NSF Funds Innovative Approach To Biomimetic Nanofiber Bone Regeneration

EurekAlert

Every year nearly 6.2 million bone fractures occur in the United States as a result of trauma and disease. Current standards for bone repair can lead to rapid bone fusion but with limited mechanical strength often due to the lack of cortical bone tissue which is difficult to harvest without pain and severe morbidity. Funded by the National Science Foundation, Dr. Hongjun Wang, a professor in the Department of Chemistry, Chemical Biology and Biomedical Engineering at Stevens Institute of Technology and his collaborators have developed a revolutionary "bottom-up" approach for reconstructing intricate bone tissue with the potential to form hierarchical cortical bone.

Dr. Wang's research project, "Biomimetic Creation of Cortical-like Bone with Hierarchical Structure," will develop robust, controllable and effective platforms for the creation of tissues with complex and hierarchical structure for potential applications in reconstructive and transplant surgery. Biomimetics is the study and development of synthetic systems that mimic the formation, function, or structure of biologically produced substances, materials, mechanisms and processes. Wang's research team is part of a thriving tissue engineering industry that uses a combination of cells, engineering and materials methods, and suitable biochemical and physio-chemical factors to repair or replace portions of damaged tissues. In contrast to current state-of-the-art research that focuses on creating highly porous cancellous bone, Dr. Wang focuses on engineering cortical bone, the major load bearing component. He takes a modular approach to generating dense cortical bone by synthesizing osteon-like repeating units and fusing these units together to form large, compacted cortical-like bone tissue. This "bottom-up" methodology uses nanotechnology to enable the development of scaffolds that focus on the smallest level possible and build upward. Incorporating nanofibers into bone tissue engineering to form the small cortical bone repeating units, these biomimetic scaffolds offer large surface areas and well-interconnected pores for nutrient transport and cell penetration, and more importantly, provide a biomimetic cell-friendly microenvironment to facilitate the bone tissue formation, needed for successful repair of large bone defects.

"The results of Dr. Wang's research will have a far-reaching impact on tissue engineering," says Dr. Michael Bruno, Dean of the Schaefer School of Engineering and Science. "The wealth of basic and applied knowledge learned at Stevens will lay the foundation for our long-term research efforts and the development of real-world applications."

Over the next three years, Dr. Wang's research team plan to make substantial strides in synergistically integrating nanobiomaterials with bone tissue engineering for the creation of cortical bone with hierarchical structure and functional complexity.

We hope to establish a family of biomimetic nanofibers containing collagen and calcium phosphate to support the phenotype of bone-forming cells; new practical approaches to creating osteon-like units using biomimetic nanofibers and osteoblasts; formulation of calcium phosphate containing collagen gel for bone tissue formation; and most importantly, an innovative approach to generating cortical-like bone by assembling osteon-like structures into one fused construct," explains Dr. Wang.

"The intellectually rich environment established by Dr. Wang and his team is inspiring to our graduate and undergraduate students who are participating in the transformative benefits of cutting-edge research and its profound application," says Dr. Philip Leopold, Director of the Department of Chemistry, Chemical Biology and Biomedical Engineering.

For more information on Stevens Pioneering Bone Regeneration research, please contact Dr. Wang: http://www.stevens.edu/research/research_profile.php?fac_id=16

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