Syllabus

11:375:340 Environmental Applications of Organic Chemistry (undergraduate)

16:375:522 Environmental Organic Chemistry (graduate)

Instructor: Lisa Rodenburg

Credits: 3

Book: None. See electronic text on sakai.

Course description: This course uses concepts from organic chemistry and applies them to environmental systems. In the first half of the class, the physico-chemical properties of organic compounds will be discussed, with emphasis on Henry's Law and octanol-water partitioning. Student will learn how to use these physico-chemical properties to calculate the partitioning of organic chemicals in environmental systems. The second half of the course will focus on reactions of organic compounds that are important in the environment, including acid-base reactions, nucleophilic substitution reactions (especially hydrolysis), and redox reactions. The students will then use all of the concepts learned in the course to predict the lifetimes of organic chemicals in the environment.

Pre-requisite: Elementary Organic Chemistry (Chem 209) or two semesters of Organic Chemistry (Chem 307 & 308). Or instructor approval.

Grading:

> **Undergraduate (340):** grades will be based on attendance (5%), homework (20%), two mid-term exams (20% each), and one final exam (35%).
>
> **Graduate (522):** grades will be based on attendance (5%), homework (5%), two mid-term exams (20% each), one final exam (25%), and one final project (25%)

Attendance policy: Attendance is required. If for any reason you cannot come to class, you must notify the instructor at least 48 hours in advance of the class session and receive permission to miss a class period. In the case of illness or accident, you must provide a doctor's note or other documentation of your situation in order to avoid losing points from your attendance score.

LEARNING GOALS (undergraduate only):

This course addresses goals 1, 2, 4, and 7 of the Environmental Science curriculum, namely:

Students completing this program will be able to:

1. apply knowledge from the sciences and mathematics to environmental problems and solutions;
2. use the skills and modern environmental science techniques and tools necessary for a successful career in the field;

3. design and conduct experiments, and analyze and interpret data;
4. function effectively on multidisciplinary teams;
5. communicate technical information effectively (orally, in writing, and through electronic media).

Additionally, they will understand:

6. professional ethical responsibilities;
7. contemporary environmental science issues and the impact of environmental science in a global and societal context;
8. the need, and have the ability, to engage in lifelong learning and to participate in professional organizations.

ASSESSMENT ACTIVITIES (undergraduate only):

1. **Ability to apply knowledge from the sciences and mathematics to environmental problems and solutions**

Instructional Activity:

Knowledge of chemistry, physics, and mathematics will be applied to predict the partitioning, behavior, and fate of organic chemicals in the environment.

Assessment Activity:

Exams 1 and 2 and the final exam will require the student to calculate the partitioning of an organic chemical between various media. Grades on exam 1 (30%), exam 2 (30%), and the final exam (40%) will determine the overall assessment.

2. **use the skills and modern environmental science techniques and tools necessary for a successful career in the field;**

Instructional Activity:

EPA's Epiwin Software will be used to determine the physical-chemical properties of an organic chemical and to calculate its fate in the environment. Also, simple box models of the type used to calculate Total Maximum Daily Loads will be constructed to predict fate. The final exam will utilize Epiwin and box models.

Assessment Activity:

Grade on the final exam (100% of assessment)

3. **Not applicable**

4. **function effectively on multidisciplinary teams;**

Instructional Activity:

Students will work in teams of between 2 and 4 to solve all homework assignments.

Assessment Activity:

Homework is turned in complete and on-time. (50%)
Fellow team members judge the student's teamwork as acceptable (50%)

5. **Not applicable**

6. **Not applicable**

7. **contemporary environmental science issues and the impact of environmental science in a global and societal context**

Instructional Activity:

Case studies of the fate of organic chemicals in real-world systems will be explored in class. The final exam will examine a real-world scenario of chemicals in a real system. Students will calculate a TMDL in the final homework assignment.

Assessment Activity:

Grade on final homework assignment (50%)

Grade on final exam (50%)

Approximate timeline:

Date	Topic	Readings
	Section I: Equilibrium	
1	Review of chemical structures and nomenclature/Thermodynamics review	Chs 1,2,3
2	Molecular forces: van der Waals, polarity, and H bonding	
3	Vapor Pressure	
4	Vapor Pressure	Ch 4* pp 98-109
5	Solubility in water	Ch 5* pp 135-164
6	Solubility in water	
7	Henry's Law	Ch 6* pp 182-185, 197-204
8	Henry's Law	
9	Octanol-Water Partitioning	Ch 7* pp 214-218, 223-235
10	Octanol-Water Partitioning	
11	Calculating equilibrium partitioning in complex environmental systems	
12	Three phase water column partitioning and gas-particle partitioning	
13	MIDTERM EXAM I	
14	Sorption	Ch 9* pp 280-313
15	Sorption (Groundwater partitioning)	
	Section II: Reactions	
16	Organic Acids and Bases	Ch 8
17	Partitioning of acids and bases	
18	Review of reaction kinetics	Ch 12
	SPRING BREAK	
19	Nucleophilic substitution reactions, including hydrolysis	Ch 13* pp 491-540
20	Hydrolysis	
21	Redox reactions	Ch 14
22	Gas-phase oxidation of organics and formation of tropospheric ozone	
23	Water-phase oxidation of simple organics/drinking water disinfection	
24	Biotic oxidation and reduction	
25	Reductive dehalogenation	
26	Predicting the biodegradability of organics	
27	MIDTERM EXAM II	
	Section III: Predicting the lifetimes of chemicals in the environment	
28	Box models	
29	Special topic: Chirality	
30	Graduate students present final projects	
31	final projects OR review for final	

* Graduate students should read the entire chapter