

Sources and roles of non-phosphorus lipids in anoxic environments

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Recent studies observed the abundant presence of phosphorus-free lipids in anoxic waters, oxygen minimum zones and marine sediments [1, 2], suggesting that microbes living in these environments may be limited by phosphorus [3]. However, as the degradation of organic matter and microbial nitrogen cycling gradually increases P:C and P:N ratios, these areas are typically not considered as P limited.

To identify sources and potential roles of phosphorus-free glycolipids and aminolipids in environmentally-relevant anaerobic bacteria we investigated growth and lipid contents of different strains of sulfate-reducing bacteria at micromolar concentrations of phosphate. Phosphate concentrations between 2 and 36 μM , which are typically encountered in anoxic environments, significantly reduced cellular doubling times and final cell densities and altered cell size and morphology. We found that phosphorus-free lipids, including betaine lipids and glycolipids almost completely replaced phospholipids at phosphate concentrations $<4 \mu\text{M}$ indicating that these lipids function as important substitute lipids in obligate anaerobic bacteria. These findings identify phosphorus limited anaerobic microbes as sources of the abundant phosphorus-free lipids in suboxic and anoxic marine environments and confirm that phosphorus availability may limit microbial growth and activity in a much broader range of environments than previously thought.

[1] Schubotz *et al.* (2009) *Environ. Microbiol.* **11**, 2720-2734. [2] Braun *et al.* (2016) *Geochim. Cosmochim. Acta* **188**, 330-351. [3] Bosak *et al.* (2016) *PlosOne* **11**, e0168719.