**ECOSYSTEM ECOLOGY**

PLB 545, 3 H Credit

Spring 2013

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Required Text: Schlesinger, W.H. and E. Bernhardt 2013. *Biogeochemistry - An Analysis of Global Change.* Academic Press, San Diego, CA.

Additional readings: Foundational scientific papers in biogeochemistry (see last page of syllabus), others may be added over the course of the semester

Course Objectives: This course will focus on the fundamentals of atmospheric chemistry, cycling of major nutrients in the lithosphere and biosphere, and global change phenomena. Through this course students will gain an understanding of: 1) major reservoirs of nutrients in the atmosphere, lithosphere and biosphere, 2) factors regulating transformations of nutrients and fates of nutrients in ecosystems, and 3) global consequences of human modifications to reservoirs, transformations and fluxes of nutrients.

Grading Policy:

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|---|---|
| Midterm Exam (Feb 27th) | 120 pts |
| Final Exam (May 7th) | 120 pts |
| Review Paper (Due April 5nd) | 100 pts |
| Peer reviewed presentations | 20 pts |
| Total | 360 pts |

*Examinations*. Exams will cover lecture material and all reading assignments. Exams will be short answer and essay format.

*Review Paper*. OPTION 1: Select an element *other than* C, N, or P and review its natural cycling and human alteration to pools and fluxes of that element. OPTION 2: Review how human alteration to a specific ecosystem has altered a biogeochemical cycle (or interactions between cycles) in that system. **All topics need to be approved by February 6 and no two students can review the same topic.** REQUIREMENTS: References to the literature should be the format for publication in *Ecosystems*. Papers should be 9-10 manuscript pages in length (not including title page or literature cited), contain 15 citations to the peer-reviewed literature (additional sources can be used but do not count as peer-reviewed), and formatted to contain 1 inch margins, New Times Roman font (12 pt), and double spaced throughout. If you choose to include a table or figure from the literature, then it needs to be cited and should be attached to the manuscript following the literature cited (**not** embedded within the text).

*Presentation.* Each student is required to give a presentation on their review paper. Presentations will be limited to 12 minutes with 3 minutes for questions. Presentations will be reviewed by other students in the course and the grade will be derived from the average of those evaluations. PowerPoint is the only acceptable format.

PLB **545 LECTURE SCHEDULE** (subject to modification)

| **Week** | **Lecture topic and reading assignment** |
|---|---|
| Jan 14, 16 | Syllabus; Introduction (Ch.1): defining ecosystem ecology; Why biogeochemistry? Thinking like a biogeochemist: *Phanerozoic cycles of sedimentary carbon and sulfur* (Garrels and Lerman 1981)] |
| Jan 20 (NO CLASS), 22 | Thermodynamics (Ch. 1) ; Origins (Ch. 2): Oxidation Reduction; Origin of life and metabolic pathways; *Biological chemistry: building cells from elements* (Sterner and Elser 2002) |
| Jan 28, 30 | The Atmosphere (Ch. 3): structure, composition & circulation; reactions in the troposphere |
| Feb 4, 6 | The Atmosphere (Ch. 3): reactions in the stratosphere; global climate models; IPCC 2007 Report<br>**Review paper topic approval by Feb 6** |
| Feb 11, 13 | The Atmosphere (Ch. 3): atmospheric deposition; *Atmospheric deposition of nutrients and pollutants in North America: an ecological perspective* (Lovett 1994)**;** *Acidic deposition in the Northeastern United States: Sources, inputs, ecosystem effects, and management strategies* (Driscoll et al. 2001) |
| Feb 18, 20 | The Lithosphere (Ch. 4): major classifications of soil; phosphorus cycle; weathering; soil development |
| Feb 25, 27 | **Feb 27 –Midterm Exam** |
| Mar 4, 6 | *Mar 4: Guest lecture TBA*<br>*Mar 6: No Class; Read - The fate of phosphorus during pedogenesis* (Walker & Syers 1976); |
| Mar 11, 13 | **SPRING BREAK – No classes** |
| Mar 18, 20 | Carbon Cycling in Terrestrial Ecosystems (Ch. 5): photosynthesis, water and nutrient use efficiency<br>*Nutrient cycling and nutrient use efficiency* (Vitousek 1982) |
| Mar 25-27 | Carbon Cycling in Terrestrial Ecosystems (Ch. 5): net and gross primary productivity, net ecosystem productivity. *The strategy of ecosystem development* (Odum 1969) |
| Apr 1, 3 | Carbon Cycling in Terrestrial Ecosystems (Ch. 5): Production of detritus, decomposition<br>**Review paper due APRIL 5** |
| Apr 8, 10 | Soil organic matter and global change (Ch. 5); Global C cycle (Ch. 11)<br>**Apr 10 Student presentations:**<br>**1)**_____ **2)**_____ **3)**_____ **4)** _____ **5)** _____ |
| Apr 15, 17 | Biogeochemical cycling on land (Ch. 6): Plant N uptake, effects on N availability, assimilation, and fixation, and allocation.<br>**APR 17Student presentations:**<br>**6)**_____ **7)**_____ **8)**_____ **9)**_____ **10)** _____ |
| Apr 22, 24 | Biogeochemical cycling on land (Ch. 6): N cycling in soil; Global N cycle (Ch. 12); *Nitrogen mineralization: challenges of a changing paradigm* (Schimel and Bennett 2004)<br>**APR 24 Student presentations:**<br>**11)**_____ **12)**_____ **13)**_____ **14)**_____ **15)** _____ |

