Biology 362: Ecotoxicology

Spring 2008
Wednesday 1:30 – 4:20, Sloan B011

INSTRUCTOR: Dr. Christopher J. Paradise Office: 272 Watson
Office Hours: Mon. 11:30-12:20; Wed. 10:30-11:20; Fri. 10:30-12:20 and 1:30-2:20, or by appt.
Phone: 2890 (office) e-mail: chparadise@davidson.edu

TEXTBOOK

Newman MC & Unger MA (2003) Fundamentals of Ecotoxicology, 2nd ed. Lewis Publ., Inc., Boca Raton. 458 pp.

COURSE DESCRIPTION AND ORGANIZATION

The course meets only once each week – therefore, it is expected that you will be present at and prepared for every class. The semester will be divided into **three** sections:

1. Overview of ecotoxicology – I will lecture and students will lead class discussions.
2. Student presentations and discussions on specific toxins or classes of chemical.
3. Student presentations and discussions on ecotoxicological issues.

We will use class to discuss concepts in the textbook and readings; you must read the material before class.

ASSIGNMENTS AND CLASS PARTICIPATION

Lectures and In-Class Discussions: To provide you the background you require to investigate toxins and conceptual issues on your own, we will proceed through the textbook at a fairly rapid pace. Some of the material in the chapters will be covered by you or your peers later in the semester as part of your presentations. I will cover the remaining material in this early part of the course. This requires you to select topics fairly early on so I can tailor the first third of the class to reduce redundancy and allow you to explore topics of interest to you. In addition, there will be reading assignments outside the textbook, which we will discuss in class. **Pairs of students will be assigned to lead discussion of each article.** Those sources are either listed below or will be handed out in class.

Short Essays: For two of the articles we discuss in class you will write a short (3-4 page, single-spaced) essay on the topic of the article, integrating and extending beyond textbook material and other sources, and outlining the topic's importance to the development of the science of ecotoxicology. To begin, review the textbook, lecture material, class discussions, and main article on which you're writing. In order to move beyond class discussion and support your argument, you will need to perform a literature search. Think about the following questions:

- Have you stated your thesis clearly, and does the body of your essay support that thesis?
- Are the sources that you've discovered and read relevant to your fundamental thesis?
- Given the information provided in your sources and the concepts and ideas we've discussed, can you ascertain the merit, validity, and importance of the source?
- Do the author's conclusions agree with your understanding of the relevant concepts and theories?
- Are the results and conclusions from the main article widely supported by other literature?

Your paper must be typed and single-spaced, with 1 inch (2.5 cm) margins on all sides. Use a 12 pt font. Separate paragraphs with two hard returns, not one. There should be **NO** title page; **type** your title, name, date, and course name and number at the top of the first page of text. DO NOT print out your paper – I accept electronic submissions only. When you are ready to submit your manuscript to me, attach it in an e-mail. Your file name should adhere to the following convention: **lastname_essay#.doc**.

You must have at least two references besides the main article and your textbook, at least one of which must be from a peer-reviewed scientific journal. You may also use Internet sources, but you must cite the URL properly. You may include up to two Internet sources. If you use Internet sites, they must be credible – use your best judgment. Remember that ".edu", ".org" and ".com" sites may not be peer-reviewed, meaning that the owner of the page might put unsupported ideas on their sites. You may also cite lectures or the text. Also note that many peer-reviewed journals have begun to deliver their articles online (for instance, see Dr. Lom's Journal of Undergraduate Neuroscience Education, http://www.funjournal.org). If you use such sources, they will count towards a scientific journal article, as long as they are peer-reviewed research articles, and even if they only appear on the Internet, they will not count towards the limitation of two Internet sources.

Oral Presentation and Annotated Bibliography Assignments: Each student will present two 25-30 minute lectures during the course of the semester. This is your opportunity to explore a topic that interests you and that is

not covered in class (at least, not in depth). I will provide a list of some broad topics from which you may choose. The exact format will be discussed in class and you will be given a handout with more direction. Each of these assignments will be worth 200 points (100 for the presentation and 100 for the annotated bibliography).

- Your talk must include a computer-aided presentation (e.g., PowerPoint). See the separate handout on preparing a presentation for guidelines, suggestions, and specific instructions.
- All annotated bibliographies must include at least ten sources, no more than four of which can be Internet sources. See the separate handout on preparing annotated bibliographies for more specific instructions.

