Progress Toward Artificial Cells

August 11 2009

(PhysOrg.com) -- In cosmetics, lipid vesicles, also known as liposomes, effectively transport ingredients through the skin. However, they are also used to encapsulate pharmaceuticals and release them at the intended point of treatment. They are used as tiny biochemical reactors, and in research they serve as models for biomembranes and cells. A team led by Shoji Takeuchi at the University of Tokyo (Japan) has now developed a simple, highly efficient method for the production of vesicles. As reported in the journal *Angewandte Chemie*, it is based on microfluidic T junctions.

The applications described above all require unilamellar vesicles, which means that the vesicle membrane must consist of a single lipid double-layer. In addition, the vesicles need to be of uniform size - about the same size as a natural cell. Also, the desired contents must be effectively encapsulated. In order for the vesicles to carry a sufficient load, the substances must be used in highly concentrated solution. Previous production methods could not achieve all of these goals or were too complex.

The Japanese team has now developed a new method that is simple but still meets all of these needs. The secret of their success is a microfluidic technique in which tiny volumes of liquid flow through tiny channels. This elicits effects that do not occur in systems of “normal size”. The scientists’ microfluidic system consists of a main channel with many delicate side channels that branch off (T junctions). These broaden into little chambers. First water is introduced, then a solution of lipids in oil, then water again. When the water rinses the oil (or the oil rinses the water) out of the main channel, a small amount remains behind in the chambers.

This results in a fine film of oil whose two boundary layers facing the water contain lipid molecules arranged in a monolayer. The lipids do this because they consist of a water-friendly section and a fat-friendly portion. A gentle flow through the side channels and a simultaneous flow through the main channel push the oil film out of the chamber and press it together so that the two lipid monolayers join to form a double layer. This lipid film then bulges out into the main channel and follows the direction of flow. Obstacles designed into the system ensure that the bulge closes itself off into a spherical vesicle. This produces vesicles of uniform size. The tiny volumes used minimize the consumption of agents and reagents while achieving high throughput.

The researchers were also able to incorporate proteins into their lipid membranes to form pores and encapsulate a complete gene expression system. These are the first steps toward the development of artificial cells.

More information: Shoji Takeuchi, Microfluidic Formation of Monodisperse, Cell-Sized, and Unilamellar Vesicles, Angewandte Chemie *International Edition*, doi: 10.1002/anie.200902182

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