CHEM 470 ***ENVIRONMENTAL BIOCHEMISTRY*** *Winter 2018*

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Introduction: The title of this course is broad enough to cover a multitude of possible subjects within the general realm of biochemistry and the environment. I have chosen to define "environmental biochemistry" in two basic ways. First, we will examine how organisms cope with environmental stresses at the biochemical level. Second, we will look at some ways in which biochemistry and molecular biology can be used to devise more environmentally "friendly" ways of using natural resources.

Environmental stresses are many. It is not too difficult to imagine what sorts of stresses are placed on organisms by the presence of xenobiotics. We will look at the biochemical effects of some representative organic and inorganic compounds. Interest in the biochemistry of these processes stems from the possibility of predicting or preventing toxic effects, or in using biological activities to remove these compounds from the environment.

Other types of environmental stresses faced by organisms will be examined, including: temperature extremes; radioactivity; and difficulties in obtaining necessary nutrients. At least some organisms have evolved the ability to deal with stresses such as these: we will study how they cope at the molecular level.

Of what use is a study of these processes? On a very basic level, it expands our knowledge of what organisms on the planet are capable of: often, we generalize from what we know about human or mammalian biochemistry, forgetting that other life forms deal with the world differently. There are also numerous potentially important applications of these processes. For example, agricultural crop plants are sensitive to stresses such as nutrient-poor soils, temperature extremes, and attack by insects. Since some plants (and even other organisms) can deal with these stresses better than others, engineering resistance into crop plants may be used to improve agricultural productivity. Although desirable traits have been engineered into plants by traditional breeding techniques, an understanding of the biochemistry and molecular biology of environmental stress allows the potential to effect much more rapid change using genetic engineering.

The second aspect of this course is using our knowledge of biochemistry and molecular biology to devise more environmentally friendly ways of exploiting natural resources. Living organisms are often able to carry out synthetic or degradative reactions much more cleanly and inexpensively than the corresponding industrial process. One example of this is biological nitrogen fixation, which is far less energetically expensive than the corresponding industrial process, which is carried out at high temperatures and pressures. The possibility of using and manipulating organisms to replace wasteful or inefficient industrial processes is currently of considerable interest.

Of course, biotechnology does not offer the only possible solutions to environmental problems. While that is what we emphasize in this course, there are also physical and chemical methods that hold much promise.

For some of the work in this course, you will have to search the scientific literature for information. To ensure that you will find the right information, there will be a session in the library about searching for information and which sources are considered reliable. This session will be given **Thursday January 25th, 2018** by Krista Alexander, the librarian responsible for chemistry and biochemistry.

Goals

1. To become familiar with environmentally-related biochemistry and molecular biology.
2. To examine the potential applications of this knowledge.

Moodle website

There is a Moodle website for this course which will contain up-to-date information on the course. You are expected to take part of this information.

Topics

1. Introduction
2. Some basic environmental chemistry; soil, air and water
3. Pollution sources, fates and cleanup; what defines toxicity?
4. Mammalian detoxification of organic chemicals
5. Regulation of gene expression by pollutants
6. Endocrine-disrupting chemicals
7. Toxicological testing
8. Microbial degradation of aromatic and aliphatic compounds
9. Microbial degradation of chlorinated organic compounds
10. Regulation of degradative processes and strain construction
11. Microbial tolerance of solvents and drugs
12. Some practical aspects of bioremediation
13. Metals in the environment
14. Mammalian responses to heavy metals
15. Microbial responses to heavy metals and ionizing radiation
16. Biosensors for chemical pollutants
17. Artificial evolution to enhance detoxification activities
18. Plant responses to heavy metals
19. Acquisition of metals by plants
20. Phytoremediation
21. Tolerance to low temperatures
22. Biological alternatives to industrial processes

Grading

Class Exam:	30 %
Assignments:	25 %
Class participation	5 %
Final Exam:	40 %

Assignments must contain proper references, following the guidelines handed out during class and the library session. **Failure to follow these instructions will lead to deductions from the mark**. There will be 5 assignments, due on Jan. 25th, Feb 13th, Mar 13th, Mar 27th, and April 5th, respectively. Deductions will be made on late assignments. You will, however, be given 5 grace days to use at your discretion.

The class exam is scheduled for **February 27th, 2018**. There will be one make-up test a week after the class exam, which you must have my permission to write. No excuses are accepted for missing the make-up test. If you are unable to write the final exam, you must make arrangements with the examinations office in order to write a make-up final exam at a later date.

Resources

There is no textbook for this course. Extensive notes will be provided via the Moodle website for this course. The notes have references to several scientific papers. Most of these are available online from the library. Readings also include some chapters or pages in books left on reserve in the library.

Books on reserve at Vanier library

Alexander, M., Biodegradation and Bioremediation, 2nd ed., 1999.
Alloway, B.J., and Ayres, D.C., Chemical Principles of Environmental Pollution, 2nd ed., 1997.
D.W. Connell, Basic Concepts of Environmental Chemistry, 2nd ed., 2005.
Environmental Biotechnology, Concepts and Applications. H.-J. Jördening and J. Winter, eds. 2005.
Manahan, S.E., Environmental Chemistry, 9th ed., 2010.
Sterner, O., Chemistry, Health and Environment, 2nd ed. 2010.

Other resources

Website:
There is a website set up for this course at the library website
http://www.concordia.ca/library/guides/chemistry/chem470.html

You can also find it by going to the Concordia Library website,
Click on subject guide in the sentence “Find databases & more via the subject guide for your department”
Scroll down to Science where you will find Chemistry & Biochemistry.
In “Chemistry subject guide: you click on Course guides and you will see a list of all CHEM courses, including CHEM 470 Environmental Biochemistry

This site contains information on additional resources, including useful websites. Papers used as references for lectures can also be found at this website.

PLAGIARISM AND OTHER FORMS OF ACADEMIC DISHONESTY

The academic code of conduct can be found in section 17.10 of the academic calendar (http://www.concordia.ca/academics/undergraduate/calendar/current/17-10.html). Any form of unauthorized collaboration, cheating, copying or plagiarism found in this course will be reported and the appropriate sanctions applied. The Department of Chemistry and Biochemistry offers a seminar on the academic conduct code and the appropriate use of information sources which aims to clarify what practices will be considered unacceptable with regards to work submitted for grading in Chemistry and Biochemistry courses. Attendance at this seminar is highly recommended and represents a clear and fair opportunity to learn what our faculty regards as academic misconduct. Failure to take part in this learning opportunity and thus ignorance of these regulations is no excuse and will not result in a reduced sanction in any case where academic misconduct is observed. This short seminar (1 hour) will be held at the following times (note that late-comers will not be admitted):

Date	**Time**	**Place**
Monday, Jan. 22	16:45-17:45	CC-310
Tuesday, Jan. 23	16:45-17:45	CC-310
Wednesday, Jan. 24	16:45-17:45	CC-310
Wednesday, Jan. 24	20:45-21:45	HC-157
Thursday, Jan. 25	16:45-17:45	CC-310
Thursday, Jan. 25	20:45-21:45	CC-310
Friday, Jan. 26	16:45-17:45	CC-310

As space for each of the seminars is limited by the room size, please **sign up** to your preferred time as soon as possible (slots fill up quickly). Sign-up sheets are available two weeks in advance of the seminars outside SP 201.01 (Departmental office).