Student Name: _____ Student Number: _____

Module 1 Origins and Earth Systems
Problem set_01 “Prokaryotes: The unseen majority”

Learning objectives:

- Describe the numerical abundance of microbial life in relation to the ecology and biogeochemistry of Earth systems.

Specific Questions:

• *What are the primary prokaryotic habitats on Earth and how do they vary with respect to their capacity to support life? Provide a breakdown of total cell abundance for each primary habitat from the tables provided in the text.*

• *What is the estimated prokaryotic cell abundance in the upper 200 m of the ocean and what fraction of this biomass is represented by marine cyanobacterium including Prochlorococcus? What is the significance of this ratio with respect to carbon cycling in the ocean and the atmospheric composition of the Earth?*

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• *What is the difference between an autotroph, heterotroph, and a lithotroph based on information provided in the text?*

• *Based on information provided in the text and your knowledge of geography what is the deepest habitat capable of supporting prokaryotic life? What is the primary limiting factor at this depth?*

• *Based on information provided in the text your knowledge of geography what is the highest habitat capable of supporting prokaryotic life? What is the primary limiting factor at this height?*

• *Based on estimates of prokaryotic habitat limitation, what is the vertical distance of the Earth's biosphere measured in km?*

• *How was annual cellular production of prokaryotes described in Table 7 column four determined? (Provide an example of the calculation)*

• *What is the relationship between carbon content, carbon assimilation efficiency and turnover rates in the upper 200m of the ocean? Why does this vary with depth in the ocean and between terrestrial and marine habitats?*

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• *How were the frequency numbers for four simultaneous mutations in shared genes determined for marine heterotrophs and marine autotrophs given an average mutation rate of* 4×10^{-7} *per DNA replication? (Provide an example of the calculation with units. Hint: cell and generation cancel out)*

• *Given the large population size and high mutation rate of prokaryotic cells, what are the implications with respect to genetic diversity and adaptive potential? Are point mutations the only way in which microbial genomes diversify and adapt?*

• *What relationships can be inferred between prokaryotic abundance, diversity, and metabolic potential based on the information provided in the text?*