1. The first assignment will be on a specific toxin or contaminant.
    a. For the chosen chemical, or class of chemical, you should discuss and present its chemistry (i.e., chemical features that contribute to its activity), mode(s) of action, fate in the environment, biotransformation or detoxification, bioavailability, effects at different ecological levels (from organismal to ecosystem), and risk assessment.
    b. You may choose a single chemical or a class of chemicals. There are drawbacks and advantages to each. A class of chemicals with individual toxins that have dissimilar activities and modes of action in biota (e.g., POPs) might be difficult to cover in the allotted time. Alternatively, if you pick a single chemical you might run into a literature acquisition problem, although this is not too likely unless you choose a newly emerging contaminant for which testing has not been done.
    c. Here is a non-inclusive list of classes of toxins and contaminants from which to choose (see also pp. 28-50 of text):
        i. Heavy metals
        ii. Persistent organic pollutants – POPs (e.g., PCBs, DDT, CFCs)
        iii. Pesticides (different classes of pesticides include organophosphates, carbamates, pyrethroids, "natural" insecticides)
        iv. Radioactive compounds
        v. Organometallic compounds (e.g., tributyltin, dimethylmercury)
        vi. Endocrine disruptors
        vii. Inorganic gases (e.g., hydrogen sulfide, carbon monoxide)

2. The second assignment will be on a conceptual or methodological issue or topic.
    a. For the chosen issue or topic, discuss any controversy surrounding the topic, the current state of thinking regarding the issue, ecological concepts integrated with the topic or issue, recent improvements in science or technology that advance our knowledge of the topic, or other pertinent concepts or issues we discussed that relate to your topic. The coverage of these aspects will vary depending on your chosen topic.
    b. Topics include but are not limited to:
        i. Debate over acute vs. chronic toxicity tests
        ii. Environmental fate models and movement of pollutants in ecosystems
        iii. Use of molecular biology and genomics to predict ecosystem level effects
        iv. Soil or sediment ecotoxicology – difficulties in assessment or monitoring
        v. Evolution of resistance to toxins
        vi. Effects of toxins on interspecific interactions
        vii. Synergistic effects of chemical mixtures

Class Participation and Attendance: Active participation and engaged learning cannot occur when you are not in class. I expect you to be present at each class. This is a discussion-oriented course that meets only once per week, and this category will be worth ~12.5% of your final grade. Unexcused absences and lack of participation in class will result in a lower Participation point total.

EVALUATION

Final grades will be based on the following distribution of points out of 650 possible. If at any time you feel unsure about your standing in the course, please come and see me!

Short Essays (2@100 pts each):	200
Oral Presentations (2@100 pts each):	200
Annotated Bibliographies (2@100 pts each):	200
Leading Discussion:	100
Participation:	100
Total:	800

Grades will be assigned using the follows distribution;

		A:	94.0-100%	A-:	90.0-93.9%
B+:	87-89.9%	B:	83.0-86.9%	B-:	80.0-82.9%
C+:	77-79.9%	C:	73.0-76.9%	C-:	70.0-72.9%
D+:	65-69.9%	D:	60.0-64.9%	F:	< 60%

TENTATIVE COURSE CALENDAR		
Date	**TOPIC**	**READINGS / NOTES**
1/16	The scope of ecotoxicology; why are we here?	Ch. 1 – ALL
	Discussion	Eggen et al. (2004)
	What makes a toxin toxic?	Ch. 2 – pp. 21-27 (& parts of 28-50, but also use to select a toxin)
1/23	Toxins in organisms	Chapter 3 (but skip models on pp.71-72)
	Discussion	Chapman (2002)
	Bioaccumulation	Ch. 4; Hermens et al. (2007)
1/30	Bioaccumulation and Food Webs	Ch. 5
	Discussion	McIntyre & Beauchamp (2007); short essay #1 assigned
	Toxicant effects below the individual level	Ch. 6; Deadline to choose toxin
2/6	Discussion	Escher & Hermens (2002)
	Toxicant effects below the individual level	Ch. 7
	Discussion	Sugni et al. (2007)
2/13	Sublethal effects	Ch. 8
	Discussion	Sánchez-Bayo & Goka (2007); Kolok (2001)
	Acute and chronic assessment; bioindicator assays	Ch. 9; Burger (2006)
2/20	How to present and prepare a seminar & annotated bibliography; Discussion	Deadline to choose method/concept Theodorakis (2001) **or** Morgan et al. (2007)
	Populations	Ch. 10
	Discussion	Relyea & Hoverman (2006)
2/27	Communities and ecosystems	Ch. 11
	Discussion	Cash et al. (2003)); short essay #2 assigned
	Landscape ecotoxicology	Ch. 12
3/5	NO CLASS	SPRING BREAK
3/12	Discussion	Malley (1996); Vasseur & Cossu-Leguille (2003)
	Risk assessment in ecotoxicology	Ch. 13
	Discussion	Breitholtz et al.(2006)
3/19	Oral Presentations on Toxins	*Two seniors*
	Catch up time, if needed, or reflection	
	Oral Presentations on Toxins	*Two seniors*
3/26	Oral Presentations on Toxins	*Two seniors*
	Discussion	Sandermann (2004)
	Oral Presentations on Toxins	*Seniors or juniors*
4/2	Oral Presentations on Toxins	*Seniors or juniors*
	Discussion	Fent et al. (2006)
	Oral Presentations on Toxins	*Two juniors*
4/9	Discussion	Follak & Hurle (2002)
	Discussion	Chapman (2001)
	Discussion	Fischer (2005)
4/16	Oral Presentations on Conceptual Issues	*Two seniors*
	Discussion	Snell et al. (2003) **or** Lettieri (2006) **or** Snape et al. (2004)
	Oral Presentations on Conceptual Issues	*Two seniors*
4/23	Oral Presentations on Conceptual Issues	*Two seniors*
	Discussion	Reader's choice
	Oral Presentations on Conceptual Issues	*Seniors or juniors*

TENTATIVE COURSE CALENDAR		
Date	**TOPIC**	**READINGS / NOTES**
4/30	Oral Presentations on Conceptual Issues	*Seniors or juniors*
	Discussion	Reader's choice
	Oral Presentations on Conceptual Issues	*Two juniors*
5/7	Discussion	Round table discussion of essay topics
	Wrap up	Final thoughts

Reading List (available on the Ecotox website, or will be passed out in class).

