

**SOS 6161**  
**BIOAVAILABILITY OF SOIL NUTRIENTS - Fall 2007**  
**Course information**

**Instructor:**

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**Office Hours:**

Call for specific appointments in office or on-line

**Objectives:**

1. To introduce soil and plant factors that affect a plant's ability to acquire nutrients from the soil.
2. To introduce the concept of soil nutrient bioavailability as a soil environmental service
3. To synthesize these factors and concepts into a conceptual and mathematical nutrient uptake model, and
4. To discuss the limitations of current nutrient uptake models and limitations in investigatory techniques and current knowledge.

**Delivery Method**

On campus:                   Lecture supported by Vista Web CT and model simulations. On campus are encouraged to participate in the Bulletin Board maintained for the class

Off campus:                 Lecture by way of PowerPoint presentations in Vista Web CT, supported by a bulletin board in Vista Web CT, chat rooms in Breeze, model simulation and email interchanges.

**Target Students**

1.     Graduate students interested in soil fertility related to plant growth and production
2.     Graduate students interested in soil fertility related to natural ecosystem function
3.     Graduate students interested in nutrient bioavailability as an environmental service

This course is appropriate for students who are studying soil science, agronomy, forestry, horticulture, botany and the environmental sciences who wish to have a better understanding of the soil nutrient supply mechanism in natural and managed ecosystems. The information in this course should be useful to ecosystem managers and related to plant production, water quality and soil

quality. The processes stressed in this course are appropriate for all ecosystems and all plant root/soil interactions. It should promote a basic knowledge that will allow the user to frame relevant questions based on solid first principles of science.

**Class Attendance:**

On campus: Class attendance is required because class discussion is the basis of this course. If you don't attend class, you are not taking the class.

Distance education: Class attendance of chat sessions and participation in bulletin board activities are required because they are the basis of this course. If you don't participate, you are not taking this class.

**Grading:**

Attendance/participation	15%
Homework	10%
Exam 1	25%
Exam 2	25%
Exam 3	25%
Final Exam (optional; choice of the student)	can substitute for up to 2 Exams

All exams are take-home exams. Late submission of exams or homework will result in a reduced grade which will be proportional to how late is the submission. The grading scale is as follows:

A	90-100%
B+	85-89%
B	80-84%
C+	75-79%
C	70-74%
D+	65-69%
D	60-64%
F	< 60%

**Required Text:**

There is no required text.

**Useful Text References:**

Barber, S.A. Soil Nutrient Bioavailability: a mechanistic approach. 2<sup>nd</sup> Edition. Wiley & Sons. ISBN 0-471-58747-8.

This is a basic text that is easy to read and is a good source of examples for each of the major nutrients. However, it is weak in developing the theory and modeling.

Tinker, P.B and P.H.Nye. 2000. Solute movement in the rhizosphere. Oxford University Press. 444 pp.

Nye, P.H. and P.B. Tinker. 1977. Solute movement in the soil-root system. Univ. of Calif. Press. 342pp. [This book is out of print but we have permission from the publisher to copy it. It will be available by the middle of the first week of class from the University Copy Center on University Avenue.]

These two texts above are the best references around on nutrient bioavailability. While they are more difficult to read, you will find them outstanding reviews of the literature. The 1977 version is also an excellent handling of the math and modeling that represents the models you will see used in this class.

Rudall, P. 1987. Anatomy of flowering plants: An introduction to structure and development. Edward Arnold (Ltd.) 80 pp.

Fahn, A. 1990. Plant anatomy. (4th Ed.). Pergamon Press. 588pp.

These two texts will provide some background on root anatomy. The information you need will be presented in the course, however these are recommended as good background.

Glinski, J. and J. Lipiec. 1990. Soil physical conditions and plant roots. CRC Press, Inc. 250pp.

While this is older, it is a nice representation of how soil physical properties affect roots. It is an excellent reference from which much course material is drawn.

