For hundreds of years microbiology has relied on studying organisms in the laboratory. However, the vast majority of microbes have not been grown in the laboratory. Recent advances in DNA sequencing technologies and computational approaches have enabled the recovery of genomes directly from the environment, called metagenomics. This has dramatically enhanced our understanding of biodiversity and the tree of life. Also, these genomes have provided the first glimpses into the physiologies, ecology, and evolution of new branches of life. My laboratory is focused on understanding the biogeochemistry and evolution of marine sediment microbial communities. Genomes of several new microbial phyla fall within a group named “Asgard” have been obtained from carbon-rich anoxic sediments. Asgard archaea are related to eukaryotes and surprisingly their genomes contain a variety of genes previously only seen eukaryotes. Understanding the functions of the genes, which are hallmarks of eukaryotic cellular structure, will advance our understanding of the origin of eukaryotes.