ES/RP 531
Fundamentals of Environmental Toxicology

Fall Semester, 2005

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Class Time: Monday & Wednesday, 7:15 - 8:30 pm;
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Course Synopsis

For many consumers, Rachel Carson's Silent Spring (which was published in book form in 1962) marks year one of environmental contaminant awareness and a push to "clean up our acts". Unnoticed is the evolution of understanding that preceded this landmark popular publication. Prior to the end of World War II, toxicology was simply the science of classically acute poisons, but it was also a discipline highly relevant to studying pharmaceuticals. The explosion of synthetic organic chemistry that produced a myriad of commercial products after the 1940's gave way to an increasing number of studies examining the toxicology of these new chemicals.

Prior to WWII, environmental chemistry was nebulously a study of the chemistry of natural systems. With the post-WWII commercialization and widespread use of DDT, coupled with advances in analytical detection, environmental chemistry coalesced into a standalone discipline. It gained a theoretical foothold as physical chemistry was applied to understanding the fate and behavior of society's chemical products. Environmental chemistry became indispensable to predicting exposure, as well as measuring it directly or indirectly.

The elucidation of biological mechanisms at the molecular scale helped define in greater detail specific toxicological mechanisms. Physiological effects from sublethal exposures occurring over long periods of time replaced concerns over acutely lethal effects. Over the last decade, focus honed in on the endocrine system as one node among the interactions between the brain, the immune system, and hormones.

Concepts that were progenitors of what we now call environmental toxicology probably had their early origins in the historical use of pest control agents and the need to understand how they worked in an environmental context. Additionally, episodes of air

and water pollution with documented effects on human health were also drivers for development of an environmental perspective on toxicological effects. The widespread use of DDT and its persistence coupled with its broad-spectrum effects on invertebrates and putative effects through the food web were early lightening rods for the evolutionary trajectory of environmental chemistry and toxicology. All chemical technology became subjects of scrutiny as widespread burial of hazardous wastes came bubbling to the surface. Now, pharmaceuticals and consumer products in the environment are beginning a new wave of study.

Making sense of the ubiquitous residues of our technologies and managing them to balance the benefits and risks has been greatly benefited by development of the risk assessment paradigm. Its four "steps", hazard identification, dose-response characterization, exposure assessment, and risk characterization, can be universally applied to all chemicals.

Environmental toxicology has evolved as an integration of principles and techniques from environmental chemistry and toxicology. Although it has broad applicability to all organisms, including humans, it is most frequently applied to understanding and predicting the interaction of environmental contaminants with non-human organisms. In one sense, environmental toxicology can be viewed as a sub discipline of toxicology, but it is really the application of toxicology in conjunction with environmental chemistry to understand and predict the effects of chemicals in the environment. Whereas traditional toxicological studies focus on mechanisms of effects at different scales (molecular, cell, tissue, organ, system), environmental toxicology goes beyond mechanisms to examine exposure relationships. Whereas traditional toxicology is mammalian centric, environmental toxicological studies encompass the universe of organisms. Whereas traditional toxicology focuses on the individual, environmental toxicology examines relationships at higher levels of organization—the population, the community, and the ecosystem

At Washington State University, two basic environmental toxicology courses are offered through the Program in Environmental Sciences and Regional Planning—ES/RP 531 (Fundamentals of Environmental Toxicology) and ES/RP 532 (Applied Environmental Toxicology). In this course (ES/RP 531), we will focus on the principles driving our understanding of the interaction of organisms with environmental contaminants. The course will combine basic toxicological understanding of mechanisms of toxicity at different scales with interactions of organisms and environmental contaminant residues. How different groups of organisms respond will be examined at different scales of organization. ES/RP 531 differs from its sister course, ES/RP 532, in that the latter focuses on different groups of environmental contaminants, concentrating on their production, environmental residues, chemistry, toxicological effects, and epidemiology.

Student Objectives

1. Students will be able to differentiate risk assessment from risk management.
2. Students will be able to describe the four processes of risk assessment.
3. Students will be able to discern the differences between risk assessment and risk management, and also be able to describe examples of risk management in developed countries that require some knowledge of environmental toxicology.

