

EXAMINATION GEO4-1440 Microbes and Biogeochemistry
 November 3, 2014 @ 1700-2000 h.

In total 100 credits.

1. Complete the following table regarding the different microbial metabolisms (8 points)

Type	Energy source	Carbon source	Electron donor	Example
Photolithoautotroph	Light	....	.....	.....
Photoorganoheterotroph	Light	....	Organic compound	Purple non sulfur bacteria
.....	Inorganic compound	CO ₂	Inorganic compound	.....
Chemoorganoheterotroph	.....	Organic carbon	.....	Several bacteria and Archaea

2. Microbial symbionts inhabit the rhizosphere of *Sphagnum* mosses in peat bogs (12 points):
- Which microorganisms are involved?
 - What is the advantage/s for the plant
 - What is the benefit for the microorganism?
3. Soil microorganisms are important for the support of plant growth. (12 points).
- How do plants benefit from bacterial degradation of organic matter?
 - Some plants have root nodules. What are these nodules and which is the benefit for the plants?
 - How do fungi support plant growth?
4. CO₂ and biogeochemical processes (12 points)
- What is the effect of calcium carbonate precipitation on total inorganic carbon and alkalinity?
 - What is the effect of calcium carbonate dissolution on pH?
 - What is the effect of primary production on alkalinity and pH?

- d) What is the effect of CO₂ uptake on alkalinity, total inorganic carbon and pH?
5. Sediment oxygen consumption (9 points, 6/3)
- Give three ways how to measure sediment oxygen consumption?
 - Why is sediment oxygen consumption not equal to aerobic respiration?
6. Primary production in the ocean (16 points)
- What are the main factors governing deep chlorophyll maxima?
 - What is the rationale underlying the use of remote sensing in estimating primary production in the ocean?
 - Explain in a few lines what Sverdrup's depth model is about.
 - Give three reasons why primary production may change in the future ocean.
7. Size does matter in ocean biogeochemistry. Apply this concept to both primary producers and consumers (7 points).
8. What is the difference between carbonate saturation depth, the carbonate compensation depth and the snowline (8 points).
9. Dissolved organic matter is one of the largest pools of organic carbon on earth (8 points).
- Give two processes that result in the formation of dissolved organic carbon.
 - Which two large groups of organisms consume dissolved organic carbon and in this way make it available to animals?
10. Carbon transfer towards the ocean interior is often described in terms of carbon pumps (8 points).
- Name and explain the underlying principle of two of these pumps.
 - Which one is the most efficient in the present-day ocean.