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A Microfluidic Chip Architecture Enabling a Hypoxic Microenvironment and Nitric Oxide Delivery in Cell Culture

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Abstract:

A hypoxic (low oxygen level) microenvironment and nitric oxide paracrine signaling play important roles in the control of both biological and pathological cell responses. In this study, we present a microfluidic chip architecture for nitric oxide delivery under a hypoxic microenvironment in human embryonic kidney cells (HEK-293). The chip utilizes two separate, but interdigitated microfluidic channels. The hypoxic microenvironment was created by sodium sulfite as the oxygen scavenger in one of the channels. The nitric oxide microenvironment was created by sodium nitroprusside as the light-activated nitric oxide donor in the other channel. The solutions are separated from the cell culture by a 30 µm thick gas-permeable, but liquid-impermeable ploydimethylsiloxane membrane. We show that the architecture is preliminarily feasible to define the gaseous microenvironment of a cell culture in the 100 µm and 1 mm length scales.

Keywords: hypoxia, nitric oxide, microenvironment, cell culture, microfluidic chip, oxygen depletion, sodium nitroprusside, gasotransmitter