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Microfluidic device for rapid solution exchange to study kinetics of cell physiology HOWARD HU, University of Pennsylvania, MEGHANA HONNATTI, KEVIN GILLIS, University of Missouri - Columbia — Exchanging the extracellular solution of the cell rapidly (less than 10ms) is an important requirement in study the kinetics of cell physiology. A microfluidic device is developed to exchange the solution around the cells as they flow through a junction at the intersection of two microfluidic channels. The solution exchange time is measured experimentally by fluorescently labeling the cell surface membranes with a styryl dye, FM1-43 or FM 2-10, and then observing the time course of cell fluorescence decay following the rapid drop in the extracellular concentration of the FM dye that occurs as the cell flows past the fluidic junction. A numerical model is developed to guide the experimental design of microfluidic device. In the model, the motion of a single cell through a fluid junction is simulated and the mixing process of the solutions is solved. The model also includes the kinetics of departitioning of FM dyes from the cell membrane. The departitioning time constants for the FM dyes are determined from fitting the measured data of the cell fluorescence decay. This departitioning kinetics is important as FM dyes are commonly used to label cell membranes for the purpose of measuring the release of neurotransmitter from synaptic vesicles via exocytosis and the subsequent reuptake of vesicular membrane by endocytosis.

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