**MICROBIAL BIOGEOCHEMISTRY AND GLOBAL CHANGE**

SWES 410 / 510, 3 units

Cross-listed as EEB 427 / 527, PLS 427 / 527, GEOS 424 / 524

Spring 2014, Fri 12:30 – 3pm, Saguaro Hall, Room 223

### INSTRUCTORS

### Virginia Rich (SWES) [vrich@email.arizona.edu](mailto:vrich@email.arizona.edu)

### Saguaro Hall 309, 626-1309

### Scott Saleska (EEB) [saleska@email.arizona.edu](mailto:saleska@email.arizona.edu)

### Biosciences West 510, 626-1500

**OFFICE HOURS**  Open door policy, appointment recommended.

**TEXT** Readings from the primary literature, distributed during the course via D2L.

**COURSE DESCRIPTION**

Microbes are the drivers of planetary biogeochemistry. They produce half the oxygen on the planet, and likely fix more than half the carbon. They introduce bioavailable forms of nitrogen into the biosphere. If human life ceased to exist, the central biogeochemical cycles would continue turning. However, while the planet’s biogeochemistry can persist readily in the *absence* of human life, that does not mean that humankind’s *presence* lacks impact. The Anthropocene (era of human impact) has seen significant changes to planetary stocks and fluxes of C, N, S, etc. Many of these changes involve or impact microbes, and have significant impacts on biogeochemical cycles. To understand microbial biogeochemistry in *today’s* world, one must include the context of global change. And, conversely, one cannot understand the trajectory of global change without understanding microbial feedbacks via biogeochemical cycles. In this interdisciplinary undergraduate and graduate class we will cover major microbial biogeochemical cycles, and how these cycles are impacted by, and feedback to, global change. To understand the research in this area, we will also discuss current methods in both microbial ecology and biogeochemistry, ranging from molecular meta-omics to the use of isotopes as biogeochemical tracers. Lectures will be mixed with journal club-style readings and discussions, so active participation essential. This course is designed for graduate students from diverse backgrounds and advanced undergraduates.

**COURSE OBJECTIVES**

A major goal of this course is to provide integrated upper-division and graduate training in microbial biogeochemistry within the context of global change. This course contributes to undergraduate & graduate training in speaking and presentation skills,

with instructor and peer feedback on improving individuals’ presentation skills. The course also aims to improve participants’ objective analysis and discussion of the primary literature.

**EXPECTED LEARNING OUTCOMES**

By the end of this course, you will be comfortable reading primary literature in both fields (biogeochemistry & microbiology) and be familiar with the key concepts and major methods of each, including environmental metagenomics, -transcriptomics, and proteomics, micrometeorological methods, isotope ratios as tracers of biogeochemical cycling, and isotopes as probes of microbial function (stable isotope probing). You will also be familiar with the key concepts in global change, and, focally, the connections between global change and microbial biogeochemistry. Some topic areas: understanding the role of microbes in the local and global cycles of carbon, nitrogen and water, in processes in the soil, oceans, the biota, and the atmosphere. Your critical reading and discussion skills will be honed within the interdisciplinary setting of mixed backgrounds. In addition, you will have an overview of some of the research being done at the fields’ intersection, and have developed opinions about its strengths, weaknesses, and future trajectories.

**SCHEDULE**

Each class period will be a mix of a ~1-hr instructor lecture and ~1.5-hr topically-matched student-led journal club presentation and discussion (of classic and/or cutting-edge papers). At the start of the semester students will sign up to present based on their interest.

VR gone ; both gone ; SRS gone

Date Lecturer Topic

1/17 VR & SRS Intro to course, IDing background of students to shape course content

1/24 VR 1. Why study microbial biogeochemistry?

