Development of Synthetic Microenvironments for Stem Cell Growth and Differentiation

Grant Award Details

Development of Synthetic Microenvironments for Stem Cell Growth and Differentiation

Grant Type: Tools and Technologies II

Grant Number: RT2-01889

Project Objective: The goal of this project is to develop synthetic matrices composed of polymers and peptides to support stem cell growth and differentiation.

Investigator:

Name:	Shu Chien
Institution:	University of California, San Diego
Type:	PI

Human Stem Cell Use: Embryonic Stem Cell

Award Value: $1,706,628

Status: Closed

Progress Reports

Reporting Period: Year 1

View Report

Reporting Period: Year 2

View Report

Reporting Period: Year 3

View Report

Reporting Period: NCE Year 4

View Report

Grant Application Details

Application Title: Development of Synthetic Microenvironments for Stem Cell Growth and Differentiation

Public Abstract: Currently, many chronic diseases and injuries do not have effective cures; millions of people suffer from disabilities while carrying on daily lives without appropriate medical assistance. Advances in human pluripotent stem cells (hPSCs) research have provided the potential hope for significant improvements of disease treatment and management. The success of stem cell-based therapy will have major impacts on the quality of life of people with chronic health problems such as cancer, cardiovascular diseases, and neurodegenerative disorders (e.g. Alzheimer's and Parkinson's diseases). The California Institute of Regenerative Medicine was established to develop such novel cell-based therapies to treat disorders that are presently incurable. HPSCs process the enormous potential to be directed to all cell types in the human body as the "raw material" for many cell-based therapies. The realization of the full potential of hPSCs in regenerative medicine requires, among other things, the establishments of well-defined culture conditions for their growth and differentiation and cost-effective protocols for their expansion. In this grant application, we propose a series of experiments to develop a novel technology platform using cost-effective and well-defined synthetic matrices to expand and differentiate hPSCs. The results will provide critical information and protocols for hPSC researchers aiming at developing cures for the diseases mentioned above.

Due to the high cost and limited range of testing capability, previous studies on factors affecting stem cell growth have focused on only one or a few elements of the cellular microenvironment, e.g., individual extracellular matrix components or growth factors. In addition, most protocols for hPSC culture use non-human products such as animal supporting materials and recombinant proteins isolated from bacterial culture, which represent potential complications for clinical usage. Our proposed research will develop a high-throughput cellular microarray screening tool that incorporates synthetic materials, including polymers and peptides, to select the optimal matrix for supporting self-renewal and differentiation of hPSCs. This tool and technology will allow the concomitant screening of the effects of thousands of conditions on growth, maintenance and differentiation of hPSCs with a cost-effective approach. The results from our studies will provide fully defined and optimized culture conditions for the expansion and differentiation of hPSCs without exposure to animal-derived products.

In summary, we will develop a comprehensive approach to elucidate the responses of hPSCs to microenvironmental factors in a combinatorial and systematic manner. Application of this novel and powerful technology will lead to the definition of the optimal synehtic matrices for the control of hPSC growth and differentiation and the production of hPSCs without contamination by non-human products.

Statement of Benefit to California:

Many California families have suffered or will suffer from diseases and injuries that do not have an effective cure. Current medical treatments can manage, but cannot cure, diseases and injuries such as cancer, heart diseases, spinal cord injuries, Alzheimer's, and Parkinson's disease. Recent advances in human pluripotent stem cells (hPSCs) studies have provided the opportunity to develop novel strategies involving cell-replacement therapies to overcome the inadequacy of conventional drug-based treatments. However, cell-replacement therapies require sufficiently large numbers of clinically viable hPSCs that have been thoroughly tested and characterized. To address this critical need, we have developed a comprehensive and cost-effective technology for high-throughput screening of native matrix proteins that regulate hPSC growth and differentiation. The aim of our current research is to apply this high-throughput technology to synthetic polymers and peptides to establish cost-effective protocols for efficient and precise controls of hPSCs growth and differentiation.

Our technology will allow the screening of thousands of well-defined material properties to identify the optimal synthetic matrix for stem cell growth and differentiation. In contrast to current bio-reagents used in hPSC studies, our focus on synthetic materials will enable the development of cost-effective, scalable, robust platform for generating clinically viable hPSCs or hPSC-derived cells. Our technology, which we will make freely available to the biomedical community, will also benefit many other lines of scientific inquiries, such as defining growth conditions of rare adult stem cell populations. Thus, our proposed research is fundamental to the clinical applications of hPSCs in regenerative medicine and has broad benefits to a wide spectrum of scientific interests.

Our research will not only benefit the health of the people, but also the economy of California by enhancing and generating local businesses. With this project, we will be able to hire researchers to conduct and manage the proposed research. In addition, the outcome of this project will lead to the development of a biotechnology platform that can provide great benefits to the advancement of California biotechnology industry. The patents, royalties and licensing fees that result from advances in the proposed research will provide tax revenues to California. Thus, this proposed research project provides not only the essential foundation for the scientific progresses in stem cell biology and regenerative medicine to improve health and quality of life, but also potential technology advancement and financial gain for the people in the State of California.
