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Fluidic control over cell proliferation and chemotaxis

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Microscopic flows are almost always stable and laminar that allows precise control of chemical environment in micro-channels. We describe design and operation of several microfluidic devices, in which various types of environments are created for different experimental assays with live cells. In a microfluidic chemostat, colonies of non-adherent bacterial and yeast cells are trapped in micro-chambers with walls permeable for chemicals. Fast chemical exchange between the chambers and nearby flow-through channels creates essentially chemostatic medium conditions in the chambers and leads to exponential growth of the colonies up to very high cell densities. Another microfluidic device allows creation of linear concentration profiles of a pheromone (α-factor) across channels with non-adherent yeast cells, without exposure of the cells to flow or other mechanical perturbation. The concentration profile remains stable for hours enabling studies of chemotropic response of the cells to the pheromone gradient. A third type of the microfluidic devices is used to study chemotaxis of human neutrophils exposed to gradients of a chemoattractant (fMLP). The devices generate concentration profiles of various shapes, with adjustable steepness and mean concentration. The "gradient" of the chemoattractant can be imposed and reversed within less than a second, allowing repeated quantitative experiments.