Microfluidic devices for cell biology

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Embryonic stem cells (ESCs) have enormous potential for satisfying the demand for transplantable cells, once we learn how to properly control their proliferation and differentiation into specific cell types. We explore the use of a microfluidic platform to deliver growth factors to ESCs in a controlled manner to direct cell proliferation and differentiation. In order to examine the effect of BMP signaling on ESC proliferation and differentiation, a mouse ESC line (BRE mESC) harboring a BMP responsive element (BRE) driving lacZ expression was generated. When BRE-mESCs were grown in the conventional Petri dish culture condition (with non-circulating media), ESCs respond heterogeneously to BMP signaling irrespective of the presence or absence of LIF. However, a significantly improved uniform response to BMP4 treatment was observed in the microfluidic chamber where steady levels of BMP4 were constantly perfused over ESCs. This suggests that perfusion of a growth factor to ESCs may be an efficient way to direct the differentiation of ESCs, and this approach may be generally applicable to expand the population and uniformly steer the differentiation of adult stem cells.