A Method to Evaluate Membrane Protein Compatibility with Biomimetic Membranes

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Cell membrane matrices are mainly composed of lipids and membrane proteins. Membrane proteins, present in the membrane, performing a vast majority of functions including signal reception[1], material transport and biochemical reactions[2,3], that occur at membrane-liquid interfaces. High compatibility between cell membranes and membrane proteins are necessary for living organisms to finish complicated tasks and thrive in the nature[4]. Inspired by living cell systems, researchers are using lipids and lipid-like membrane matrices as models for functional biomimetic membranes development and the number of these membrane matrices are increasing. However, only compatible biomimetic membranes specific to different membrane proteins will provide desired membrane performance[5]. Highly compatible biomimetic membranes have high membrane protein reconstitution density without compromising membrane protein single molecule properties. However, there are few accurate methods for compatibility evaluation[4].

Here, we propose and test a method to evaluate membrane protein compatibility with biomimetic membranes. We use aquaporin (AQP) reconstituted biomimetic membranes (ABMs) as examples to verify the accuracy of this evaluation method. ABM is a widely accepted model system for novel biomimetic membrane research. Previous researchers found that ABMs have higher water transport rate and better salt rejection performance than traditional reverse osmosis membranes[6,7]. However, AQPs compatibility with different biomimetic membranes hasn't been studied systematically. We combined Stopped Flow Light Scattering technology and Fluorescence Correlation Spectroscopy technology for compatibility evaluation[8]. AQPs reconstitution density and single channel water permeability were accurately measured at the single molecule level. By reconstituting AQPs into different ABMs (both block copolymers and lipids), we show that AQP single channel water permeability stays similar in different membranes. However, reconstitution density varies in different materials, and AQPs have higher reconstitution density in block copolymers. We have also implemented this evaluation method on other membrane proteins and artificial water channels[9] and these results will be summarized as well.

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