65b Nurturing Membranes from Nature: Possible Opportunities for the Future

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Transport of ions or large macromolecules from the nucleus to the cytoplasm or from the cytoplasm to the external fluid occurs through different complex protein machines that traverse biological membranes. These and other biological transport processes are often associated with mono-dispersed pore sizes, expenditure of energy (ATP), exquisite selectivity, cyclic processes, movement of components, chaperone–like shuttle carriers, and low binding energies. Synthetic membranes, on the other hand, usually have wide pore size distributions or no noticeable pores at all, are driven by gross energy inputs (pressure or electrical), exhibit relatively low selectivity, do not regenerate and recycle molecules, do not use shuttle molecules, and are often fouled by molecules with strong binding energies.

In this paper, we will discuss these differences and look for opportunities using two diverse biological transport machines – the potassium transport channel and the nuclear pore complex. We will also ask if self-assembly could be used to prepare membranes of the future with homogeneous surfaces and very low adhesive properties. In addition, transport in cells is associated with diffusion or very low convective flows (essentially without inertia), while that in synthetic membranes usually occurs at high Reynolds number flows. Dean vortices have also been measured in blood flow and have been used in membrane filtration to increase mass transfer. Questions such as what aspects of biological transport should we mimic and what aspects should we forgo, will be addressed.