Purpose: Royal Society workshop in “Unifying scientific disciplines to understand and solve emerging membrane filtration challenges”
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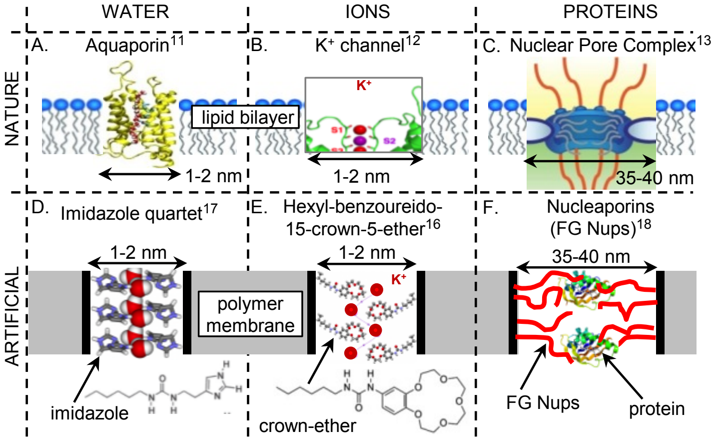
“Can we emulate Nature’s exquisite selectivity for water, ions and proteins?”

Georges Belfort
[1]Howard P. Isermann Department of Chemical and Biological Engineering, and
Center for Biotechnology and Interdisciplinary Studies
Rensselaer Polytechnic Institute, Troy NY 12180-3590

Creating a new class of membranes with the high selectivity of biological membranes and while maintaining large permeation fluxes is the holy grail of industrial membrane science and technology[1-5]. Fundamental understanding of the mechanisms underlying biological membrane structure and function and incorporating that efficiently into synthetic materials would lead to a new class of membranes critical to the solution of several grand challenge problems including water purification and production of better and less expensive medicines[6]. For example, biological membranes (containing phospholipid molecules and proteins) exhibit (a) exquisite selective transport of water, ions and proteins, among other molecules, at separation factors of α = 1 as compared with synthetic membranes (i.e. ~0.60<α < 0.985 for bioprocessing and desalination of seawater)[7], (b) but much lower permeation rates (i.e. ~10^2-10^3 lower for human Aquaporin (AQP) versus reverse osmosis) that is compensated for by very high surface areas in the body They use transmembrane protein complexes (tmPCs) that comprise molecular-scale pores (**Fig. 1A-C**)[8-13]. The pores in these natural protein separators are exquisitely designed with chemical specificity, angstroms to nanometer length scales and with angstroms tolerances. Certain species like water or potassium ions permeate these structures while others, like sodium ions, are impermeable. Recent attempts to mimic some of the properties of biological membranes with artificial supramolecular assemblies (ASAs) highlight the magnitude of our knowledge gap (**Fig. 1D-F**)[14-18]. Their permeation rates are in some cases orders of magnitude worse than corresponding natural systems.

Fig.1 BIOINSPIRED SUPRAMOLECULAR ASSEMBLIES FOR SEPARATION

Natural (A-C) and artificial (D-F) separators



In this presentation, we will compare different approaches for synthesizing nature-inspired membrane separators with separation factors of α ~ 1, describe progress to date, and present current challenges.

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