The regulation of intracellular water activity is a necessary characteristic of many physiological functions in all living organisms. The high water transport rate across cell membranes is due to a type of water channel protein, aquaporin. The unique selectivity, high water transport capability, and low activation energy of aquaporins have garnered strong scientific interests with many studies concentrating on the fabrication of biomimetic membranes based on the reconstitution of aquaporins into self-assembled amphiphilic lipid or polymer bilayers. Aquaporin-incorporated biomimetic membranes possess an extremely high potential for water purification and desalination. It has been estimated that the permeability of an aquaporin Z (AqpZ) reconstituted biomimetic membrane is 167 \( \mu \text{m/s/bar} \), which is by two orders of magnitude greater than the commercial polymeric membranes. However, limitations of the biomimetic membrane lie in that the ultrathin biomimetic bilayers are too fragile to withstand high hydraulic or osmotic pressure in the water purification application. The objective of our study is to design and fabricate aquaporin embedded membranes with excellent water purification performance. We have studied the mechanism of water transport through membrane-embedded aquaporin Z and established a relationship between membrane tension and osmotic permeability of an amphiphilic block copolymer bilayers. Moreover, we have developed several innovative yet simple and easy-to-implement methods to incorporate water-channel proteins into pre-fabricated membranes to develop advanced membrane materials for purifying water at low pressures and low energy. The biomimetic membrane exhibits high water permeability as well as high salt rejection during forward osmosis, while the AqpZ-vesicle imprinted membrane exhibits high mechanical strength and stability during nanofiltration process.

About the Speaker: Associate Professor Yen Wah Tong joined the Department of Chemical and Biomolecular Engineering at the NUS in 2001. His research started with biomaterials based on peptide-amphiphile hydrogels for tissue engineering of the liver and brain together with biomolecule delivery. The major focus of his Biomimetic Materials and Systems Laboratory is thus on applying biomimetic principles for various applications, including membranes, scaffolds and processes. Recently, his group has expanded research into bioenergy using biomass wastes and municipal solid wastes, converting these into renewable fuels and chemicals. Prof Tong is currently the Assistant Dean for Research in the Faculty of Engineering at NUS. He is also the co-Programme Director for an NRF CREATE programme with Shanghai Jiaotong University “Energy and Environmental Sustainability Solutions for Megacities.”