Pipette petri dish single-cell trapping (PP-SCT) in microfluidic platforms: A passive hydrodynamic technique

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ABSTRACT

Microfluidics-based biochips play a vital role in single-cell research applications. Handling and positioning of single cells at the microscale level are an essential need for various applications, including genomics, proteomics, secretomics, and lysis-analysis. In this article, the pipette Petri dish single-cell trapping (PP-SCT) technique is demonstrated. PP-SCT is a simple and cost-effective technique with ease of implementation for single cell analysis applications. In this paper a wide operation at different fluid flow rates of the novel PP-SCT technique is demonstrated. The effects of the microfluidic channel shape (straight, branched, and serpent) on the efficiency of single-cell trapping are studied. This article exhibited passive microfluidic-based biochips capable of vertical cell trapping with the hexagonally-positioned array of microwells. Microwells were 35 µm in diameter, a size sufficient to allow the attachment of captured cells for short-term study. Single-cell capture (SCC) capabilities of the microfluidic-biochips were found to be improving from the straight channel, branched channel, and serpent channel, accordingly. Multiple cell capture (MCC) was on the order of decreasing from the straight channel, branch channel, and serpent channel. Among the three designs investigated, the serpent channel biochip offers high SCC percentage with reduced MCC and NC (no capture) percentage. SCC was around 52%, 42%, and 35% for the serpent, branched, and straight channel biochips, respectively, for the tilt angle, θ values were between 10–15°. Human lung cancer cells (A549) were used for characterization. Using the PP-SCT technique, flow rate variations can be precisely achieved with a flow velocity range of 0.25–4 m/s (fluid channel of 2 mm width and 100 µm height). The upper dish (UD) can be used for low flow rate applications and the lower dish (LD) for high flow rate applications. Passive single-cell analysis applications will be facilitated using this method.

KEYWORDS:

hydrodynamics; microfluidics; pipette Petri dish single-cell trapping (PP-SCT); passive trapping; single-cell trapping; single cell analysis; tilt trapping