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Microfluidic biochip technology for biological cell research

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Abstract

Microfluidic technology is an emerging area that couples multidisciplinary fields encompassing physics, chemistry, engineering and biotechnology and that manipulates tiny (e.g. 10^{-9} to 10^{-18} liters) amounts of fluids and/or biological entities, using microchannels with dimensions of tens to hundreds of micrometers. It allows the integration of various chemical and biochemical processes into fast and automatic micro-scale analytical systems. Microfluidic devices have been progressively used as versatile research tools in different fields, including chemical engineering, biotechnology, pharmaceutics, and medicine. The real value of miniaturized analytical devices is that they lead to many benefits, particularly decreased analysis timescales, reduced consumption of experimental resources, enhanced performances, and increased portability. Among the various applications, microfluidic devices are especially suitable for biological applications particularly at the cellular level, because the scale of microchannels corresponds well with the native cellular microenvironment. This paves the way to create a more bio-mimetic condition *in vitro* that is particularly meaningful for a faithful biological cell research. Due to the small dimensions in typical microfluidic systems, moreover, a microfluidic-based biological cell research consumes relatively less research resources, making high throughput biological cell researches feasible. Furthermore, microfluidic devices also hold promising to provide a stable, and well-defined culture condition for a more precise biological cell research because of the continuous culture medium perfusion and miniaturized cell culture format. All above technical features are currently impossible using the conventional techniques or devices for biological cell researches. The presentation will start with a general introduction discussing the key advantages of using microfluidic technology for biological cell researches. In the subsequent sections, some examples will be provided including the microfluidic-based cell culture systems for drug testing, the microfluidic system for tissue engineering, and the microbioreactor systems for the investigation of mechanical stimulations on cells' function.