Microfluidic Platform for High-Density Cell Delivery

Generates chemical cues to a dense array of cells while simultaneously using image-based assays to observe cell response at single-cell resolution

Georgia Tech inventors have designed a microfluidic technology that generates chemical cues to a dense array of cells while simultaneously using image-based assays to observe cell response at a single-cell resolution. The design couples arbitrary chip design with a chemical signal generator using a perforated polydimethylsiloxane (PDMS) membrane, which allows the delivery of finely-tuned dynamic chemical signals to individual cells. This microfluidic device ensures that all cells loaded in the platform experience the same chemical signal simultaneously- which shows that any differences observed between cells is due the heterogeneity of the cell population and not by experimental design. The chemical generator also has the ability to deliver high frequency chemical signals over a large temporal dynamic range in order to simulate different biological process over different time scales. In summary, this microfluidic technology enables fast and repeatable switching of stimulus and buffer at a single cell resolution that is necessary in understanding signal transduction pathways.

Summary Bullets

- Allows for hundreds of cells to be immobilized on a very small footprint- including non-adherent cells
- Can analyze cell response at a single-cell resolution
- Can simultaneously observe cell response and generate chemical cues- allows for observation of immediate cell response

Solution Advantages

- Allows for hundreds of cells to be immobilized on a very small footprint- including non-adherent cells
- Can analyze cell response at a single-cell resolution
- Can simultaneously observe cell response and generate chemical cues- allows for observation of immediate cell response
- Minimizes shear stress.
- Requires minimal auxiliary equipment and is accommodating to any chip design.

Potential Commercial Applications

- Cell biology laboratories in university, industrial, and clinical settings

- Earlier stages of drug discovery prior to clinical testing
- Personalized medicine by analyzing patient cell response by using cells recovered from a biopsy or peripheral blood sample
- Point-of-care diagnostics and for use in resource-limited setting

Background and More Information

There is a large interest in understanding how biologic systems use external cues and transduce them into physiologic functions. On the cellular level, extracellular chemicals trigger an intracellular signal transduction pathway that results in a physiological function. The cellular microenvironment is highly dynamic and involves complex, temporally varying chemical signals. In order to further understand these cellular process, there is a need to develop devices that can provide rapidly changing experimental conditions while assaying their response on a cellular level. Microfluidic systems have emerged as a tool to apply spatiotemporal chemical gradients to modify the chemical environment for small organisms, unicellular bacteria, or mammalian adherent cells. However, many of these systems do not have the ability to accommodate non-adherent cells or have the ability to analyze individual cells. Currently, this limits the information that can be obtained on cell behavior in physiologic relevant conditions or assess the heterogeneity of a cell population.

Inventors

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IP Status

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Publications

Imaging single-cell signaling dynamics with a deterministic high-density single-cell trap array, Analytica Chem - August 2, 2011

Images

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