Elucidating Molecular Mechanisms of Psychrophilicity: A Study of Cytochrome c_{552} from *Colwellia psychrerythraea*

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Psychrophilic microorganisms such as *Colwellia psychrerythraea* are important both as major components of global biogeochemical cycles and for specific roles in hydrocarbon degradation and bioremediation. Using genomic information, we have overexpressed the *Colwellia* electron-transfer protein cytochrome c_{552} in *E. coli*. We have purified the protein and are characterizing its structure, dynamics, and energetics by UV-visible absorption, circular dichroism, and NMR spectroscopies, X-ray crystallography, and electrochemistry. In addition, we are studying the homologous protein from the mesophile *Marinobacter hydrocarbonoclasticus*. We report the van't Hoff enthalpies and midpoint temperatures (T_m) of unfolding for the two proteins, based on thermal denaturation experiments. The results indicate a surprising stability for *Colwellia* cytochrome c_{552} and suggest that overall protein stability and protein dynamics (flexibility) are not simply coupled in this protein. We propose a role for specific iron–methionine interactions in the protein stabilization mechanism. In addition, structural and electrochemical analyses suggest functional adaptations for microbial life in the cryosphere.