A NOTE ON DISCUSSION FORMAT AND PAPER/TOPIC SELECTION

Weekly Discussions

Each student will lead a discussion on a topic and readings -- either derived from the example list (see below), or a topic of their choosing, selected in consultation with the instructors. Students will conduct a literature search on the chosen topic and make two or three key references available to the entire group at least one week in advance of the presentation (possibly with additional suggestions for background material for those not as familiar with the area being discussed). These papers will form the basis of a general discussion and will be available as pdf files on the course website. Each student should meet with one of the instructors at least once before their presentation (at least two weeks in advance to allow time for consideration of the paper selection) to discuss and clarify the readings and scope of the topic.

When leading a discussion, students should prepare an overview of the general topic as well as an overview of the specific papers. This overview (which may be in the form of a powerpoint presentation) should include an outline of key points, tables or illustrations, a bibliography of relevant papers, and a list of questions to generate discussion. This overview should be made available for posting on the website after the class, where all participants may refer to it.

Paper/Topic Selection:

The goal for paper selection is to ground a discussion that integrates: **(1)** any aspect of ecosystem function that is controlled by (or might be controlled by) microorganisms or microorganismal diversity, with **(2)** the microorganisms themselves, as studied via modern molecular techniques. By ecosystem function, we mean such things as energy flow, biogeochemical cycling, ecological resilience, or mechanisms of climate regulation.

Since the goal is to advance understanding of the interactions and feedbacks between these dimensions, readings for a given discussion should therefore substantively address both dimensions, ideally within a single paper. Given the challenges presented by such integration and the relative newness of this area of research, it may not always be possible to find such papers. In some cases the integrative discussion may have to emerge from a comparison of multiple papers that collectively encompass the two dimensions.

There is an art to the selection of papers that lead to exciting and productive discussion, especially in an areas such as this, and we encourage some care in selecting papers: many papers aspire to integration as a goal, but in fact focus the actual new research on a discipline-centric area (e.g., the numerous microbial papers that describe links to biogeochemical cycles but don't actually measure anything other than genes).  Whether such papers are appropriate depends on whether there are alternative papers in that area that accomplish integration more effectively, and on whether there are effective companion papers that can be selected.

Some Potential Topics for Meta-omics and Ecosystem Function.

(note: this is a short list of possibilities – we want this to be driven by your interests as much as possible so will brainstorm together on the first day of class, and continue to welcome your ideas for your own presentation topics. The expanded list from brainstorming will be posted on the course website in the next few days).

* Any biogeochemical cycle on land, sea, or globally -- carbon, water, nitrogen, phosphorous, sulfur, hydrogen, etc. (see Falkowski et al., 2008) – on the condition that the paper(s) marry understanding of the ecosystem-scale aspects of the cycle with the microbes that drive it. Examples include Nitrogen fixation (Houlton et al., 2008), denitrification, methanogenesis (Hendrickson et al., 2007; Freitag et al., 2009), methane oxidation/methanotrophy (including the recently discovered anaerobic methane oxidation, Orphan et al. 2002), organic matter decomposition.
* Ways in which microbes may play a role in climate feedbacks. E.g. the idea that sulfur emissions (in the form of DMS) from the ocean could form Cloud condensation nuclei that importantly regulate rainfall (the original example of a mechanism that would support the Gaia hypothesis, Charlson et al., 1987). Or ways in which evolutionary ecology of microbial symbionts may affect organismal tolerance of climate change (Harmon et al., 2009).
* something from the relatively growing new field of atmospheric microbiology (Poschl et al., 2010; Womack et al., 2010).
* The biogeochemistry of plant-microbe interactions. e.g. nutrient acquisition via mycorrhizae (Martin et al. 2008), N-fixation in legumes)
* The biogeochemistry of animal-microbe interactions (e.g. termite guts, rumens) (Warnecke, et al. 2007).
* Underappreciated microbial habitats/processes with high potential importance to biogeochemistry (e.g. subphotic pelagic marine systems, basalt seafloor...; Ingalls et al 2008, Santelli et al., 2008).
* The crux of the matter – how transcripts, proteins, and enzymatic transformations (of biogeochemically-important molecules) actually correspond (e.g. Zhang et al., 2010).

