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Characterization of Aquaporin Containing Vesicles via Electron Microscopy, Light- and Small Angle Scattering

Water is essential for all life forms on the planet, yet after thousands of years in which it has been an abundant resource, the situation is drastically changing to the point where water scarcity has become one of the greatest threats of the 21st century (1). Membrane filtration technologies are able to provide reliable filtered water qualities and a low footprint meanwhile presenting a high degree of automation which is essential for scalability (2). Inspired by nature, a new generation of membranes have been gaining a particular interest. Biomimetic membranes combine the mechanisms of cellular water transport via transmembrane proteins (aquaporins) with classical synthetic membrane technologies (Figure 1) (3). Even though the technology is extremely promising, preparation of biomimetic membranes is not a trivial task, as aquaporins need to be stabilized in an artificial environment that mimics the natural cell membrane (4).

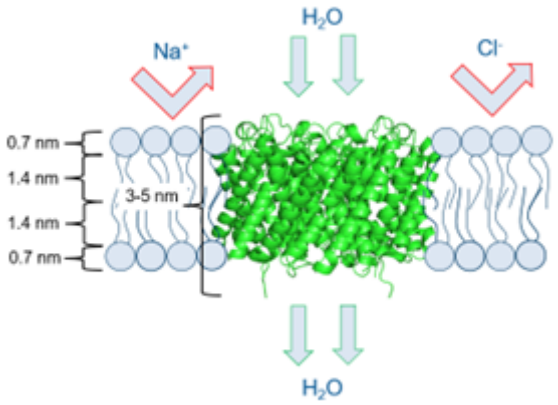

Figure 1: Figure 1: Schematics of the lipid bilayer embedded AqpZ protein transport

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In the presented work, a variety of analytical techniques are used to characterize the incorporation of aquaporin proteins in different vesicle systems, mimicking the cellular bilayer. The two types of vesicle materials in focus are natural lipids and synthetic polymers. Liposomes provide a native-like membrane environment with their lipid bilayer structure, but lack physical and chemical stability, which is a problem for most industrial applications (5). Polymersomes on the other hand, are made of block copolymers and offer greater physical and chemical stability with the opportunity for customizations. However the reconstitution of aquaporin proteins into polymersomes, while maintaining their structure and functionality, poses great challenges (6). Different tools such as Electron Microscopy, Light-and Small Angle Scattering are used to obtain structural information on the nanocarriers as well as the protein incorporation within the different types of bilayers. While Electron Microscopy can provide mostly qualitative data, Stopped-Flow Light Scattering has the potential of producing dynamic results of real-time water transport. In combination with changes of the scattering profiles that Small Angle Scattering methods can detect, information regarding the vesicles' size and shape can be derived, while via contrast variation the bilayer material can be distinguished from the protein, allowing for a quantitative assessment of aquaporins within the vesicles.

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