CHEMICAL ENGINEERING

DISTINGUISHED YOUNG SCHOLARS SERIES

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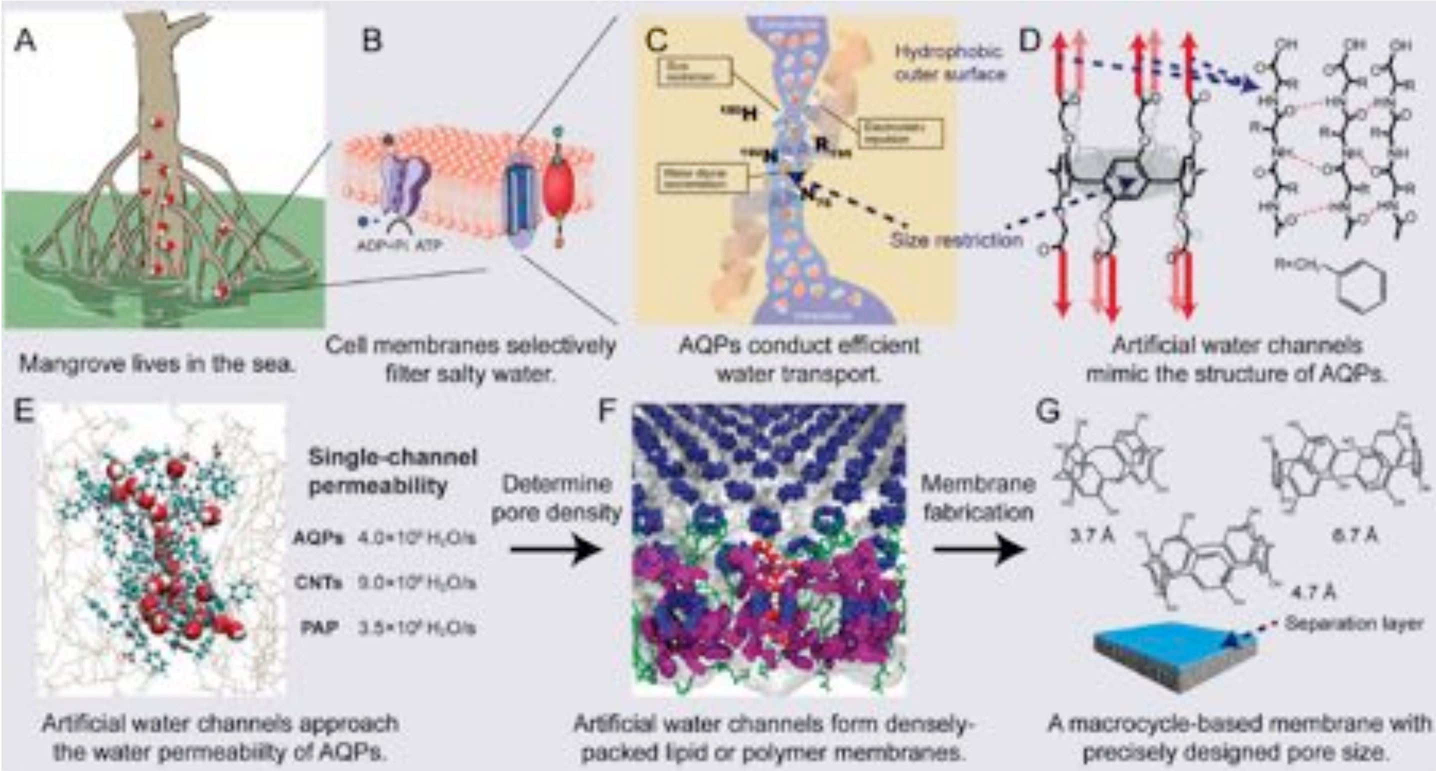
Energy efficient water purification ⊥ from biological channels to bioinspired artificial channels

ABSTRACT: Water purification is an important challenge in the 21st century globally, 1 and even in our own back- yard with surprising instances of unsafe and scarce potable water in Milwaukee, Flint and California in recent years. Membrane-based technologies have been extensively used to produce fresh water from seawater and to purify microbiologically and chemically contaminated water but are energy intensive. Nature provides excellent examples for energy-efficient desalination and water filtration. Mangrove trees purify saline water through its root systems with minimal energy input (Fig. A). In cell membranes (Fig. B), including those in the mangrove roots, biological water channel proteins aquaporins (AQPs) conduct highly efficient single file water transport through a subnanometer pore while excluding all other molecules (Fig. C).2 This mechanism, which is distinct from the solution-diffusion mechanism utilized in current solute rejecting membranes, has inspired me to work on the design of artificial structures that mimic AQPs using supramolecular chemistry and has led to the exciting development of biomimetic membranes for energy-efficient desalination around these structures (Fig. 0).3 Artificial water channels combine the advantages of AQPs and their analogues, carbon nanotubes, and improve upon them through their relatively simple synthesis and chemical stability.4 Combining the high water conductance (Fig. E) and the high pore density of artificial water channel-based membranes (Fig. F), these materials are promising energy-efficient water purification materials for the future.5 6 More importantly, the idea of molecular sieving and efficient channel-based transport using precisely designed Angstrom-scale pore structures can be applied to a wide variety of gas and liquid separations (Fig. G).



BIOGRAPHY: Yuexiao Shen received his bachelor┌s degree in Environmental Engineering from Tsinghua University, China in 2009. He investigated the fouling in large-scale membrane bioreactors for municipal wastewater treatment and finished his master┌s degree in Environmental Engineering in Prof. Xia Huang┌s research group at Tsinghua. In 2011, he moved to the Pennsylvania State University to pursue his Ph.D. degree. Under the supervision of Prof. Manish Kumar, Yuexiao Shen conducted creative research on biological water channels in lipid mimicking block copolymers and then mimicking biological water channels themselves using supramolecular chemistry and investigating them using biophysical techniques. He synthesized and characterized the first artificial channels that approach the performance of biological water channel proteins, aquaporins, with improved chemical stability. He then joined Prof. Enrique Gomez┌s lab as a postdoc to characterize 3D structures of polymeric films using advanced technologies such as electron tomography and X-ray scattering. During his Ph.D., Yuexiao has been recognized by national academic organizations and received a number of highly competitive awards including the North American Membrane Society (NAMS) Student Fellowship Award and the AIChE Separations Division Graduate Student Research Award. He is Chair elect of the Gordon Research Seminar on Membranes: Materials & Processes to be held in 2018.

LECTURE 4:00 – 5:00 (PAA) A110
Happy Hour in Benson Hall Lobby Following