Droplet-based linear concentration gradient formation for applying on biological assay

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Cells are always exposed to the microenvironment of different chemical concentration gradients. Microfluidic device facilitates the control the composition in droplets similar to in vivo microenvironment allowing high-throughput screening of cellular interactions.

We present a novel microfluidic platform producing monodisperse droplets having linear concentration gradient profile in a single device. Our strategy is utilizing significant difference of flow resistance of two aqueous phases: 1) We integrated parallel flow-focusing channels to produce the droplets containing eight different concentrations. We also introduced delivery channel which distributes the fluids evenly to each flow-focusing channel to ensure the formation of uniform droplets. 2) We adopted multi-height structure and controlled the channel width of two aqueous phase channels to generate the concentration gradients. We verified the linearity of the gradient based on fluorescence intensity of the droplets. The results showed a perfect match between the theoretical and measured value. We expect that our approach has great potential to be used in biological assays such as antimicrobial susceptibility testing.