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Biomedical Engineering
Wallace H. Coulter Foundation
Seminar Series

Corneal Stromal Tissue Regeneration by Human Corneal Stromal Stem Cells (hCSSCs)

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LECTURE: 9:00 AM - 10:00 AM

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Abstract: The cornea is the transparent outermost layer of the eye. Trauma, bacterial and viral infections, and heritable conditions lead to loss of corneal function and visual impairment in over ten million individuals world-wide. The limited supply of healthy cornea donor tissue has stimulated efforts to develop biological equivalents of human cornea. Corneal stroma comprises 90% of the corneal thickness and is the major structural component of the cornea characterized by layers of highly organized parallel collagen fibrils, mono-disperse in diameter with uniform interfibrillar spacing. The unique microstructure determines the robust biomechanical properties of this tissue and its optical transparency. Recapitulating the microstructure of native human corneal stromal tissue is believed to be a key feature in successfully engineering corneal tissue. Employing a strategy of surface contact guidance and growth factor supplementation, we demonstrate that on aligned fibrous substrates made from biodegradable poly(ester urethane) urea (PEUU), human corneal stromal stem cells (hCSSCs) could be induced by FGF-2 and TGF-β3 to secrete and organize a type-I collagen-based extracellular matrix (ECM) abundant in characteristic human corneal stromal ECM components, including keratan sulfate, lumican, and keratocan. Spatial self-organization of the collagen-based ECM by hCSSCs featured stratified multilayered collagen -fibril lamellae with orthogonal orientation, and uniform fibril size and inter-fibril spacing in a pattern mimicking human corneal stromal tissue. The approach of combining substrate cues with growth factor augmentation offers a new means to engineer well-organized, collagen-based constructs with appropriate nanoscale structure for corneal repair and regeneration.

Biography: Dr. Jian Wu (Ph.D.) is a research assistant professor of McGowan Institute for Regenerative Medicine at University of Pittsburgh School of Medicine. Dr. Jian Wu earned B.S of Materials Chemistry and M.S. of Polymer Chemistry and Physics from Fudan University in Shanghai, China at 1998. After two-year industry work, Dr. Wu joined Department of Chemical Engineering at University of Connecticut to pursue his Ph.D. degree. During his Ph.D study, he focused on the study of synthesis, microstructure and rheology of polymer nano-composites. After obtaining Ph.D. degree in 2005, he moved to Texas to conduct his post-doctoral research work pertaining to colloidal materials and micro-rheology. In 2008, Dr. Wu began shifting his research interests to biomaterials and biomedical devices, and was appointed as a research assistant professor of chemical and biomedical engineering at Syracuse University, where he extensively studied Polyhedral Oligosilsesquioxane (POSS)-based nano-structured multi-block polyurethanes applicable to biomedical devices and long-term surgical implants. In 2010, Dr. Wu, being a research assistant professor, moved to Pittsburgh and joined McGowan Institute for Regenerative Medicine at University of Pittsburgh School of Medicine. His current research project is to take the technical strategy of corneal tissue engineering to develop the artificial biological equivalent of the native cornea employing the micro-integration of human cornea stromal stem cells and biodegradable polymer-based scaffolds. Dr. Wu's research interests include synthesis and processing of biomaterials, stem cell tissue engineering, drug and gene delivery, specifically in Ophthalmology. So far, Dr. Wu has published 28 peer-reviewed journal papers and proceedings, such as *Biomaterials, Biomacromolecules, Macromolecules, Langmuir, Chemistry- a European Journal*, ect, (Total Citations > 460, H-index = 10), 3 patent applications, and given numerous oral presentations at international professional conferences, including Gordon Research Conference, and others.

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