Coupling Microfluidic Devices Yields Physiologically Relevant Micro-Environment for Cellular Assays

Published date: March 14, 2017

Technology description

Cellular interactions and signaling in multicellular organisms involve complex pathways that can be difficult to study when using macroscale in vitro culture systems, in part because traditional macroscale systems do not adequately mimic the in vivo cellular environment. For example, concentration gradients play a key role in mediating biological activity in vivo , but the large volumes in macroscale systems make it impractical to control concentration gradients to coordinate the growth, differentiation and metabolism of cells. In addition, traditional macroscale systems necessitate the use of large amounts of expensive reagents.

Investigating signaling pathways on a smaller, more physiologically relevant scale is crucial to understanding the fundamental roles of particular biochemical processes. New approaches utilize microfluidic devices as they offer microscale dimensions that mimic necessary in vivo conditions and offer the ability to regulate the experimental micro-environment. Further improvements to current methods and in vitro culture system designs are necessary to pave the way for developing new drugs that target signaling pathways. UW-Madison researchers have developed an improved device to create a controllable, physiologically relevant micro-environment for studying cellular interactions and pathways. This device provides a means for coupling two discrete microfluidic channels using only fluid contact. Two microchannels, each having one inlet and one outlet, can be coupled by combining fluid droplets on the outlet port and inlet port of the respective microchannel. This fluid contact method allows channels with two isolated environments to initiate the transfer of signaling molecules by means of diffusion or flow, thus allowing controllable physiological communication between cells. Cells can be exposed to a variety of cellular signals without cell contamination by simply breaking fluid contact with the current microchannel and forming a new fluidic coupling with a new microchannel. This new approach can be particularly useful in the co-culture of cells, where cell contamination can be prevalent and result in skewed data.

The controllable micro-environment implemented by this device also provides improved parameters for cellular assays and is well suited for high throughput screening. The reduction of culture dimensions in this microfluidic system results in a more physiologically relevant cellular micro-environment due to certain physical phenomena and interactions that become more dominant. The scale of microfluidic

systems offer more precise control over parameters that affect the cellular micro-environment, including fluid shear stress, diffusion of soluble factors and patterning of cells and extracellular matrix (ECM). These parameters can influence cell development and signaling pathways. For example, shear forces can modulate stem cell differentiation pathways and/or apoptotic activity.

In addition, the fluid reduction that results from using a microscale, rather than a macroscale, culture system allows minimal use of expensive reagents. Less reagent use also increases the repeatability and reliability of assays and reduces the amount of time necessary to move cells and reagents in and out of channels.
The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a fluidic coupling method for microfluidic devices that offers improved features for high throughput screening and cellular assays, such as co-culture of cells.

Application area

More robust cellular assays including co-culture of cells; soluble factor delivery; and cell capture, identification and sorting
Adaptable for high throughput screening

Advantages

Reduces costs by using smaller amounts of expensive reagents
Minimizing reagent use results in more efficient, repeatable and reliable experiments.
Provides precise control of cellular micro-environment parameters, such as fluid shear stress, diffusion of soluble factors and patterning of cells and extracellular matrix (ECM)
Suitable for ordinary laboratory purposes and very large-scale applications

Institution

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