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Role of microfluidics in stem cells

Vandhana SU

The microenvironment of stem cells plays a vital role in their maintenance and differentiation. To study this microenvironment, microfluidics has been used, which was introduced two decades ago. Microfluidics aims at the isolation of stem cells using physical methods that are label-free. There are mainly two types of microfluidic protocols, namely active and inactive that are based on the physical parameters analysed. This technology utilises three-dimensional cell culture systems and has achieved many advancements in recent years. It has been developed with the capacity to control the physical and chemical signals from the cell surface as well as perform cell analysis as it exerts a sound control on the growth conditions and the number of stem cells. It involves the use of pneumatic valves, osmotic pumps and gradient-based production (for nutrient analysis) that enables the creation of 3-D cell culture systems. It also enables us to track cell responses to a variety of stimuli. This technology also employs automatic fluorescence surfaces to facilitate vivid cell imaging.

Integrating microfluidics and polydimethylsiloxane (PDMS) has resulted in the successful engineering of nerve cells from adipose-derived stem cells. This technology can also be exploited to study the different properties of stem cells, such as differentiation and proliferation in response to stimuli. This has paved the way to map several neurodegenerative disorders and the development of a possible treatment. Production of identical embryonic stem cells (ESCs) can be achieved by employing microfluidics to produce uniform embryoid bodies of adjustable sizes. This property can be employed to generate tissues that have been damaged due to injury and chronic ailments. However, one of the main disadvantages associated with microfluidics technology is that it is time-consuming. This can be avoided by the use of multichannel arrays. Therefore, microfluidics dominates the future perception of stem cell isolation by offering many perks in the form of small size, low sample and reagent consumption, less operator handling, all processes under one chip, mass processing, etc. The future of treatment for cancer and several chronic diseases has also laid its dependency on microfluidics technology.

Keywords: Stem cells, Microfluidic technology, Isolation protocols, Cell culture systems

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