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|---|---|
| Apr 29,<br>May 1 | Ecosystem studies: quantifying whole ecosystem flux; Acid rain, N saturation; *Effects of forest cutting and herbicide treatment on nutrient budgets in the Hubbard Brook watershed-ecosystem* (Likens & Bormann 1980); *Is nitrogen deposition altering the status of northeastern forests?* (Aber et al. 2003)<br><br>**MAY 1 Student presentations:**<br>**16)**_____ **17)**_____ **18)**_____**,19)**_____ **20)** _____ |
| **TUESDAY MAY 7** | **Final exam: 12:50-2:50 (Lecture Room)** |

## CITATIONS FOR REQUIRED READINGS and other classic biogeochemistry papers


Aber, J. D., C. L. Goodale, S. V. Ollinger, M. L. Smith, A. H. Magill, M. E. Martin, R. A. Hallett, and I. L. Stoddard. Is nitrogen deposition altering the status of northeastern forests? Bioscience 53: 375-389.

Garrels, R. M., and A. Lerman. 1981. Phanerozoic cycles of sedimentary carbon and sulfur. *Proceedings of the National Academy of Science* 78: 4652-4656.

Hobbie, S.E. 1992. Effects of plant species on nutrient cycling. *Trends in Ecology and Evolution* 7:336-339.

Likens, G.E, F.H. Bormann, N.M. Johnson, D.W. Fisher, and R.S. Peirce. 1970. Effects of forest cutting and herbicide treatment on nutrient budgets in the Hubbard Brook watershed-ecosystem. *Ecological Monographs* 40:23-47.

Lovett, G.M. 1994. Atmospheric deposition of nutrients and pollutants in North America: an ecological perspective. *Ecological Applications* 4:629-650.

Odum, E. P. 1969. The strategy of ecosystem development. Science 164:262-270.

Schimel, J.P. and J. Bennett. 2004. Nitrogen mineralization: challenges of a changing paradigm. Ecology 85:519-602.

Sterner, R. W., and J. J. Elser. 2002. Ecological stoichiometry. Princeton University Press, Princeton, N. J., USA.

Vitousek, P. M. 1982. Nutrient cycling and nutrient use efficiency. American Naturalist 119:553-572.

Vitousek, P.M. 1994. Beyond global warming: ecology and global change. *Ecology* 75: 1861-1876.

Vitousek, P. M., P. R. Ehrlich, A. H. Ehrlich, and P. A. Matson. 1986. Human appropriation of the products of photosynthesis. BioScience 36:368-373.

Walker, T. W. and J. K. Syers. 1976. The fate of phosphorus during pedogenesis. Geoderma 1-19.