2. Molecular Microbial Ecology: key concepts & methods overview

1/31 SRS Biogeochemistry: key concepts & methods overview –

With partial guest lecture by geochemist **Jon Chorover** on the thermodynamics of biogeochemical reactions; lab website <http://swes.cals.arizona.edu/chorover_lab/Home.html>

2/7 VR & SRS Methods to link microbes to biogeochemistry

1. Mini-guest-lecture by **Moira Hough** (classmate) on modeling of microbes for biogechemistry

2. Guest discussion leader theoretical ecologist **Joshua Weitz** on modeling microbial communities; lab website <http://ecotheory.biology.gatech.edu>

2/14 SRS Isotopes in Biogeochemistry (water, carbon, nitrogen)

2/21 VR (Rodeo days) The C cycle from the microbes’ side, take 1: autotrophy

2/28 VR The C cycle from the microbes’ side, take 2: heterotrophy

3/7 SRS 1. Partial guest lecture on Fungal decomposition by **Naupaka Zimmerman**, postdoc in the Arnold Lab; personal website [http://naupaka.net](http://naupaka.net/)

2. C cycle: from the biogeochemistry perspective

3/14 MBS Viral roles in biogeochemical cycling, guest lecture by environmental

virologist **Matt Sullivan**; lab website at <http://www.eebweb.arizona.edu/faculty/mbsulli/>

3/21 ­ – No class, spring break

3/28 VR The N cycle: the microbiological perspective

4/4 SRS The N cycle: the biogeochemistry perspective

4/11 FD The water cycle & links to microbiology, guest lecture by

hydroclimatologist **Francina Dominguez**; lab website at <http://www.atmo.arizona.edu/~dominguez/Site/Home.html>

4/18 SRS/VR Overview of other key cycles (e.g. S) or emergent topic of burning

interest

4/25 ­ – Student project presentations & discussions

5/2 ­ – Student project presentations & discussions

**STUDENT PRESENTATIONS, WRITE-UPS, & PROJECT**

Grading is based upon **attendance, participation, weekly summaries, journal-club presentations, and final project presentations**.

1. *Attendance & discussion participation* is expected, and required for a passing grade. Graduate students are expected to be especially active in discussion participation and in linking discussed topics to their own research and backgrounds.

2. *Weekly summaries*: Each week before class all students will turn in (on D2L) a concise (e.g. 1-2 paragraphs) summary of that week’s paper(s)’s key points, its notable successes or failures of communication, and a list of at least 3 questions about the work. Briefly include:

* An introduction of the research topic and its importance, **and** an explanation of how the paper(s) contributes to the research topic - what are the take-home points the paper(s) makes.
* A description of the approach the authors took – what experimental design and methods were used (summarized, not detailed!) – and do you think they were appropriate? Are there other methods you think might have been useful or better?
* Did the authors communicate their work effectively? How or how not?
* Any the next experiment or analysis that you think should be performed?
* In bullet form below your text, include at least 3 Qs you have about the paper(s).

To accomplish the above with brevity, use concise, direct language. Avoid run-on sentences. And always check your spelling and grammar.

3. *Journal club presentations & discussion leadership*: Once or twice during the semester (depending on enrollment), each student will lead journal club paper(s) discussion. Leadership will be evaluated by both peers and instructors.

*Suggestions to students for making a good journal club presentation:* Your job is create a dialogue with the class , not just to lecture. You yourself need to understand the following points so you can help guide the discussion, and fill in gaps in understanding and helpful background. The resulting discussion should collectively address:

(i) EXECUTIVE SUMMARY: Specifically solicit a classmate to summarize the paper, up front, covering all the below concepts : who can state as neutrally as possible what the paper purports to do? THEN delve into the details below…

ii) the intellectual / scientific problem(s) the paper is addressing - get this from the group. What is the specific Q or hypothesis being addressed?

As a presenter you may wish to provide additional background context to this overall scientific motivation for the paper. (For example, in a paper looking at carbon cycling in thawing permafrost microbial community using metaproteomics, you might provide background information on global warming-induced permafrost thaw, arctic microbial carbon cycling, molecular biology’s Central Dogma, and environmental proteomics. Briefly describe the actual experimental plan and results; these will be covered in more detail by the entire group during discussion.)

(iii) Solicit from the group: how did the authors go about addressing the problem? (experimental plan & methods)

(iv) Solicit from the group: what are particular challenges associated with these method(s)?

As a presenter you may wish to provide additional background to key or confusing methods, and insights into methodological challenges/limitations

(v) Solicit from the group: what were the take-home results, and do folks believe them?

