ENVIRONMENTAL TOXICOLOGY

ADVS, BIOL, PUBH 5400/6400

Spring 2021

3 credits

Instructor: Professor R. A. Coulombe, Jr.

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My office is AGRS 240. During the pandemic, I am mostly working from home.

Teaching Assistants: Mr. Andy Nguyen (andy.nguyen@aggiemail.usu.edu) and Ms. Morgan Eggleston (morgan.eggleston@aggiemail.usu.edu); AGRS 201

Course Organization: Lectures and presentations are normally held 9:30-10:20 MWF, but this semester will be presented asynchronously online via Canvas. There is a video presentation of all lecture modules stored in the Canvas **Media Gallery** link. Lectures are presented in order in the **Playlist** link in **Media Gallery.**

Examinations will be administered online using **Proctorio** plug-in which you must install and test prior to each exam. Exams will emphasize case studies, illustrations, special presentations, examples and discussions from class. Exams will be synchronously administered at times noted below. Depending on demand, we will hold a weekly or bi-weekly Zoom Q&A recitation during class time (9:30-10:20)

The **Objectives** of this course are to develop practical knowledge of a broad array of toxic environmental chemicals, to be able to think critically about factors impacting the fate of chemicals, the potential biological effects associated with chemical exposures, methods of assessing associated public and environmental health risks, and mechanisms of toxic action.

This course is intended for third- or fourth-year undergraduates or graduate students in the sciences. In addition to the required prerequisites, a working knowledge of general biology, biochemistry, math and statistics, inorganic and organic chemistry is necessary.

Toxicology is a cross- and **multi-disciplinary science**, requiring the real-world skills of utilizing and integrating a broad science background.

Essential Learning Objectives:

1. Gaining factual knowledge (terminology, classifications, methods, trends)
2. Learning fundamental principles, generalizations or theories

Important Learning Objectives:

1. Developing specific skills, competencies, and point of view needed by professionals in the field most closely related to this course
2. Learning to apply course material to improve thinking, problem solving, and to decisions
3. Acquiring an interest in learning more by asking my own questions and seeking answers

Course Reader: lecture material for each module, in both **pdf** and **MS Word** format, is posted on Canvas, and can be downloaded and printed. The reader is not all inclusive, but provides a foundational principles onto which illustrations from contemporary examples of toxicology related events, case studies, reading assignments, special presentations, and class discussions will be built.

Your grade will be determined by **two mid-term examinations** (60%), and **one final** examination (40%). Examinations will be administered **synchronously** at the dates and times posted, and will include multiple choice, short answer, and essay questions. The **final examination** will emphasize new material, but will be comprehensive with respect to foundational concepts and principles reinforced throughout the semester. There are **no makeup examinations** unless you provide a written request documenting a valid **USU-sanctioned Excused Absence (Links to an external site.)**.

Graduate students enrolled in 6400: Will have an additional requirement: one written assignment is required on a relevant topic of approximately 12 printed pages with 1" margins and 12-point font, fully referenced using the style found in the journal *Toxicological Sciences*. Make an appointment with me by the 4th week of class to discuss possible topics, and format requirements.

Physical Impairments. Special needs based on physical impairments or other problems that will likely require some accommodation by the instructor, must be made known to the instructor during the first week of the course. Any requests for special considerations relating to attendance, pedagogy, examinations, etc., must be discussed with and approved by the instructor prior to completion of the fifth day of the course. In cooperation with the Disability Resource Center, course material can be provided in alternate formats--large print, audio and Braille.

Modules and Lecture Topics

I. History of Toxicology

History and scope of toxicology; Development of toxicology as a science. **Case study**: How toxicology protects public health

II. Principles of Toxicology

Dose-response; interactions of chemicals; mechanisms of toxicity; target organ toxicity; hazard, potency; characteristics of exposure and effects;

III. Absorption, Distribution, and Elimination (ADME) - Chemical Disposition and Metabolism

Disposition of chemicals in the body; absorption, distribution, and elimination; volume of distribution. Metabolism and biotransformation: phase I, II and III. Cytochrome P450s, bioactivation of chemicals. Mechanisms of carcinogenesis. **Case studies**: CYP 2D6 polymorphism; P450 polymorphisms in human populations; Percival Pott and chimney sweeps, PAHs.

IV. Toxicity testing and Risk Assessment and Regulatory toxicology

Species extrapolation; toxicity tests; short-term genetic toxicology—Ames assay; decision point analysis; epidemiology; Hill's Criteria for Causation; low dose estimation models; ADI, RfD, BMD; principles of risk assessment; exposure limits and standards; biological monitoring; biomarkers; The Precautionary Principle; Regulatory toxicology; legislation important in toxicology; EPA information databases. Toxic release inventory,

PBT chemicals. **Case studies**: Thalidomide and the Precautionary Principle. Dietary Supplements and vitamins: safety concerns.

V. Environmental Chemistry and Toxicology

TRI and PBT chemicals; Chemodynamics; adsorption, soil types and soil fractions; evaporation from water and soil; biomagnification; model systems for chemical movement and biomagnification; **Case study**: biomagnification and PCBs, half life and the plateau principle

VI. Toxicology of Metals

Toxic metals of environmental significance; metal antidotes; As, Be, Cd, Cr, Fe, Pb, Mn, Hg, Ni, Tl. Renal physiology and toxicology, the Inflammatory response. **Case studies**: Arsenic in drinking water: Fallon NV; Bangladesh; *Itai Itai Disease;* Minamata Disease. Danbury Hat Company. Flint Michigan.

VII. Pulmonary Toxicology

Types and sources of air pollutants; ambient standards for urban pollutants; Pulmonary structure and function; aldehydes, acrolein, formaldehyde, H_2S, NO_2, SO_2, O_3, CO, urban particulates ($PM_{2.5}$/PM_{10}); nanoparticles; asbestos. **Case studies**: Health effects of urban $PM_{2.5}$ in Northern Utah; Formaldehyde and Katrina Trailers.

VIII. Solvents and vapors

benzene, styrene, 1,3-butadiene, MTBE, vinyl chloride, CN^-, TCE; MIC. **Case study**: Union Carbide, MIC and Bhopal India.

IX. Aromatic and Halogenated hydrocarbons, PAHs

PCBs, chlorophenols, TCDD, low MW halogenated hydrocarbons, polycyclic aromatic hydrocarbons and aromatic amines; Bay region. Environmental estrogens. Estrogen receptors, estrogen antagonists; Bisphenol A. **Case studies**: PCB Superfund Cleanup at GE Hudson River Plant; Dioxin; Xenoestrogens

X. Pesticides

Comprehensive survey of pesticides, and their mechanisms of action. **Case study**: DDT and Silent Spring

Examination Schedule:

Midterm #1: Friday, 12 February 9:30-10:20

Midterm #2: Wednesday 17 March 9:30-10:20

Final Exam: Wednesday 5 May 9:30-12:00