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From genes to geochemistry - tracing microbial phosphorus cycling in a changing ocean.

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Phosphorus is fundamental to life, and exerts control over marine ecosystem structure and function on a variety of timescales. In the modern ocean, phosphorus is utilized and transformed by microbes in the sea driving complex metabolic and biogeochemical dynamics as the phosphorus moves between inorganic and organic forms and between dissolved and particulate phases. Once considered relatively simple, the phosphorus cycle is now recognized to be increasingly complex, with the cycling of reduced forms and unexpected linkages to the cycling of methane, iron, and other metals. Further, phosphorus metabolism is more specialized across microbial taxa than previously appreciated. Knowledge about the microbial biogeochemistry of phosphorus in the sea has been rapidly advancing. These advances are driven, in part, by new methods and molecular approaches that link genes to geochemistry. This overview will highlight aspects of marine microbial phosphorus biogeochemistry with an emphasis on recent areas of discovery, and provide examples of the role that phosphorus plays in driving the distribution and activities of marine microbes, and the complimentary role that marine microbes play in phosphorus cycle transformations. Tracing biogeochemical phosphorus cycling with complimentary approaches and perspectives, from genes to geochemistry, can provide powerful mechanistic insights critical to modeling phosphorus biogeochemistry in a changing ocean.