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Integrated omics in systems biology: The new frontier for environmental biotechnology, ecology and evolution

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Abstract
Environmental biotechnology encompasses a wide range of characterization, monitoring and control or remediation technologies that are based on biological processes. Recent breakthroughs in our understanding of biogeochemical processes and genomics are leading to exciting new and cost effective ways to monitor and manipulate the environment. Indeed, our ability to sequence an entire microbial genome in just a few hours is leading to similar breakthroughs in characterizing proteomes, metabolomes, phenotypes, and fluxes for organisms, populations, and communities. Understanding and modeling functional microbial community structure and stress responses in subsurface environments has tremendous implications for our fundamental understanding of biogeochemistry and the potential for natural attenuation or bioremediation of contaminated sites. Monitoring techniques that inventory and monitor terminal electron acceptors and electron donors, enzyme probes that measure functional activity in the environment, functional genomic microarrays, phylogenetic microarrays, metabolomics, proteomics, and quantitative PCR are also being rapidly adapted for studies in environmental biotechnology. Integration of all of these new high throughput techniques using the latest advances in bioinformatics and modeling will enable break-through science in environmental biotechnology. A review of these techniques with examples from field studies and lab simulations will be discussed.