**ACADEMIC HONESTY:** As a result of completing the registration form at the University of Florida, every student has signed the following statement: "I understand that the University of Florida expects its students to be honest in all their academic work and understand that my failure to comply with this commitment may result in disciplinary action up to and including expulsion from the University". *We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity.*

**UF COUNSELING SERVICES:** Resources are available on-campus for students having personal problems or lacking clear career and academic goals which interfere with their academic performance. These resources include: 1) University Counseling Center – 301 Peabody Hall, 392-1575, personal and career counseling; 2) Student Mental Health, Student Health Care Center, 392-1171, personal counseling, 3) Sexual Assault Recovery Services (SARS), Student Health Care Center, 392-1161, sexual assault counseling, and 4) Career Resource Center, Reitz Union, 392-1601, career development assistance and counseling.

**SOFTWARE USE:** All faculty, staff, and students of the University of Florida are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against university policies and rules, disciplinary action will be taken as appropriate.

**STUDENTS WITH DISABILITIES:** Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Student Office will provide documentation to the student who must then provide this documentation to the instructor when requesting accommodation.

### **Course outline, Concepts Covered and Readings**

This outline describes the major and sub-topics covered by this course. We will follow the topics in order with an attempt to keep the on-campus and DE sections together. This will allow for both sections of students to participate in the chats and bulletin board discussions if they so wish. I will post after each on-campus lecture the material covered that day and any additional information for the DE students. Likewise, I will go over interesting discussions that occurred with the DE students via chat and bulletin board at the beginning of each on-campus class. Students from both sections are encouraged to interact. Ask each other questions and use each other as resources. A common discussion board will be set up for this purpose. The readings below are given as supporting material from the Barber text in case you would like backup information.

#### **I. Introduction**

Early history, more recent history, current thought and definitions for bioavailability, defining plant nutrient uptake, role of plant and soil in defining the concept of bioavailability.

Readings: Pages: 1-8

#### **II. Soil and Plant Water**

Continuity Equation and law of conservation of mass, Darcy's Law, chemical free energy of water, chemical potential of water, hydraulic conductivity, water release curve, transpiration and water uptake, water movement in the rhizosphere. Mass flow, diffusion, Fick's Law, effective diffusion coefficient, derivation of diffusive flux, diffusion in the continuity equation,

Readings: Pgs: 41-top of 45; Chapter 4; 180-185; 202 to top of 206; 231-236; 262-267; 278-281; 301-302; 311-314; 318-321; 330-334; 338-341; 345-348; 353-355; Chapter 20

*First Exam*

#### **III. Solute Interchange between solid and liquid soil phases**

Need for interchange from solid to maintain nutrient availability, equilibrium reactions, kinetic reactions, buffering of the soil solution, review of concentration and activity, buffer power, inner sphere/outer sphere equilibrium reactions, exchange reactions, partition coefficient, adsorption/desorption isotherms, zero to first order rate reactions, mineralization, modeling mineralization.

Readings: Pgs: 9-41; 180-185; 190-196; 206-217; 233-239; 263-267; 279-286; 303-305; 321-325; 356-363

#### **IV. Roots as a boundary condition to uptake from the soil**

Root functions, root anatomy relative to uptake, mycorrhizae, nutrient uptake process in the root, active passive uptake, uptake of organic compounds directly, Michaelis-Menten kinetics, scaling

from cell to whole root, morphology of a root and root system, controls on morphology, soil mechanical resistance and root development, root modeling.

Readings: Pgs: Chapter 3; Chapter 4; Chapter 6; Chapter 7; 85-190; 217-221; 239-246; 267-274; 286-292; 305-308; 325-327; 334-336; 348-351; 363-365

### *Second Exam*

#### **VI. Modeling nutrient uptake using mass flow/diffusion theory**

Assumptions made for modeling, combining mass flow and diffusion, modeling uptake, single root in infinite soil volume, competition between two roots, spatial patterns of roots, examples of use for various nutrients

Readings: Pgs: Chapter 5; 196-199; 221-226; 246-249; 255-259; 274-275; 295-298; 314-316; 365-368

#### **VIII. Problems and limitations with current attempts to model uptake**

Assumptions, limitations presented by assumptions, ways of overcoming limitations, processes not accounted for

### *Third Exam*

### *Final Exam (Cumulative over the semester)*