Mechanisms of cryospheric life: Protein dynamics, thermodynamics, and electron transfer in psychrophilic hydrocarbonoclastic marine bacteria

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Cryosphere environments include numerous oil-rich areas, including polar regions and the deep ocean. Understanding the geomicrobiology of these environments is important for understanding mechanisms of microbial petroleum degradation. Hydrocarbonoclastic microbes are major players in global biogeochemical cycling, with applications to bioremediation and heavy oil upgrading. We are investigating proteins from psychrophilic and mesophilic hydrocarbon-degrading bacteria, specifically *Colwellia psychrerythraea* and *Marinobacter hydrocarbonoclasticus*. Using UV-visible absorption, circular dichroism, and NMR spectroscopies, X-ray crystallography, and electrochemistry, we are studying energetics, dynamics, and electron transfer in cytochromes from these organisms. We report new insights into roles of protein flexibility in structure and function in electron-transfer proteins. In addition, we explore how specific methionine residues are involved in protein stabilization and activity. Cytochromes with the native iron replaced by Zn(II) or Co(III) are used to elucidate these mechanisms. Our work suggests a series of important molecular adaptations for life in the cryosphere.