4. Students will be able to describe how dose-response curves are generated and the different types of dose-response relationships.
5. Students will be able to describe the derivation of toxicological endpoints, including the LD50, LC50, ED50, NOAEL, and NOAEC.
6. Students will be able to differentiate acute and chronic toxicity and describe the organismal factors that influence the magnitude of toxicity.
7. Students will be able to describe the types of hazards examined for risk assessment of contaminants.
8. Students will be able to describe for vertebrates and invertebrates the symptomology and mechanisms of action for selected contaminants that are associated with neuroendocrine toxicity, neurotoxicity, developmental and reproductive toxicity, soft tissue toxicity, and behavioral toxicity.
9. Students will be able to describe the hazards of selected contaminants to microorganisms and plants.
10. Students will be able to describe the hazards of chemical mixtures and how to determine if two or more chemicals are interacting in causing a toxicological response.
11. Students will be able to describe the environmental chemodynamic processes that are relevant determinants of exposure.
12. Students will be able to differentiate bioconcentration from bioaccumulation and describe how bioavailability modifies toxicity.
13. Students will be able to describe how hazard at different levels of ecological organization can be measured and/or analyzed.
14. Students will be able to describe the difference between deterministic and probabilistic risk assessment.
15. Students will be able to describe the uses and limitations of epidemiology applied to ecological systems (ecoepidemiology).

Evaluation

Critical thinking and writing skills rather than regurgitation of facts will be emphasized to evaluate student performance in this class. You will be given four take-home evaluations consisting of questions about class subject matter and questions related to research papers that will be handed out. The required answers will range from short phrases to expository narratives. Each evaluation will comprise 25% of the final grade. Evaluations will be completed digitally and submitted via email by the beginning of the next class.

The final grade is not based on a curve, and thus its magnitude depends solely on your effort. The final letter grade will be determined by averaging the cumulative evaluation points. I will assign the appropriate letter grade according to the following scale: A = 95-100; A- = 90-94; B+ = 85-89; B = 80-84; B- = 75-79; C+ = 70-74; C = 65-69.

Text

No text is required. Students will receive copies of lecture notes & relevant papers. Lectures will be posted on the WSU Food & Environmental Quality WEB site (URL http://feql.wsu.edu/teaching.htm; link to ESRP 531).

Class Syllabus

Lecture #	Date	Topic
1	8/22/05	Environmental Toxicology: History & Overview of Major Concepts
2	8/24/05	Risk Management & Environmental Toxicology
-	8/29/05	No Class (Am. Chem. Soc. Mtg., Washington DC)
3	8/31/03	Nature of Toxicity
-	9/5/05	No Class (Labor Day)
4	9/7/03	Pharmacodynamics/Pharmacokinetics
5	9/12/03	Pharmacodynamics/Pharmacokinetics
6	9/14/03	**Dose/Response 1** (Overview of the Dose-Response Relationship) ***Evaluation 1, due 9/19/05***
-		**Hazard Identification 1 (Invertebrates/Vertebrates)**
7	9/19/03	Neuroendocrine Toxicity
8	9/21/03	Neuroendocrine Toxicity
9	9/26/05	Neuroendocrine Toxicity
10	9/28/05	Developmental & Reproductive Toxicity
11	10/3/05	Developmental & Reproductive Toxicity
12	10/5/05	Neurotoxicity
13	10/10/05	Neurotoxicity
14	10/12/05	Immunotoxicity ***Evaluation 2, due 10/17/05***
15	10/17/05	Soft Tissue Toxicity (Liver, Lung, Kidney)
16	10/19/05	Behavioral Toxicity;
		Hazard ID 2 (Microorganisms, Plants, Beneficial Insects)
17	10/24/05	Microbial & Plant Toxicity
18	10/26/05	Beneficial Insects; Evolution of Resistance
19	10/31/05	**Dose/Response 2** (Chemical Interactions)
		Exposure Assessment (Environmental Chemodynamics)
20	11/2/05	Physicochemical Properties; Phase Transfer (Partitioning)
21	11/7/05	Mass Transfer
22	11/9/05	Abiotic/Biotic Degradation & Transformation ***Evaluation 3, due 11/14/05***
23	11/14/05	Bioconcentration; Bioavailability
24	11/16/05	Biomarkers; Tissue Residues
-	11/21-25/05	Thanksgiving Vacation
25	11/28/05	**Ecological Risk Characterization** (Deterministic vs. Probabilistic)
26	11/30/05	**Ecological Risk Characterization** (Deterministic vs. Probabilistic)
27	12/5/05	**Ecotoxicological Issues** (Measuring Effects at Higher Levels of Organization; Ecoepidemiology)
28	12/7/05	**Ecotoxicological Issues** ***(Evaluation 4, due 5 pm on scheduled day of final exam)***
-	12/12-16/05	**Finals Week**