A Microfluidic Device For Yeast Single-Cell Analysis

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Abstract

Saccharomyces cerevisiae are model organisms for studying various phenomena in eukaryotic cells. Some examples of phenomena studied with these cells are molecular mechanisms of aging and behaviour of synthetic circuits for different purposes. Traditional methods for making these studies are laborious, low throughput and difficult for single-cell characterisation of a population. These limitations have been addressed with the use of microfluidic devices. Recently, different devices have been designed for making such studies. Measuring cells at the single-cell level with high throughput in a not-so-laborious way can reveal new insights on the way cells work. Current microfluidic devices trap cells mechanically, exerting some pressure on them to maintain them fixed. The exertion of pressure on the cells, can generate stress and therefore modify gene expression. We present a Microfluidic Device that enables lifespan and gene expression measurements on yeast cells that does not use a mechanical trapping. We take advantage of the hydrodynamic effect of Slipstreaming to trap cells. In order to design the device, various parameters (e.g. flow rate, channel dimensions, trap configuration) must be chosen. Therefore, we used numerical simulation to best choose these parameters. We used COMSOL MEMS Module for simulating Fluid-Structure Interaction between cells, flowing media and traps. COMSOL allowed us to choose the parameters for chip fabrication. We build the chip and tested it with BY4741 cells. Using this device, we can measure RLS (Replicative-Life-Span), cell size and gene expression of hundreds of cells without exerting pressure on them. These studies give new insights to the way molecular mechanisms work in eukaryotic cells, having several applications in Cell Biology, Systems and Synthetic Biology.