Analytical Instrumentation, Methods & Materials

Simple Microfluidic Device and Method for Determining Single-Cell Adhesion Strength

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The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a new device and method for measuring single-cell adhesion strength that allows a microfluidic chamber to be created around a cell on any surface, including a Petri dish.

Overview

Quantifying cell adhesion strength is crucial for the development of implantable biomaterials and tissue scaffolds, as well as in understanding many fundamental physiological and disease processes. However, existing techniques for characterizing the mechanical strength of cell adhesion are either simple and provide only a relatively coarse measure of adhesion strength, or are technically challenging and have not been adopted widely by researchers due to their complexity. To enhance the development of new biomaterials as well as to open new avenues of investigation in cell biology and disease research, simple and sensitive instrumentation and procedures for measuring single-cell adhesion strength are needed.

The Invention

UW–Madison researchers have developed a new microfluidic device and method for measuring the adhesion strength of individual cells. The method is compatible with existing measurement and imaging approaches found in industrial biology, biomedical and pharmaceutical research labs, including standard Petri dish- and multiwell plate-based procedures on an inverted microscope.

In the device, a local microfluidic chamber is created by positioning a microfluidic top chip with an inlet and outlet port a small distance above a surface. The chip does not make physical contact with the surface. In contrast to a traditional microfluidic channel in which the structure is created by forming a channel in a plastic, glass or silicon substrate, this device produces a microfluidic chamber by simply positioning a structured substrate above another surface.

After the microfluidic chamber is created over a cell, flow is applied to generate shear stress on the cell. The shear stress is linearly proportional to the flow rate and inversely proportional to the square of the channel height. In a typical cell adhesion test, the shear stress on the cell is increased over time by changing either the flow rate or channel height and the cell is monitored using optical or fluorescence microscopy. At some critical point, the cell delaminates. The stress applied to the cell at this time is defined as the shear strength.

Applications

- Determining adhesion strength of single cells
- Analyzing cellular adhesion to engineered biomaterials and implantable devices

Key Benefits

- Applicable to cells cultured on a broad range of surfaces, including cells in Petri dishes and multiwell plates

- Simple, sensitive and compatible with microscopy techniques commonly used in the life sciences
- Avoids many problems associated with culturing cells in microfluidic channels and with the integration of microfluidic devices in traditional cell biology research environments
- Allows strength measurements of single cells through local application of flow
- Small dimensions of the microfluidic chamber allow high shear stresses to be applied while maintaining laminar flow, in contrast to conventional assays in which the switch from laminar to turbulent flow often limits the maximum shear stress that can be applied.

Additional Information

For More Information About the Inventors

- Justin Williams

Publications

- Christ K.V., Williamson K.B., Masters K.S. and Turner K.T. 2010. Measurement of Single-Cell Adhesion Strength Using a Microfluidic Assay. Biomed Microdevices. 12, 443-455.
- Christ K.V. and Turner K.T. 2011. Design of Hydrodynamically Confined Microfluidics. Lab Chip 11, 1491-1501.

Tech Fields

- Analytical Instrumentation, Methods & Materials : Microfluidics

For current licensing status, please contact Jennifer Gottwald at jennifer@warf.org or 608-960-9854