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Ion Transport Characteristics of Individual Single-walled Carbon Nanotubes Mimic Those of Biological Ion Channels HASTI AMIRI, KENNETH SHEPARD, COLIN NUCKOLLS, Columbia University — Transmembrane ionic channels play a crucial role in vital cellular activities by regulating the transport of ions and fluid across the cell membrane. Their structural complexity and flexibility as well as their many unique operational features, however, make their investigation extremely difficult. The simple, atomically smooth and well-defined structure of carbon nanotubes (CNTs) provides an excellent template for studying molecular transport at nanoscale. Additionally, CNTs have been suggested as analogues to biological pores since they share several common features such as nanometer size diameter, hydrophobic core and ultrafast water flow. Functionalizing the nanotube entrance can also mimic the selectivity filter of ion channels. In this work, we experimentally study ionic transport through individual single-walled CNTs connecting two fluid reservoirs as a function of pore properties and electrolyte type and concentration. We provide strong evidence that the electrostatic potentials arising from the ionized carboxyl groups at the pore entrance significantly influence the ion permeation in a manner consistent with a simple electrostatic mechanism. Lastly, the similarities of ionic transport mechanisms between individual single-walled CNTs and protein ion channels are discussed.

Hasti Amiri
Columbia University

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