

# Environmental Health and Disease

Fall 2011

BIOL 1820

Brown/Pfizer Master of Arts Program in Biology

*This course does not fulfill a core course requirement*

Instructor: Michelle Embree Ku

Course Time: Tuesdays 3:30-6:30

Office Hours: following lectures or by appointment

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## Course Description

Humans have a long history of trying to understand and control how the environment affects their physiology. From the ancient Romans' appreciation of sewers and aqueducts to current interest in nanoparticles' influence on human health, there has been the desire to manage our environment to better our health. Today, the issues surrounding environmental health are complex and understanding them involves a multidisciplinary approach, using principles from toxicology, pathology, epidemiology and risk assessment, to name a few. Additionally, ethical, legal, and social issues must be considered. Environmental Health and Disease (BIOL 1820) will introduce students to the fundamental science that helps to guide public policy and individual decisions about human exposure to environmental insults, whether the insult is natural or manufactured. Topics covered will include:

Environmental Toxicology: how the body reacts to environmental insults

Environmental Epidemiology

Sources of exposure: physical, chemical, and biological agents

Risk management, ethical considerations and policy making

Risk communication and the media

Emerging issues in Environmental Health and Disease

## Course Objectives

It is expected that during the course of study, students will:

1. gain an appreciation of the basic principles of toxicology, epidemiology, and risk assessment.
2. understand the sources of human exposure to environmental risks
3. be able to critically examine the science that determines public policy and individual decisions about how we interact with our environment

## Ideal Student Background

Because environmental health sciences include many fields of study, the course will take a multidisciplinary approach. While courses in biology, molecular biology, pathology, histology, biochemistry, epidemiology, organic chemistry, and cell biology are all relevant, it is not expected that students will have taken all of these courses. Students will find that the more of these courses that they have taken, the more they will get out of this course.

## Required Reading

There are two recommended textbooks:

*Principles of Toxicology*, 2nd Edition, Karen E. Stine and Thomas H. Brown, editors. CRC Press Taylor and Francis Group, Publication, 2006, ISBN 0-8493-2856-X.

*Essentials of Environmental Health*. 2<sup>nd</sup> Edition, Robert H. Friis. Jones and Bartlett Publishing, 2010, ISBN-10: 0763778907, ISBN-13: 9780763778903

Review and research papers required for background reading and homework completion are available through Brown Library and will be available on the MyCourse website.

## Attendance

Attendance is expected at all classes. Because there is no required textbook, the lectures will weave together different sources. Students will be responsible for material covered in class. Therefore, participation is in your best interest.

## Academic Integrity

Students should be aware that plagiarism will not be tolerated. Plagiarism entails appropriation of passages, words and phrases without credit, appropriation of both main and supporting ideas without credit, and paraphrasing without credit. Plagiarism also includes submitting a paper written by someone else. Ethical research requires that you properly document the sources you use. Even when you do not quote directly from another work, if reading that source contributed to the ideas presented in your paper, you should give the authors proper credit. **If you have questions about when or how to cite your sources appropriately, please speak to the professor.**

## Logistics

**Lectures:** The course will consist of 14 meetings of approximately 3 hours each.

**Reading:** Background reading that supports lecture content will be noted on the syllabus next to the lecture. Additionally, there will be original research and/or review papers which will be required reading for class discussion and homework assignments.

**In-class hourly exams:** There will be two one-hour, in-class exams. These exams will cover the first and second parts of the course. They will be worth up to 100 points each.

**In-class final:** The first part of this exam will consist of questions dealing exclusively with the third section of the course for a possible 50 points. The remaining 50 points will be based on short answers in response to a case study.

**Case study report:** Students will critically evaluate a specific topic for a possible 100 points. A list of possible topics and expectations for the report will be provided. Alternatively, students may submit a topic of interest for approval.

**Homework:** Primary research and review papers will be discussed during many of the classes. One or two papers will be chosen as the focus of each of these discussions. The goal is to use these papers to illustrate important concepts in Environmental Health research and encourage critical evaluation.

