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A Microfluidic System for Biological Sample Processing and Detection

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A microfluidic system for biological sample processing and detection offers many potential advantages over conventional assay platform, including small volumes, short assay time, multiple assay, and automation. In this paper, two novel approaches to microfluidic system for biological sample processing and detection will be presented and discussed. Generally, dilution and mixing are critical issues in sample preparation because they are tedious and time-consuming processes. Specially designed microfluidic channel networks were exploited for generation of concentration gradient flows. However, the dilution ratio was always predetermined by a microfluidic channel network fabricated on a chip. Also, most laboratory instruments are designed and optimized for specific detectable range of analyte concentration due to the limited sensor performance. This occasionally prevents the direct and quantitative analysis of specific analyte from the real samples. Therefore, the serial dilution of sample solution is essential for precise determination of the solute concentration. Solutions to these problems will be addressed through the new "adaptive microfluidics" strategy based on the feed-back operation from the sensor signal.

The other approach is the ELISA reader compatible microfluidic device for enzyme assay. Until now, several approaches to develop the microfluidic device for enzyme activity measurement have been carried out in the microfluidic channels. However, they usually need a specially designed their optical instruments for microchip detection. Also, many procedures in conventional biochemical experiments including enzyme kinetics study still need an improvement of routine, tedious and repeated process. We have developed a microfluidic device for enzyme assay based on Michaelis-Menten kinetics. The device concept stems from all-in-one reaction on a chip. By using a conventional ELISA reader for microchip detection, there is no need for set-up of new optical detection system and it is possible to simultaneously detect enzyme reactions at each different concentration of the substrate solution. This microfluidics assay platform will be applicable to various enzyme assays by introducing the substrate solution for specific enzyme applications.