Microbioreactors: A Tool for Embryonic Stem Cell Bioprocess Development

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Human embryonic stem cells (hESCs) are a source of cells with tremendous potential, due to their ability to differentiate into any cell type. However, many challenges must be overcome to move cell and tissue engineering with hESCs to a clinical level. One major challenge is the lack of hESCs available to perform multiple experiments due to an inadequate source of cells and a slow growth rate. Culture conditions must be improved to reproducibly generate clinical numbers of hESCs. Consequently, our long-term goal is to develop an array of magnetically-stirred microbioreactors that will provide a high throughput screening tool for optimizing growth conditions for hESCs, toxicology tests, and other applications. Microbioreactors will require fewer cells, but will allow many experiments to be run in parallel resulting in more economical process design requiring less labour than was previously possible with larger spinner flask bioreactors. First, we estimated process parameters for stem cells in microbioreactors using theoretical approaches. Next, we performed proof of concept experiments using murine embryonic stem cells (mESCs) as a model system. Specifically, the effects of working volume, stirring rate, and the magnetic field, on mass transfer and the hydrodynamic environment were examined using theoretical and experimental approaches. Finally, our ultimate goal is to culture hESCs in microbioreactors.