Biomimetic membranes for sensor and separation applications - DTU Orbit (11/08/2019)

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Biological membranes constitute the set of membranes defining boundaries and organelles in living cells—the structural and functional building blocks of all known living organisms. The integrity of the cell depends on its ability to separate inside from outside and yet at the same time allow massive transport of matter in and out the cell. Nature has elegantly met this challenge by developing membranes in the form of lipid bilayers in which specialized and highly efficient transport proteins are incorporated. This raises the question: is it possible to mimic biological membranes and create membrane-based sensor and/or separation devices? In the development of biomimetic sensor/separation technology, both channels (ion and water channels) and carriers (transporters) are important. Generally, each class of transport proteins conducts specific molecular species in and out of the cell while preventing the passage of others, a property critical for the overall conservation of the cells internal pH and salt concentration. Both ion and water channels are highly efficient membrane pore proteins capable of transporting solutes at very high rates, up to 109 molecules per second. Carrier proteins generally have a lower turnover but are capable of transport against gradients. For both classes of proteins, their unique flux-properties make them interesting as candidates in biomimetic sensor/separation devices. An ideal sensor/separation device requires the supporting biomimetic matrix to be virtually impermeable to anything but the solute in question. In practice, however, a biomimetic support matrix will generally have finite permeabilities to water, electrolytes, and non-electrolytes. The feasibility of a biomimetic device thus depends on the relative transport contribution from both protein and biomimetic support matrix. Also the stability of the incorporated protein must be addressed and the protein-biomimetic matrix must be encapsulated in order to protect it and make it sufficiently stable in a final application. Here I will review and discuss these challenges and how they are met in some current developments of biomimetic sensor/separation devices.

General information
Publication status: Published
Organisations: Biophysics and Fluids, Department of Physics
Contributors: Helix Nielsen, C.
Pages: 697-718
Publication date: 2009
Peer-reviewed: Yes

Publication information
Journal: Analytical and Bioanalytical Chemistry
Volume: 395
Issue number: 3
ISSN (Print): 1618-2642
Ratings:
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.286 SNIP 1.224
Web of Science (2009): Indexed yes
Original language: English
DOIs:
10.1007/s00216-009-2960-0
URLs:
http://www.springerlink.com/content/m757215m60814784/
Source: orbit
Source-ID: 257327
Research output: Contribution to journal › Journal article – Annual report year: 2009 › Research › peer-review