NANO HIGHLIGHT
Laser-Guided Assembly of Living Cell Microarrays

NSF NIRT Grant 0404030

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The functionality of a cell can be used for the mass production of proteins and other nanostructures; biochemical and environmental sensing; drug development; and even computation. However, to harness it effectively, the *in vivo* microenvironment of a cell must be emulated. And while some cell types express tissue-specific features in a two-dimensional (2D) culture system, it is apparent that a three-dimensional (3D) environment is required by others. Living cell microarrays, assembled in a synthetic hydrogel matrix using optical tweezers for hierarchical control of the cell positions, are a suitable platform for exploiting the functionality of the cell. Optical tweezing affords nanometer-scale 3D control over the cell position, while the biocompatible hydrogel mimics the natural extracellullar matrix. As shown in Figure 1, we have created arrays of optical traps, formed either holographically or through time-sharing a single beam with λ=930nm, for manipulation of hundreds of *P. aeruginosa* bacteria into a 2D array with an time-averaged power <2mW per trap. And we used the same apparatus to assemble a 3D heterotypic array of a Swiss-3T3 mouse fibroblasts surrounded by a ring of 20 P. aeruginosa bacteria (Fig. 2) without loss of cell viability. The hydrogel is formed using a prepolymer solution consisting of poly(ethylene glycol) diacrylate(PEGDA) monomers grafted with biodegradable and adhesive amino acid sequences, gelled using a photoinitiator and short exposure to 365nm light. Cell viability of the array was verified using a LIVE/DEAD kit.

This is the first time that living cell microarrays of such complexity have been synthesized. The stringent nanometer-scale accuracy and precision of the cell placement, which is preserved in the hydrogel, is an essential element of tissue engineering, enabling the assessment of microenvironment of living cells and materials that can accommodate biological activity such as growth and structural adhesion.

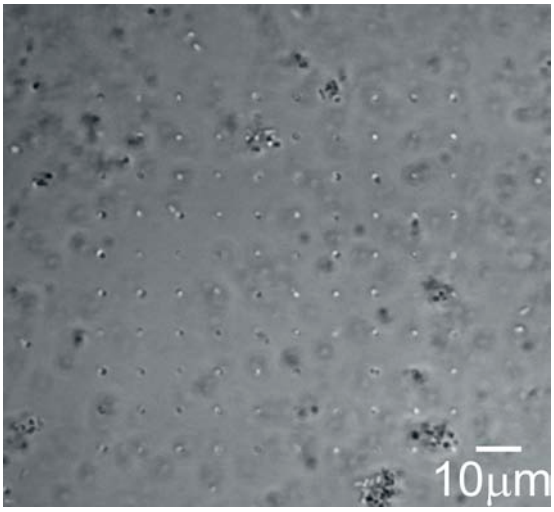

Figure 1. 10x10 Living cell microarray P. aeruginosa bacteria formed using a time-shared array of optical tweezers.

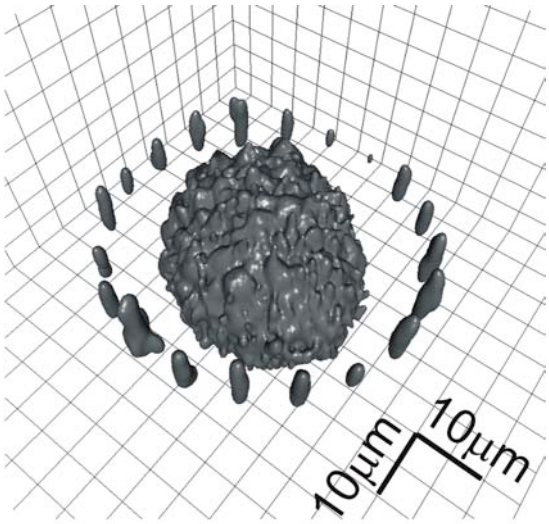

Figure 2. Heterotypic microarray of Swiss-3T3 mouse fibroblast surrounded by a ring of 20 P. aeruginosa bacteria formed with optical tweezers.