REFERENCES and Paper ideas.

Please note that in addition to the published references below, additional cutting-edge ideas may be gleaned from the following federally funded programs and their recent award lists:

U.S. DOE, Biological Systems Research on the Role of Microbial Communities in Carbon Cycling (<http://genomicscience.energy.gov/carboncycle/CarbonCyclingAwards_flyer.pdf>)

U.S. NSF, Dimensions of Diversity (<http://www.nsf.gov/news/news_summ.jsp?cntn_id=117811&org=NSF&from=news>)

Blodau, C., Bernhard, M., Peiffer, S., and Moore, T.R. (2007) Support for an anaerobic sulfur cycle in two Canadian peatland soils. Journal of Geophysical Research 112: G02004

Charlson RJ, Lovelock JE, Andreae MO, Warren SG. 1987. Oceanic phytoplankton, atmospheric sulfur, cloud albedo and climate. NATURE, Volume: 326 (6114): 655-661.

Falkowski, P.G., Fenchel, T. & Delong, E.F. (2008). The microbial engines that drive Earth’s biogeochemical cycles. *Science*, **320**,1034–1039.

Freitag, Thomas E., and James I. Prosser. 2009. Correlation of Methane Production and Functional Gene Transcriptional Activity in a Peat Soil. APPLIED AND ENVIRONMENTAL MICROBIOLOGY, Vol. 75, No. 21, p. 6679–6687.

Frias‐Lopez, J., Shi, Y., Tyson, G.W., Coleman, M.L., Schuster, S.C., Chisholm, S.W., and Delong, E.F. (2008) Microbial community gene expression in ocean surface waters. *Proceedings of the National Academy of Sciences U S A* 105: 3805‐3810.

Harmon JP, Moran NA, Ives AR. 2009. Species Response to Environmental Change: Impacts of Food Web Interactions and Evolution. Science. Volume: 323(5919). Pages: 1347-1350.

Houlton, B.Z. Wang YP, Vitousek PM, Field CB. 2008. A unifying framework for dinitrogen fixation in the terrestrial biosphere. Science. Volume: 454 (7202). Pages: 327-334.

Hendrickson, Erik L., Andrew K. Haydock, Brian C. Moore, William B. Whitman, and John A. Leigh. 2007. Functionally distinct genes regulated by hydrogen limitation and growth rate in methanogenic Archaea. *PNAS*, vol. 104, no. 21, 8930–8934.

Ingalls AE, Shah SR, Hansman RL, et al. 2008. Quantifying archaeal community autotrophy in the mesopelagic ocean using natural radiocarbon. PNAS. Volume: 103 Issue: 17 Pages: 6442-6447.

Martin et al. 2008. The genome of Laccaria bicolor provides insights into mycorrhizal symbiosis. Nature. Vol 52, pp. 88-92.

Orphan VJ, House CH, Hinrichs KU, McKeegan KD, DeLong EF. 2002. Multiple archaeal groups mediate methane oxidation in anoxic cold seep sediments. PNAS. Volume: 99 Issue: 11 Pages: 7663-7668.

Poschl U, Martin ST, Sinha B, et al., 2010. Rainforest Aerosols as Biogenic Nuclei of Clouds and Precipitation in the Amazon. Science. Volume: 329 (5998). Pages: 1513-1516.

Santelli et al., 2008. Abundance and diversity of microbial life in ocean crust. Nature 453: 653-656.

Warnecke, F. Peter Luginbu, Natalia Ivanova, et al. 2007. Metagenomic and functional analysis of hindgut microbiota of a wood-feeding higher termite. NATURE Vol 450, 560-565.

Womack, Ann M. , Brendan J. M. Bohannan and Jessica L. Green. 2010. Biodiversity and biogeography of the atmosphere

Zhang WW, Li F, Nie L. 2010. Integrating multiple 'omics' analysis for microbial biology: application and methodologies. MICROBIOLOGY-SGM Volume: 156 Pages: 287-301.