To encourage you to be prepared to ask and answer questions about the papers during class, ten times during the semester, students will be required to submit questions regarding the primary literature assigned. The questions must be e-mailed to me at michelle\_ku@brown.edu 24 hours in advance of the class. Questions will be evaluated based on their relevance for class discussions.

10 possible points for each week

( As a bonus, 5 extra points for each question that is chosen for discussion or as a test question can be earned. These points will be added on to your total points earned for the course – that is, they are a bonus.)

**Grading:** Final grades will be based upon the total number of points accumulated out of 500:

Homework	100 pts
Exam I	100 pts
Exam II	100 pts
Exam III	100 pts
Case Study	<u>100 pts</u>
Total	500 pts

## Lecture Schedule

## Background reading

### Part I: Principles of Toxicology

1: September 6

Introduction to the Course  
Environmental Health History  
Dose Concepts

1. *Course Syllabus*
2. *Essentials of Environmental Health*, Friis: chapter 1
3. *Principles of Toxicology*, Stine: chapters 1-3

2: September 13

Environmental Toxicology: target organs

1. *Principles of Toxicology*, Stine: chapters 4 and 8-12

3: September 20

Fertility  
Endocrine Disruption

1. *Principles of Toxicology*, Stine: pages 117-129
2. Casals-Casas C, Desvergne B. Endocrine Disruptors: From Endocrine to Metabolic Disruption. *Annu Rev Physiol.* 73:135–62 (2011)

4: September 27

Development  
Genotoxicity and Epigenetics

1. *Principles of Toxicology*, Stine: pages 129-142.
2. Szyf M. The dynamic epigenome and its implications in toxicology. *Toxicol Sci.* 100(1):7-23 (2007)
3. Jacobson-Kram D and Contrera JF. Genetic Toxicity Assessment: Employing the Best Science for Human Safety Evaluation Part I: Early Screening for Potential Human Mutagens. *Toxicol Sci.* 96(1):16-20 (2007).

5: October 4

Carcinogenesis  
Environmental Epidemiology

1. *Principles of Toxicology*, Stine: chapter 6
2. *Essentials of Environmental Health*, Friis: chapter 2
3. Wallace TA, Martin DN, Ambs S. Interactions among genes, tumor biology and the environment in cancer health disparities: examining the evidence on a national and global scale *Carcinogenesis* 32(8)1107–1121 (2011).

### Part II: Sources of Exposure

6: October 11

Zoonotic and Vector-borne Disease  
Toxic Metals and Elements

1. *Essentials of Environmental Health*, Friis: chapter 5
2. *Essentials of Environmental Health*, Friis: chapter 6

7: October 18

***In-class exam on Principles of Toxicology: lectures 1-5***

Pesticides and Other Organic Chemicals

1. *Essentials of Environmental Health*, Friis: chapter 7

8: October 25

Ionizing and Nonionizing Radiation  
Occupational Exposures

1. *Essentials of Environmental Health*, Friis: chapter 8
2. *Essentials of Environmental Health*, Friis: chapter 13

9: November 1

Food  
Air

1. *Essentials of Environmental Health*, Friis: chapter 11
2. *Principles of Toxicology*, Stine pages 305-313

10: November 8

Water  
Medical treatment/procedures

1. *Principles of Toxicology*, Stine pages 313-326
2. *Principles of Toxicology*, Stine chapter 15

### Part III: Applications of Environmental Health

11: November 15

Population and the Environment

1. Mascie-Taylor CGN, *et al.* The Burden of Chronic Disease. *Science*. 302, 1921 (2003)
2. Rosegrant MW, *et al.* Global Food Security: Challenges and Policies. *Science*. 302, 1917 (2003)
3. McMichael AJ, *et al.* New Visions for Addressing Sustainability. *Science* 302, 1919 (2003)
4. Hardin G. The Tragedy of the Commons. *Science* 1968: 1243-1248 (1968)

Environmental Policy, Regulation & Justice

1. *Essentials of Environmental Health*, Friis: chapter 4
2. Goldstein BD. The Precautionary Principle: Is It a Threat to Toxicological Science? *International Journal of Toxicology* 25: 3 (2006)

