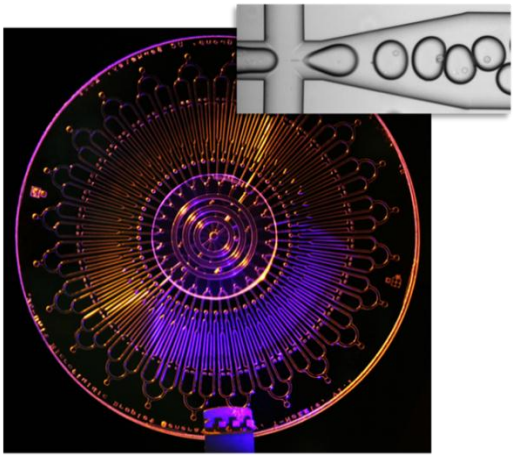
Digital Microfluidic Single Molecule/Cell Analysis: Towards Quantitative Biology and Medicine

Prof. Yong Zeng

Drawing on chemistry, molecular/cell biology, bioengineering, and materials science, our research aims to develop sensitive, quantitative and high-throughput bioanalytical tools by synergistically combining microfluidic technology and molecular/cellular assays. Our mission is to facilitate the advance of quantitative biology and personalized medicine, by leveraging on the new capabilities that our technology platforms enable.



A 96-channel microfluidic device that can produce 3×10^6 uniform nanoliter droplets (inset) per hour for single cell analysis.

The REU project is proposed to introduce undergraduate students to the forefront of an interdisciplinary research area across Chemistry, Biology and Medicine--single molecule/cell analysis. The REU students will be involved in the exciting research on developing novel microfluidic platforms, such as the microdroplet technology shown in the figure. The project aims to develop new capabilities for quantitative analysis of genetic and proteomic signatures associated with cancer (e.g. DNA, mRNA, signaling proteins, and other biomarkers) with the single molecule/cell sensitivity and resolution and the high throughput required for the system-level biological investigation. In collaboration with other research groups at KU and KUMC, we will explore the applications of the novel microfluidic technologies to basic cancer biology and clinical diagnostics, including single cell analysis of disease recurrence, development of genetic mutations and glycomic alternation as cancer biomarkers, and detection and molecular profiling of circulating tumor cells in metastatic cancer patients.

We deem undergraduate research an important part of science education. The REU students will work closely with the postdoctoral/graduate students and professor to develop skills of effective communications and team work, abilities of critical and creative thinking, and hands-on skills on state-of-the-art instruments and techniques, including micro/nanofabrication, electrophoresis, fluorescence imaging, immunoassays, cell culture, PCR amplification, and DNA sequencing.

References:

1. R. Novak,* Y. Zeng,* J. Shuga, G. Venugopalan, D. Fletcher, L. Zhang, M. T. Smith, R. A. Mathies, "Single Cell Multiplex Gene Detection and Sequencing Using Microfluidically-Generated Agarose Emulsions", *Angew. Chem. Int. Ed.*, 2011, 50, 390-395. (*Equal contribution)

2. E. C. Jensen,* Y. Zeng,* J. K. Kim, R. A. Mathies, “Microvalve Enabled Digital Microfluidic Systems for High Performance Biochemical and Genetic Analysis”, *Journal of Association for Lab Automation*, 2010, 15, 455-463. (*Equal contribution)
3. Y. Zeng, R. Novak, J. Shuga, M. T. Smith, R. A. Mathies, “High-Performance Single Cell Genetic Analysis Using Microfluidic Emulsion Generator Arrays”, *Anal. Chem.*, 2010, 82, 3183-3190.