As a presenter you may wish to highlight points of confusion, dubious statistics, challenging graphs/figures…

4. *Final project presentations:* Through the semester, in consultation with the instructors, each student will focus on a particular aspect of microbial biogeochemisty or global change in which they are especially interested. They will read 3 (undergraduate student) or 6 (graduate student) research papers on that topic that collectively span its microbial biogeochemistry and global change. They will prepare a 15” (may vary based on enrollment) presentation synthesizing their findings and understanding of the specific interactions between microbial and biogeochemistry involved, and the current and future anticipated links to global change. These presentations will be delivered to the class during the final two class sessions. Again, presentations will be evaluated by both peers and instructors.

Final presentation evaluation criteria:

*“Never give a bad talk.” – Phil Gschwend, Environmental Chemist, MIT*

Practicing is *strongly* recommended. Presenters will be cut off at the end of their allotted time, and 5” of discussion will follow each presentation. Presentations will be evaluated on the following:

1. Is the organization of the talk clear from the start? Is the planned organization followed?
2. Is the topic introduced, with sufficient and engaging background?
3. Are the links between microbes, biogeochemistry, and global change clearly made by the end of the talk?
4. Are concepts clearly conveyed, with
   1. succinct explanations,
   2. appropriate examples, and
   3. informative visual aids?
5. Are slides cluttered? Are many words used where 1-2 would suffice as placeholders?
6. Are graphics consistently attributed to their source?
7. Are literature or knowledge sources referenced?
8. Is the information correct?
9. Is the presentation style physically professional? (no nail-biting, swaying, etc)
10. Is the style verbally smooth? (after the first 5”☺)
11. Is there a good rapport developed with the audience (eye contact, “presence” in the space, etc)?
12. Was the presenter able to get through everything in 15”?

**EXAMS** There are no exams for this class.

**GRADING** Your final grade will be determined by total number of points accumulated from attendance and class participation, weekly write-ups, journal-club presentations and leadership, and final presentation.

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| --- | --- |
| Attendance & Class Participation | 25 |
| Weekly Summaries | 25 |
| Journal-club presentation and leadership | 25 |
| Final presentation | 25 |
| Total | 100 |

Graduate-level requirements include (i) a twice-as-extensive background reading and synthesis component for their final presentation as the undergraduates, (ii) an active leadership role in group discussions.

**GRADE SCALE** A: 90-100 %, B: 80-89 %, C: 70-79 %, D: 60-69 %, E (fail): 0-59 %

**TEXTBOOK** None required.

**SUGGESTED READING** Readings will be from the primary literature, to be distributed electronically.

**HONORS STUDENTS**

Honors students will be admitted with permission from the instructor, and their additional assignment(s) will be negotiated individually based on their backgrounds and goals.

**POLICY ON EXPECTED CLASSROOM BEHAVIOR**

* Due to the interdisciplinary nature of this seminar, a good classroom attitude is critical – come ready to learn and to share your own knowledge graciously. Each individual within this classroom will be treated with respect, by instructors and peers. Rude or insulting behavior will result in dismissal from the class.
* Vigorous *collegial* debate is encouraged, and expected. Feedback will be constructive.
* Each student is expected to attend every class session; however, all holidays or special events observed by organized religions will be honored for those students who show affiliation with that particular religion, and absences pre-approved by the UA Dean of Students (or Dean's designee) will be honored.
* Laptops are allowed in class but checking email is not.
* Cell phones are OFF during class period.

**POLICY AGAINST PLAGIARISM**

<http://deanofstudents.arizona.edu/codeofacademicintegrity>

**POLICY AGAINST THREATENING BEHAVIOR** <http://policy.web.arizona.edu/~policy/threaten.shtml>

**ACADEMIC INTEGRITY**

Integrity is expected of every student in all academic work. The guiding principle of academic integrity is that a student's submitted work must be the student's own. This principle is furthered by the *Student Code of Conduct* and disciplinary procedures established by ABOR Policies 5-308 - 5-403, all provisions of which apply to all University of Arizona students. For further information, please see: <http://deanofstudents.arizona.edu/codeofacademicintegrity>

**ACCESSIBILITY AND ACCOMMODATIONS**

It is the University’s goal that learning experiences be as accessible as possible.  If you anticipate or experience physical or academic barriers based on disability, please let me know immediately so that we can discuss options.  You are also welcome to contact Disability Resources (520-621-3268) to establish reasonable accommodations.

Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

**EVOLVING SYLLABUS**

Information contained in the course syllabus, other than the grade and absence policies, may be subject to change with reasonable advance notice, as deemed appropriate by the instructors.