12: November 29

#### ***In-class exam on Sources of Exposure: Lectures 6-10***

Risk communication and the media

1. Ahearn A. Communicating about Chemical Body Burden, with Tracey Woodruff and Rachel Morello-Frosch. *Environ Health Perspect* 119(5) (2011)  
Available as a podcast on EHP website
2. Schmidt CW. Communication Gap: The Disconnect Between What Scientists Say and What the Public Hears. *Environ Health Perspect* 117:A548-A551 (2009)

13: December 6

Future Directions

1. Rappaport SM and Smith MT. Environment and Disease Risks. *Science*. 330: 460-461 (2010)
2. Hartung T. Toxicology for the twenty-first century. *Nature* 460(7252):208-12 (2009)
3. Betts K. A Study in Balance: How Microbiomes Are Changing the Shape of Environmental Health. *Environ Health Perspect* 119:a340-a346 (2011)

14: December 13

#### ***In-class exam on Applications of Environmental Health: Lectures 11-13***

December 20

No class - Case study report due

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## **Instructions for homework assignments**

1. Read the assigned papers. You are encouraged to look beyond the information in the paper, whether it involves looking up definitions, reading text books, or reading related papers by the same authors or authors with opposing views. I expect it to take several hours to read and re-read the papers.
2. Note any limitations or extensions you see for the ideas in the paper. For the purposes of this class, unless you have a particular interest and background in statistics, you can assume that the statistics are appropriate for the experiment.
3. Note your opinion of the paper; primarily, the quality of the ideas and its potential impact.
4. Formulate questions that could spark discussion based on your observations. If there is more than one paper assigned, your questions should be derived from at least two separate papers.
5. E-mail four questions to [michelle\\_ku@brown.edu](mailto:michelle_ku@brown.edu) by the date indicated on the homework list.

## Reading Assignments for BIOL1820 Homework

### Questions due on September 13 for September 14 discussion: (dose concepts and EH history)

Taylor JA, Vom Saal FS, Welshons WV, Drury B, Rottinghaus G, Hunt PA, Toutain PL, Laffont CM, and VandeVoort CA. Similarity of bisphenol A pharmacokinetics in rhesus monkeys and mice: relevance for human exposure. *Environ Health Perspect.* 119(4):422-30 (2011).

Calabrese EJ and Baldwin LA. The Hormetic dose-response model is more common than the threshold model in toxicology. *Toxicol Sci.* 71(2):246-50 (2003).

### Questions due on September 20 for September 21 discussion: (target organ toxicity)

Gupta RD, Goldsmith M, Ashani Y, Simo Y, Mullokandov G, Bar H, Ben-David M, Leader H, Margalit R, Silman I, Sussman JL, Tawfik DS. Directed evolution of hydrolases for prevention of G-type nerve agent intoxication. *Nat Chem Biol.* 7(2):120-5 (2011).

Chen AA, Thomas DK, Ong LL, Schwartz RE, Golub TR, Bhatia SN. Humanized mice with ectopic artificial liver tissues. *Proc Natl Acad Sci U S A.* 108(29):11842-7 (2011).

### Questions due on September 27 for September 28 discussion: (fertility and endocrine disruption)

Toppari J, Virtanen HE, Main KM, Skakkebaek NE. Cryptorchidism and hypospadias as a sign of Testicular Dysgenesis Syndrome (TDS): environmental connection. *Birth Defects Res A Clin Mol Teratol.* 88(10):910-9 (2010).

Jones BA, Shimell JJ, Watson NV. Pre- and postnatal bisphenol A treatment results in persistent deficits in the sexual behavior of male rats, but not female rats, in adulthood. *Horm Behav.* 59(2):246-51 (2011).

### Questions due on October 4 for October 5 discussion: (dvt., genotoxicity and epigenetics)

Anway MD, Memon MA, Uzumcu M, Skinner MK. Transgenerational Effect of the Endocrine Disruptor Vinclozolin on Male Spermatogenesis. *Journal of Andrology* 27 (6): 868-79 (2006).

Dolinoy DC, Huang D, Jirtle RL. Maternal nutrient supplementation counteracts bisphenol A-induced DNA hypomethylation in early development. *Proc Natl Acad Sci U S A.* 104 (32): 13056-61 (2007).

