A biological cell communicates with the outside world via proteins embedded in the cell membrane. The structure and dynamics of a membrane protein are governed by soft-matter interactions of the protein with itself, with the lipid bilayer, and with water. I will show how the strengths of these interactions can be measured by using atomic force microscopy (AFM) to apply force to individual membrane proteins: the strengths of intramolecular interactions are related to how much force it takes to disrupt them and can be inferred from arguments grounded in force-dependent unfolding/refolding rates, the Crooks fluctuation theorem, or inversion of the canonical Boltzmann relation. These near-equilibrium and equilibrium single-molecule assays are facilitated by recent advances in AFM temporal resolution and force precision achieved by custom-modifying AFM cantilevers using ion beam lithography. I will then show how these assays can be extended to measure changes in membrane-protein energetics due to mutation and ligand interactions, establishing a toolbox for making precise biophysical measurements of a wide variety of biologically interesting membrane proteins.