Membrane Protein Chips

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Membrane proteins play very important roles in cells (e.g. recognition or transportation of molecules). They are also useful in various industrial fields, including next-generation diagnosis techniques, drug discovery, and highly sensitive ion-channel-based biosensors.

In this presentation, I will introduce our two approaches toward membrane protein chips: an array of single-species-specific membrane proteins reconstituted into (1) the surfaces of giant liposomes, and (2) planar lipid bilayers formed in microfabricated holes and channels.

In our first approach, monodisperse giant liposomes are prepared by patterning lipid films on ITO substrates with a dry lift-off process and subsequently applying voltages between the substrates. We have reconstituted peptides and aquaporins into the liposomes that are immobilized in an array on a microfluidic chip, and observed the activities of the proteins under the microscope.

In the second approach, a highly reproducible method was developed for planar lipid bilayer reconstitution. Planar lipid bilayers are formed at apertures, 100 micron in diameter, by flowing lipid organic solution and buffer alternately into an integrated microfluidic channel. Using this technique, multiple lipid bilayers are formed simultaneously in a single chip, and channel currents through peptide ion channels was recorded to prove the compatibility of the chip with single molecule electrophysiology.

We believe that these devices are useful for an efficient and rapid analysis of single-species-specific membrane proteins.

Keywords: (referred to Wikipedia):

Microelectromechanical Systems (MEMS) is the technology of the very small, and merges at the nanoscale into Nanotechnology. These devices generally range in size from a micrometer to a millimeter. They are fabricated using modified silicon fabrication technology, molding and plating, wet and dry etching, and other technologies capable of manufacturing very small devices.

MicroTAS is short for micro(μ) total analysis systems. It can be used to refer to **Lab-on-a-chip** (LOC): This is a term for devices that integrate (multiple) laboratory functions on a single chip of only millimeters to a few square centimeters in size and that are capable of handling extremely small fluid volumes down to less than pico liters. Lab-on-a-chip devices are a subset of *MEMS* devices and often indicated by *μTAS* as well.

*A **membrane protein*** is a protein molecule that is attached to, or associated with the membrane of a cell or an organelle. Membrane proteins can be classified into two groups, based on their attachment to the membrane.

***Bilayer lipid membranes (BLMs)*:** Within a critical range of concentrations, certain kinds of lipids alone in a test tube of water will self-organize to form a "bilayer". Such membranes can be used in research, for instance on their electrical behavior (using the patch clamp technique, for example).

*A **liposome*** is a spherical vesicle with a membrane composed of a phospholipid bilayer used to deliver drugs or genetic material into a cell. Liposomes can be composed of naturally-derived phospholipids with mixed lipid chains, or of pure components like DOPE (dioleolylphosphatidylethanolamine). The lipid bilayer can fuse with other bilayers, thus delivering the liposome contents. By making liposomes in a solution of DNA or drugs, they can be delivered past the lipid bilayer.