How barrel size affects the structure and conductivity of the outer membrane protein OmpX

Curtis Balusek, Dirk Linke, and J.C. Gumbart

Gram-negative bacteria utilize various β-barrel proteins at their outer membrane to obtain ions and nutrients. Porins, a subset of outer membrane proteins, act like tunnels, through which small molecules (< 600 Da) can passively diffuse. It has been hypothesized that porin evolution could occur through gene duplication events; however, it is unclear how strand number relates to pore size. Experiments in the Linke lab [1] showed that adding duplicated strands to OmpX, an 8-stranded β-barrel in the outer membrane, produced an asymptotic ion conductance that reached a maximum well below what would be expected for a fully duplicated (16-stranded) β-barrel. To determine the structural implications of a larger strand number, we have carried out molecular dynamics simulations of native OmpX, and we have created putative structural models of the larger OmpX constructs tested experimentally. These models were created using an iterative opening and strand-addition process. We have calculated the ion conductance for each model in black lipid membranes at 1 M KCl, mimicking the experimental conditions. Correspondence between experimental and simulated conductances is used as a measure of the accuracy of the modeled structures, thus revealing the complex relationship between strand number, fold, and pore size.

[1] Arnold, Poynor, Nussberger, Lupas, Linke. Gene duplication of the eight-stranded β-barrel OmpX produces a functional pore: a scenario for the evolution of transmembrane β-barrels. (2007) *J. Mol. Biol*. 366:1174-1184.