Polynucleotide labs on chips

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Technology description

Summary

Polynucleotides are long strands of DNA or RNA and the rapid identification, multiplication, and analysis of these biomolecules is essential to modern life science and health applications. This technology family is a collection of methods in which polynucleotides can be studied with increased speed and automation. These technologies use microfluidic devices with integrated electronics to combine and streamline multiple biochemistry techniques that would otherwise take days to complete. These technologies have the ability to separate, concentrate, and amplify polynucleotides, to quickly detect single-nucleotide polymorphisms (SNPs), to develop chemically binding polynucleotides (known as aptamers), and to perform single-cell gene expression profiling, among other applications. These technologies have the potential to deliver high-quality results on extremely reduced time scales.

Integrated microfluidic techniques for rapid manipulation of nucleic acids in multiple contexts

The use of these technologies as labs on chips is advantageous because it requires small reagent amounts, is highly automated, and delivers rapid analyses. Consider, in particular, systematic evolution of ligands by exponential enrichment (SELEX). This is a way to develop strands of short polynucleotides, oligonucleotide aptamers, which bind to biological targets much like antibodies. Traditionally, such development is extremely labor intensive and the screening of appropriate aptamers can take months to complete. With the family of technologies reported here, SELEX may be completed in one day, with minimal hands-on time. This could allow for the rapid development of entire collections of aptamers that bind to any desired target. Further, this technology advances the detection of SNPs via the single base extension (SBE) technique. Normally, the numerous steps of SBE are carried out on different instruments requiring manual intervention at each step. The technologies reported here can yield a single microfluidic device that executes the entire SBE process from start to finish. This represents a significant improvement in efficiency.

These technologies, which decrease cost and improve throughput by orders of magnitude, have been demonstrated with proof-of-concept devices and are seeking further commercialization.

Publications

Hilton JP, Olsen T, Kim J, Zhu J, Nguyen T, Barby M, Pei R, Stojanovic M, Lin Q. "Isolation of thermally sensitive protein-binding oligonucleotides on a microchip" Microfluidics and Nanofluidics. 2015 June 5.

Sun H, Olsen T, Zhu J, Tao J, Ponnaiya B, Amundson SA, Brenner DJ, Lin Q. "A bead-based microfluidic approach to integrated single-cell gene expression analysis by quantitative RT-PCR" RSC Advances. 2015; 5: 4866.

Application area

Labs on chips

Separation of biomolecules from complex mixtures

Concentration and amplification of biomolecules

Detecting SNPs

Generating and screening aptamers (fully-integrated SELEX)

Integrated single-cell gene expression profiling

Various PCR methods

Advantages

Automated
Integrated
Cost-effective
Quick

Institution

Columbia University

Inventors

Qiao Lin

联系我们

叶先生

电 话：021-65679356
手 机：13414935137
邮 箱：yeyingsheng@zf-ym.com