Microwell Arrays for Studying Many Individual Cells

Lyndon B. Johnson Space Center, Houston, Texas

“Laboratory-on-a-chip” devices that enable the simultaneous culturing and interrogation of many individual living cells have been invented. Each such device includes a silicon nitride-coated silicon chip containing an array of micro-machined wells sized so that each well can contain one cell in contact or proximity with a patch clamp or other suitable single-cell-interrogating device. At the bottom of each well is a hole, typically 0.5 µm wide, that connects the well with one of many channels in a microfluidic network formed in a layer of poly(dimethylsiloxane) on the underside of the chip. The microfluidic network makes it possible to address wells (and, thus, cells) individually to supply them with selected biochemicals. The microfluidic channels also provide electrical contact to the bottoms of the wells.

This work was done by Albert Folch and Turgut Fetih Kosar of the University of Washington for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809.

Droplet-Based Production of Liposomes

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A process for making monodisperse liposomes having lipid bilayer membranes involves fewer, simpler process steps than do related prior methods. First, a microfluidic, cross-junction droplet generator is used to produce vesicles comprising aqueous-solution droplets contained in single-layer lipid membranes. The vesicles are collected in a lipid-solvent mix that is at most partially soluble in water and is less dense than is water. A layer of water is dispensed on top of the solvent. By virtue of the difference in densities, the water sinks to the bottom and the solvent floats to the top. The vesicles, which have almost the same density as that of water, become exchanged into the water instead of floating to the top. As there are excess lipids in the solvent solution, in order for the vesicles to remain in the water, the addition of a second lipid layer to each vesicle is energetically favored.

The resulting lipid bilayers present the hydrophilic ends of the lipid molecules to both the inner and outer membrane surfaces. If lipids of a second kind are dissolved in the solvent in sufficient excess before use, then asymmetric liposomes may be formed.

This work was done by Donald E. Ackley and Anita Forster of Nanotrope, Inc. for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809.

Identifying and Inactivating Bacterial Spores

NASA’s Jet Propulsion Laboratory, Pasadena, California

Problems associated with, and new strategies for, inactivating resistant organisms like Bacillus canaveralius (found at Kennedy Space Center during a survey of three NASA clean rooms) have been defined. Identifying the particular component of the spore that allows its heightened resistance can guide the development of sterilization procedures that are targeted to the specific molecules responsible for resistance, while avoiding using unduly harsh methods that jeopardize equipment.

The key element of spore resistance is a multilayered protein shell that encases the spore called the spore coat. The coat of the best-studied spore-forming mi...
crobe, *B. subtilis*, consists of at least 45 proteins, most of which are poorly characterized. Several protective roles for the coat are well characterized including resistance to desiccation, large toxic molecules, ortho-phthalaldehyde, and ultraviolet (UV) radiation.

One important long-term specific goal is an improved sterilization procedure that will enable NASA to meet planetary protection requirements without a terminal heat sterilization step. This would support the implementation of planetary protection policies for life-detection missions. Typically, hospitals and government agencies use biological indicators to ensure the quality control of sterilization processes. The spores of *B. canaveralius* that are more resistant to osmotic stress would serve as a better biological indicator for potential survival than those in use currently.

*This work was done by David Newcombe, Anne Dekas, and Kasthuri Venkateswaran of Caltech for NASA’s Jet Propulsion Laboratory.*

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