading only; deferred grading pending completion of sequence.) GE credit: SciEng | SE—F, W, S (F, W, S—J. L. Howes)

214. Mechanisms of Toxic Action (3) Lecture—3 hours. Prerequisite: one course each in Chemistry 128C (or the equivalent), or Chemistry 88 and consent of instructor. Toxic chemicals: selected topics illustrating their occurrence, structure, and the reactions underlying detection, toxicity, fate, and ecological importance. Offered in alternate years. —S—Beck, Seiber

214. Mechanisms of Toxic Action (3) Lecture—3 hours. Prerequisite: one course each in Organic Chemistry, Biochemistry (course 101 or equivalent), and consent of instructor. Toxic chemicals: selected topics illustrating their occurrence, structure, and the reactions underlying detection, toxicity, fate, and ecological importance. Offered in alternate years. —S—Deisen, Hammock

220. Analysis of Toxicants Laboratory (2) Laboratory—6 hours. Prerequisite: course 220 (may be taken concurrently) and consent of instructor. Laboratory techniques for microanalysis of toxicants. Separation, detection, and quantitative determi- nation of toxicants using chemical and instrumental methods. —F—T. Zhang

228. Gas Chromatography/Mass Spectrometry of Toxic Chemicals (3) Lecture—1 hour; discussion—1 hour; laboratory—3 hours. Prerequisite: course 220 and Chemistry 129C, or consent of instructor. Application of GC/ MS techniques to investigate the mass spectral fragements and their application to the structural elucidation. Practical application of GC/ MS in current research. Open to given environmental toxicology graduate students. Offered in alternate years. —W—A. Holstege

234. Current Topics in Neurotoxicology (3) Lecture—3 hours. Prerequisite: core courses in one of the following graduate programs: Pharmacology and Toxicology, Agricultural and Environmental Chemistry, Biochemistry and Molecular Biology, Cell and Developmental Biology, Immunology, Molec- ular Cellular and Integrative Physiology or Neurosci- ence. Restricted to upper level undergraduate students must obtain permission from the course coordinator. General principles of neurotoxicology, the cell and molecular biology of specific neurotoxicants and the contribu- tion of neurotoxic compounds to complex neurode- velopmental disorders and neurodegenerative diseases. (Same course as Molecular Biosciences 234 and Molecular, Cellular, and Integrative Physi- olgy 234.)—S—S—Lein

240. Ecotoxicology (3) Lecture—3 hours. Prerequisite: elementary course in toxicology and ecology or equivalent, or consent of instructor. Principles of toxicology as applied to chemical action on natural populations, communi- ties, and ecosystems. Physical, chemical, and biological characteristics of toxicants, ecotoxicology, models, and field research. Selected case histories are analyzed and presented in class. —S—S—White- head

250. Reproductive Toxicology (3) Lecture—1.5 hours, discussion—1.5 hours, laboratory—1.5 hours. Prerequisite: Physiology 220 or Pharmacology—Tox- icology 203. Application of toxicological principles in reproductive studies. Effects of toxicants on the male, female, and developing embryo/fetus. Critical evaluation of reproductive toxicity studies conducted in develop- ment of mechanistic approaches to understanding how chemical exposure can adversely affect repro- duction. Offered in alternate years.

260. Immunotoxicology (3) Lecture—3 hours. Prerequisite: undergraduate or graduate introduction to immunology coursework recommended, but not required; graduate standing or consent of instructor. Provides students with skills and knowledge of immunological properties of pesticides, their mode of action, metab- olism and disposition, pesticide resistance, effects on human health and ecological health and methods of risk benefit analyses. Offered in alternate years.

270. Toxicology of Pesticides (3) Lecture—3 hours. Prerequisite: course 101 or equivalent. Toxicological properties of pesticides in relation to metabolism, metab- olism and disposition, pesticide resistance, effects on human health and ecological health and methods of risk benefit analyses. Offered in alternate years.

278. Molecular Toxicology (3) Lecture—3 hours. Prerequisite: graduate standing or consent of instructor. Recombinant DNA technology and its applications. (Same course as Forensic Science 278.) Offered in alternate years. —F—D. Denison, Rice

280. Forensic DNA Analysis (3) Lecture—3 hours. Prerequisite: coursework in genet- ics and molecular biology. Graduate standing; con- sent of instructor required for all students not enrolled
281. Principles and Practice of Forensic Serology and DNA Analysis (3)

Lecture—2 hours; lecture/discussion—3 hours. Prerequisite: Forensics/course 278 or Forensics/course 280, or equivalent; consent of instructor. Restricted to students enrolled in the M.S. in Forensic Science Program or by consent of Forensic Science Program Director. Comprehensive overview of forensic serology and DNA typing techniques and technologies. Strong emphasis on real-world applications, including preservation and tracking of biological evidence, detection and identification of bodily fluids, and methods to extract, quantify, and type human DNA. (Same course as Forensic Science 281.)—S. J. Rodzen

284. Non-Human Forensic DNA—Theory and Casework Application (2)

Lecture—2 hours. Prerequisite: consent of instructor required for all students not enrolled in the MS Forensics program; upper division Molecular Biology and Genetics with its laboratory. Restricted to graduate standing. Provides a comprehensive understanding of plant and animal forensic biology in terms of sample collection, preservation, analytical methods, and of the invaluable lines of inquiry these forensic evidence may permit. (Same course as Forensic Science 284.) Offered in alternate years.

290. Seminar (1-5)

Seminar—1 hour. Current topics in environmental toxicology. (S/U grading only)—F, W, S. (F, W, S.)

290C. Advanced Research Conference (1)

Lecture/discussion—1 hour. Prerequisite: consent of instructor. Presentation and critical discussion of advanced research methods and interpretation of research results. Designed primarily for graduate students. (S/U grading only)—F, W, S. (F, W, S.)

297T. Tutoring in Environmental Toxicology (1-5)

15 hours and duties will vary depending upon course being tutored. Prerequisite: graduate standing in Environmental Toxicology, a related major, or the equivalent experience, and consent of instructor. Teaching toxicology including conducting discussion groups for regular departmental courses under direct guidance of staff. May be repeated for credit up to a total of 5 units. (S/U grading only.)

298. Group Study (1-5)

(S/U grading only)

Professional

396. Teaching Assistant Training Practicum (1-4)

Prerequisite: graduate standing. May be repeated for credit. (S/U grading only)—F, W, S. (F, W, S.)