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Trapping Cells And Organelles

Technique selectively encapsulates single cells and subcellular structures

CELIA HENRY

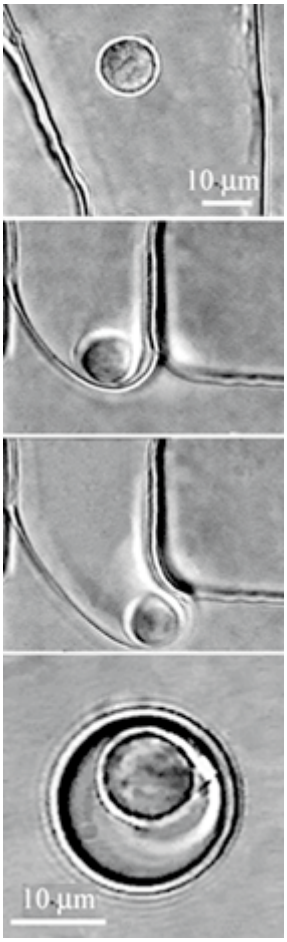
A new method enables individual cells or subcellular components to be encapsulated in aqueous droplets surrounded by an immiscible phase in a microfluidic device. Assays or other chemical reactions can then be performed within the droplet, according to Daniel T. Chiu and coworkers at the University of Washington, Seattle (*Anal. Chem.* **2005**, 77, 1539). Chiu also reported the work at the Pittsburgh Conference in Orlando, Fla., held last week.

"We're trying to develop this droplet platform into a nanolab for single-cell or single-organelle measurements so that we can do the kind of chemical manipulation that you cannot do otherwise with a bulk macroscopic container," Chiu says.

Because the volume of the droplet can be carefully controlled, the volume can approach that of the cell or organelle, avoiding problems of diffusion and dilution that can happen in an open microchannel. Chiu has demonstrated that encapsulated cells can be quickly opened with laser photolysis, essentially freezing the cell in its state at the time of photolysis. In addition, he has performed enzymatic assays with lysed cells.

"Although the approach is probably not applicable to analysis of every constituent in the cell, Chiu and his team beautifully demonstrated all steps needed to assay a model component in one cell," says Z. Hugh Fan, a microfluidics expert in the department of mechanical and aerospace engineering and the department of biomedical engineering at the University of Florida. "The confined volume provides a significant advantage for studying biomarkers and signaling pathways in a single cell due to the fact that there is no diffusion into and dilution with the surroundings."

Chiu has three methods for forming droplets. In the most widely used method, the aqueous solution is in one arm of a T-shaped intersection between two microchannels and the oil phase is in a second arm. With a laser beam, the particle being trapped is moved and held at the interface between the two phases. The pressure applied to the aqueous phase is slowly increased until a droplet forms and shears off, trapping the cell or organelle inside. Chiu's team has trapped both single cells and mitochondria this way.



GOTCHA Top to bottom: A single B lymphocyte cell is being encapsulated in an aqueous droplet surrounded by silicone oil.

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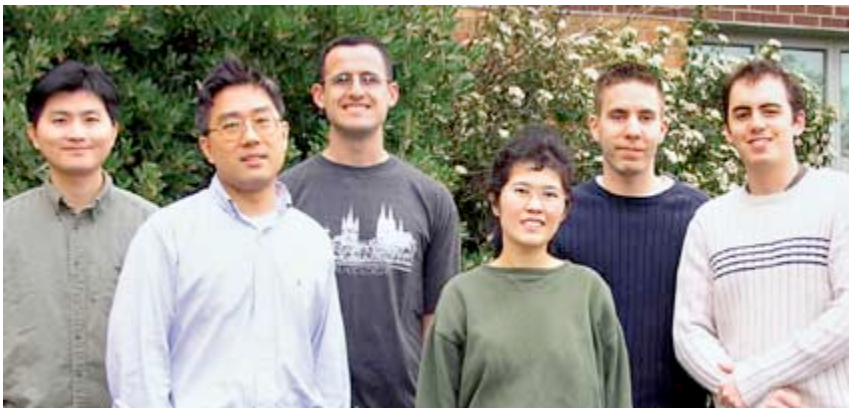
The disadvantage of this method, Chiu says, is that it requires a precisely controlled flow. "You have to be able to start it and stop it, and that turns out to be challenging." Other methods for forming droplets that Chiu is starting to use include sending the aqueous solution through a nozzle and using an electric field to assist in droplet formation.

"We might use a shear method if we want to generate a continuous stream of droplets," he

says. "For single droplets on demand, the nozzle and electric field methods work much better."



TRAPPERS Jason S. Kuo (left to right), Chiu, Robert M. Lorenz, Mingyan He, J. Scott Edgar, and Gavin D. M. Jeffries used optical methods to manipulate cells and trap them in droplets.

COURTESY OF DANIEL CHIU

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