

**EXAMINATION GEO4-1440 Microbes and Biogeochemistry**  
November 2, 2015 @ 1330-1630 h, BBG 079.

In total 100 credits.

**1. Microbial communities, 5 subquestions, each 3 point (15 in total).**

1.1. Check the **VALID** statement

- a) Cyanobacteria are photosynthetic organisms using light as energy source and H<sub>2</sub>O as electron acceptor that get oxidized to O<sub>2</sub>.
- b) Sulfate reducing bacteria use sulfate as electron donor
- c) Archaea are always extremophiles (live in extreme temperature and salt conditions)
- d) Roseobacter species can metabolize DMSP to DMS that contributes to the formation of clouds

1.2. Check the **INVALID** statement

- a) Thaumarchaeota are ammonia oxidizing archaea living in high temperature ecosystems
- b) An association of Anaerobic methanotrophic archaea (ANMEs) and sulfate reducers can mediate the Anaerobic oxidation of Methane
- c) Purple sulfur bacteria are anoxygenic photolithoautotrophs using light as an energy source and without generation of oxygen
- d) SAR11 are the most abundant marine bacterium

1.3. Check the **INVALID** statement

- a) Proteorhodopsin is a light driven proton pump used by many marine bacteria in case their electron transport chain is not fully functional
- b) Crenarchaeol is a archaeal membrane lipid only found in Thaumarchaeota
- c) The 16S rRNA molecule is used as a taxonomic marker because it has conserved and variable regions and is easily transmitted to other hosts by horizontal gene transfer
- d) Marine viruses have an important role in the marine food webs through the viral shunt

1.4. Check the **INVALID** statement

- a) Lipid biomarkers can be used as markers of taxonomic identity and abundance
- b) With a metagenomic analysis we can estimate the diversity of a microbial community and also its functions
- c) With Nanometer-scale secondary ion mass spectrometry we can estimate cellular uptake rates
- d) PCR is a fingerprinting method

1.5. Which of the following options would you choose to estimate the **ACTIVITY** of a microbial group

- a) Count the bacterial numbers under the microscope
- b) Estimate the diversity with a fingerprinting method like DGGE
- c) Quantify the abundance of a specific membrane lipid
- d) Incubate with a labeled substrate and detect the incorporation in the biomass

46/40

6/9

2. **Soil Biogeochemistry, litter decomposition (12 points in total, 4 per subquestion)**
- What are the main controls on the rate of litter decomposition? Name 3.
  - The addition of fresh substrate to a soil can trigger a 'priming effect'. Describe this process using positive priming, negative priming, apparent priming, and real priming.
  - Soils play an important role in the global carbon cycle, as they act as (temporary) sink of photosynthetically fixed CO<sub>2</sub>-C. The ongoing increase in atmospheric CO<sub>2</sub> concentrations may affect the capacity of soils to store C. The effects of elevated CO<sub>2</sub> are studied in so-called FACE projects. What is the influence of elevated CO<sub>2</sub> concentrations on SOC turnover? Describe the mechanisms.
3. **River biogeochemistry (8 points).**  
Briefly describe the River Continuum Concept and provide an example of human changes that interfere with the principles of this concept. 1
4. **Benthic primary producers (8 points).**  
Why is it important to study benthic primary productivity and why are microsensors an essential tool for studying benthic systems in general and benthic primary production in particular? 3
5. **CO<sub>2</sub> and biogeochemical processes (15 points, 5 per subquestion)**
- What is the effect of calcium carbonate precipitation on total inorganic carbon and alkalinity? 5
  - What is the effect of CO<sub>2</sub> efflux to the atmosphere on total inorganic carbon, alkalinity and pH? 5
  - What is the effect of nitrate based primary production on alkalinity and pH? 5
6. **Primary production in the ocean (15 points, 5 per subquestion)**
- What are the main factors governing deep chlorophyll maxima? 5
  - Give three methods to quantify algal primary productivity and their pros and cons? 5
  - Give three reasons why primary production may change in the future ocean. 5
7. **Nitrogen in the ocean (12 points, 4 per subquestion)**
- Explain the basics of the N\* concept and why is N\* low in the Pacific? 2
  - Nitrous oxide is a climate-active gas: how do humans interfere with its production in coastal systems. 1
  - Denitrification and anammox both result in the production of N<sub>2</sub> gas. Why is it important to elucidate their contributions/importance? 1
8. **Organic matter and sediments (8 points total, 2,4,2 points for subquestions)**
- Why are sediment mineralization rates declining with increasing water depth? 2
  - Why are organic matter degradation rates very low in older sediments, including the deep biosphere? 4
  - Where is most of the organic matter buried in the ocean? 2
9. **Dissolved organic matter is one of the largest pools of organic carbon on earth (7 points in total, 4 and 3 points for subquestions).**
- Give two processes that result in the formation of dissolved organic carbon. 4
  - Which two large groups of organisms consume dissolved organic carbon and in this way make it available to animals? 3

N<sub>2</sub>O

coastal