

Soil and Environmental Biochemistry (ENR 6610)
Course Syllabus
Winter/Spring Semester 2014

Instructor for
classes from
January 7 to
February 20:

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Office Hours: Anytime (just call or email)

Meeting Times: Soil and Environmental Biochemistry (ENR 6610) meeting times will be on Tuesdays and Thursdays. Lectures will be on Tuesdays from 2:20 – 3:40 PM in Columbus (Kottman 333C) and, on most Thursdays, via a two-way live TV link between Wooster (Gerlaugh 123) and Columbus (Kottman 333C). I will generally be in Wooster for the video lectures.

Course Materials: Students are encouraged to create a folder or loose-leaf binder containing recommended readings and other course content. Most class overheads are posted on the web (<http://senr.osu.edu/about-us/courses/enr6610>).

Course Philosophy and Content: Soil and Environmental Biochemistry (ENR 6610) is a two credit semester course designed to explore the concept that soil can be considered a tissue, with many kinds of living and life-derived cells, to which biochemical techniques are applicable. J. W. Quastel (In A. D. McLaren and G. H. Peterson (eds.), *Soil Biochemistry*, Vol. 1, Marcel Dekker, New York, 1967) adopted the conceptual theme that "the soil as a whole can be considered an organ comparable in some respects to a liver or a gland to which may be added various nutrients, pure or complex degraded plant materials, rain, and air, and in which enzymatic reactions can occur. The products of these reactions are important steps in elemental cycles, in the percolation (movement) of iron and aluminum humates, in the formation of soil crumb structure, and in other processes. The notion here is that *the soil biochemist is concerned more with what the microbes are doing in soil than with precisely what they are in respect to size and shape or the ingredients of taxonomic schemes.*"

Topics of major concern in this course will be the biochemical reactions and mechanisms involving carbon, nitrogen, phosphorus, sulfur and the trace elements in soil. Following will be discussion of the biochemistry of xenobiotics in soil and the fate of biologically active molecules and genetic material in soil. The last part of the quarter will be an introduction to the biochemistry of the plant root rhizosphere.

Course Objectives:

Specific course objectives are:

- A. For the student to become accustomed to thinking of soil-related problems in biochemical terms.
- B. For the student to acquire and demonstrate understanding of the biochemical reactions and mechanisms of the carbon, nitrogen, and phosphorus cycles and of heavy metals in soils.

C. For the student to investigate the biochemical reactions and mechanisms associated with the fate of natural and man-made biologically active chemicals added to soils.

D. For the student to develop skills in critically evaluating scientific findings related to soil and environmental biochemistry and in preparing and presenting oral and written technical information.

The Course in Brief:

Preface and Introduction

I. Soil Biochemistry: Its Definition and Scope (Lecture 1)

A working definition of soil biochemistry will be introduced. A description of how the physical, chemical, and biological components control biochemical reactions, will be presented. An important concept discussed as part this chapter is that of the soil microsite. Biochemical reactions in soil take place at a particular locus that can be described by the various soil components. The difference between microbial presence and microbial activity in soil will be described.

II. Soil Enzymes and Enzyme Kinetics (Lectures 1 and 2)

Classification of enzymes, enzyme kinetics, and the regulation of enzyme reactions will be discussed. The source of enzyme activity and how this activity is stabilized in soil are important topics. Examples and illustrations will be used from the discipline of soil biochemistry.

III. The Microbial Biomass and Soil Biochemistry (Lecture 3)

The microbial biomass plays a central role in many important biochemical transformations in soil (e.g. mineralization and immobilization of elements). Various methods of determining microbial biomass and evaluating biomass dynamics will be presented.

IV. Biochemistry of Carbon Transformations in Soil (Lectures 4-5)

Material presented will describe the major carbon-containing materials added to soils, radioactive decay and ¹⁴C-dating, the formation and characterization of humus and the biochemical reactions of humus, free radical formation and coupling of aromatics in soil, the cycling of carbon in soils (i.e. the degradation of naturally occurring organic compounds in soils and carbon turnover), and the metabolism of phenolics.

V. Biochemistry of Nitrogen Transformations in Soil (Lecture 6-7)

A description of the N compounds found in soil and the major biochemical transformations that comprise the N cycle in soils will be discussed. Topics include mineralization, immobilization, nitrification, and gaseous losses of N through ammonia volatilization and denitrification. Attention will be focused on several specific biochemical reactions catalyzed by enzymes such as urease, the amidases, the proteases, and the deaminases. Also specific enzymatic reactions involved in the degradation of nucleotides and various amino acids will be presented.