### Questions due on October 11 for October 12 discussion: (carcinogenesis and epidemiology)

Anisimov VN, Ukraintseva SV and Yashin AI. Cancer in rodents: does it tell us about cancer in humans? *Nat Rev Cancer* 5(10):807-19 (2005).

Siontis GC, Ioannidis JP. Risk factors and interventions with statistically significant tiny effects. *Int J Epidemiol.* 2011: 1-16 (2011).

*For an interesting read (but not part of the homework):*

Freedman DH. Lies, damned lies, and medical science. *The Atlantic* November (2010).

### Questions due on October 25 for October 26 discussion: (pesticides)

Laetz CA, Baldwin DH, Collier TK, Hebert V, Stark JD, and Scholz NL. The synergistic toxicity of pesticide mixtures: implications for risk assessment and the conservation of endangered pacific salmon. *Environ Health Perspect* 117:348–353 (2009).

Waller SA, Paul K, Peterson SE, Hitti JE. Agricultural-related chemical exposures, season of conception, and risk of gastroschisis in Washington State. *Am J Obstet Gynecol.* 202(3):241.e1-6 (2010).

### Questions due on November 1 for November 2 discussion: (radiation and occupational exposure)

Porter DW, Castranova V, Robinson VA, Hubbs AF, Mercer RR, Scabilloni J, Goldsmith T, Schwegler-Berry D, Battelli L, Washko R, Burkhart J, Piacitelli C, Whitmer M, Jones W. Acute inflammatory reaction in rats after intratracheal instillation of material collected from a nylon flocking plant. *Journal of Toxicology and Environmental Health, Part A* 57:25–45 (1999).

Warheit DB, Webb TR, Reed KL, Hansen JF, Kennedy GL. Four-week inhalation toxicity study in rats with nylon respirable fibers: rapid lung clearance. *Toxicology* 192:189–210 (2003).

Normile D. Fukushima revives the low dose debate. *Science* 332(6032): 908-910 (2011).

### Questions due on November 8 for November 9 discussion: (food and air)

de Vendômois JS, Roullier F, Cellier D and Séralini GE. A comparison of the effects of three GM corn varieties on mammalian health *Int. J. Biol. Sci.* 5(7):706-726 (2009).

Johnson KL, Raybould AF, Hudson MD and Poppy GM. How does scientific risk assessment of GM crops fit within the wider risk analysis?, *Trends Plant Sci.* 12(1):1-5 (2006).

Goodman RE, Vieths S, Sampson HA, Hill D, Ebisawa M, Taylor SL and van Ree R. Allergenicity assessment of genetically modified crops—what makes sense? *Nat Biotech* 26(1):73-81 (2008).

### Questions due on November 15 for November 16 discussion: (water and medical)

Benotti MJ, Trenholm RA, Vanderford BJ, Holady JC, Stanford BD, Snyder SA. Pharmaceuticals and endocrine disrupting compounds in U.S. drinking water. *Environ Sci Technol.* 43(3):597-603 (2009).

Beaumont J J, Sedman RM, Reynolds SD, Sherman CD, Li L-H, Howd RA, Sandy MS, Zeise L, Alexeeff GV. Cancer Mortality in a Chinese Population Exposed to Hexavalent Chromium in Drinking Water. *Epidemiology* 19(1): 12-23 (2008).

### Questions due on December 6 for December 7 discussion: (population, policy regulations and justice)

Joint FAO/WHO expert meeting to review toxicological and health aspects of bisphenolA: summary report 1–5 November 2010.

vom Saal FS, Akingbemi BT, Belcher SM, Birnbaum LS, et al. Chapel Hill bisphenol A expert panel consensus statement: integration of mechanisms, effects in animals and potential to impact human health at current levels of exposure. *Reprod Toxicol.* 24(2):131-8 (2007).

Chapin RE, Adams J, Boekelheide K, Gray LE Jr, Hayward SW, Lees PS, McIntyre BS, Portier KM, Schnorr TM, Selevan SG, Vandenbergh JG, Woskie SR. NTP-CERHR expert panel report on the reproductive and developmental toxicity of bisphenol A. *Birth Defects Res B Dev Reprod Toxicol.* 83(3):157-395 (2008).