Breitholtz M, Ruden C, Hansson SO & Bengtsson B-E (2006) Ten challenges for improved ecotoxicological testing in environmental risk assessment. Ecotoxicology & Environmental Safety 63(2):324-335.

Burger J (2006) Bioindicators: A review of their use in the environmental literature 1970-2005. Environmental Bioindicators 1(2):136-144.

Cash KJ, Culp JM, Dube MG, Lowell RB, Glozier NE & Brua RB (2003) Integrating mesocosm experiments with field and laboratory studies to generate weight-of-evidence risk assessments for ecosystem health. Aquatic Ecosystem Health & Management 6(2):177-183.

Chapman PM (2001) Ecological risk assessment (ERA) and hormesis. The Science of the Total Environment xx (2001) xxx–xxx.

Chapman PM (2002) Integrating toxicology and ecology: putting the "eco" into ecotoxicology. Marine Pollution Bulletin 44(1):7-15.

Eggen RL, Behra R, Burkhardt-Holm P, Escher B & Schweigert N (2004) Challenges in ecotoxicology. Environmental Science & Technology 38(3):58A-64A.

Escher BI & Hermens JLM (2002) Modes of action in ecotoxicology: Their role in body burdens, species sensitivity, QSARs, and mixture effects. Environmental Science & Technology 36(20):4201-4217.

Fent K, Weston AA & Caminada D (2006) Ecotoxicology of human pharmaceuticals. Aquatic Toxicology 76(2):122-159.

Fischer DL (2005) Accounting for differing exposure patterns between laboratory tests and the field in the assessment of long-term risks of pesticides to terrestrial vertebrates. Ecotoxicology 14(8):853-62.

Follak S & Hurle K (2002) Effect of herbicides on non-target plants. Zeitschrift fuer Pflanzenkrankheiten und Pflanzenschutz (Sp. Iss. 18):997-1004.

Hermens JLM, Heringa MB & ter Laak TL (2007) Bioavailability in dose and exposure assessment of organic contaminants in (eco)toxicology. Journal of Toxicology & Environmental Health Pt A. 70(9-10):727-730.

Kolok AS (2001) Sublethal identification of susceptible individuals: using swim performance to identify susceptible fish while keeping them alive. Ecotoxicology 10(4):205-9.

Lettieri T (2006) Recent applications of DNA microarray technology to toxicology and ecotoxicology. Environmental Health Perspectives 114(1):4-9.

Malley DF (1996) Cadmium whole-lake experiment at the Experimental Lakes Area: an anachronism? Canadian Journal of Fisheries and Aquatic Sciences 53:1862-1870.

McIntyre JK & Beauchamp DA (2007) Age and trophic position dominate bioaccumulation of mercury and organochlorines in the food web of Lake Washington. Science of Total Environment 372(2-3):571-584.

Morgan AJ, Kille P, Sturzenbaum SR (2007) Microevolution and ecotoxicology of metals in invertebrates. Environmental Science & Technology 41(4):1085-1096.

Relyea R & Hoverman J (2006) Assessing the ecology in ecotoxicology: a review and synthesis in freshwater systems. Ecology Letters 9(10):1157-1171.

Sánchez-Bayo F & Goka K (2007) Simplified models to analyse time- and dose-dependent responses of populations to toxicants. Ecotoxicology 16(7):511-23.

Sandermann H, Jr. (2004) Molecular ecotoxicology of plants. Trends in Plant Science 9(8):406-413.

Snape JR, Maund SJ, Pickford DB & Hutchinson TH (2004) Ecotoxicogenomics: the challenge of integrating genomics into aquatic and terrestrial ecotoxicology. Aquatic Toxicology 67(2):143-154.

Snell TW, Brogdon SE & Morgan MB (2003) Gene expression profiling in ecotoxicology. Ecotoxicology 12(6):475-483.

Sugni M, Mozzi D, Barbaglio A, Bonasoro F & Candia Carnevali MD (2007) Endocrine disrupting compounds and echinoderms: new ecotoxicological sentinels for the marine ecosystem. Ecotoxicology 16(1):95-108.

Theodorakis CW (2001) Integration of genotoxic and population genetic endpoints in biomonitoring and risk assessment. Ecotoxicology 10(4):245-56.

Vasseur P & Cossu-Leguille C (2003) Biomarkers and community indices as complementary tools for environmental safety. Environment International 28(8):711-717.