VI. Biochemistry of Phosphorus and Sulfur Transformations in Soil (Lectures 8)

A description of P and S compounds in soil will be followed by discussion of mineralization-immobilization reactions and oxidation-reduction reactions of P and S in soils. The role of specific enzymes in degrading P- and S-containing plant and microbial residues in soil will be discussed.

VII. Biochemistry of Metal Transformations in Soil (Lecture 9)

This chapter will focus on the oxidation-reduction reactions of metals (Mn, Fe, Se, etc.) that are enzymatically catalyzed in soil. Other biochemical reactions that bring about the production of volatile forms of metals will be presented. The effects of heavy metals in the soil environment, which have been introduced by man's activities or which are present naturally, on many soil biochemical reactions will be presented. A specific portion of this section will focus on the biologically important iron-binding compounds called siderophores,

VIII. Biochemistry of Xenobiotics in Soils (Lecture 10)

The main chemical families of xenobiotics will be surveyed. The effect of various xenobiotics on the biochemical reactions in soil will be addressed. Topics presented under the general heading of xenobiotic metabolism will include the relationship between the structure of a xenobiotic molecule and its persistence in soil, general biochemical reactions which are important in the degradation of xenobiotics, and specific pathways of breakdown of various xenobiotic chemicals.

IX. Biochemistry of Biologically Active Materials in Soil (Lecture 11)

Production and persistence of plant hormones, allelopathic responses in soil, production of antibiotics by microbes and their activity in soil, and pathogenic and viral introduction and survival in soil will be topics introduced.

Teaching Methods and Grades:

Teaching methods that will be used in the course include lectures, assigned readings, problem solving and discussion.

Final grades for this section of ENR6610 will be calculated by weighting participation, project quality, and the midterm examination as follows:

Participation	15%
Project (written)	15%
Project (oral)	15%
Midterm Examination	55%
	100%

Midterm exam date and type will be decided at a later time.

Discussion:

1) Each Tuesday every student is to bring to class a question, on a separate sheet of paper, which can be discussed by the class. This must be more than a simple yes-no question because such questions do not lead to discussion. Questions can arise out of the lectures, reading, your own studies, etc. They must, however, be relevant to the topics currently being addressed in the course.

2) Each week students will also be required to submit two exam questions based on the material being covered in class. Please send these to me via e-mail. These should include multiple choice, matching questions, or questions that can be answered with one or two words. One additional question requiring a longer response (two to four sentences) will also be required. These must be submitted each week to obtain participation credit. Finally, by the end of the quarter, each student

will be required to submit three essay questions. These can be submitted any time during the quarter.

3) Participation in “in-class” discussion will be monitored. No comment or discussion is really inappropriate in a learning environment. Participation by all is absolutely essential for a discussion format to be successful.

Project:

Objectives:

A. For the student to thoroughly assimilate, digest and understand specific topics (chosen by the student) from among the vast subject material which composes soil biochemistry.

B. For the student to learn writing and oral skills required in the scientific and professional community for presentation of knowledge.

The Task:

The project will be a two-fold activity. The first activity will involve choosing a research journal paper and writing a lay interpretation of the results. Papers chosen must have as their theme a topic that is related to the subject matter of soil biochemistry. If there is a question about the appropriateness of a paper to be used for this activity, please review the topic with me before beginning. Two samples of such types of writing can be found at:

http://senr.osu.edu/sites/senr/files/imce/files/course_materials/enr6610/Project_1A.pdf

http://senr.osu.edu/sites/senr/files/imce/files/course_materials/enr6610/Project_1B.pdf

http://senr.osu.edu/sites/senr/files/imce/files/course_materials/enr6610/Project_2A.pdf

http://senr.osu.edu/sites/senr/files/imce/files/course_materials/enr6610/Project_2B.pdf

The second activity will be a 10-15-minute oral presentation in which you will provide a quick overview and lead a discussion on the paper for which you wrote your lay interpretation. These presentations will probably take place on February 14, 2013. The order of presentation will be determined by random draw.

Evaluation:

Evaluation will be made in two areas which will receive equal weight: (i) the organization and writing of material in a concise but readable and understandable summary and (ii) the quality of the oral presentation. This project will count for 30% of your grade for my portion of ENR 6610.

Other Items of Importance:

Availability of Special Accommodationa. If special accommodations are needed because of a disability, please contact me as soon as possible. Assistance from the Office For Disability Services will be obtained to verify the need for accommodations and to develop accommodation strategies.

Academic Misconduct. The University's Code of Student Conduct defines academic misconduct as "[a]ny activity that tends to compromise the academic integrity of the University, or subvert the educational process" (<http://oaa.osu.edu/coam.html>). Students charged with Academic Misconduct will be referred to the University Committee on Academic Misconduct for any further action.