

Bone Structure

Tissue engineer builds new framework for cell growth

CRAWFISH, CRABS AND SHRIMP — they're not only tasty staples on Louisiana tables, they're also potential ingredients for replacing bone through tissue engineering.

UL Lafayette's Dr. Wah Wah TheinHan is a physician and research scientist working in the Biomaterials and Biomedical Engineering Research Laboratory. The lab is part of the Center for Structural and Functional Materials within the Department of Chemical Engineering.

TheinHan's work begins with a substance called chitin. Translucent, flexible and tough, it is the basis of insect exoskeletons and crustaceans' hard shells.

Proteins and calcium are chemically removed from the shells, turning chitin into chitosan, a substance that is proving useful, especially in biomedical applications. For instance, it is used in battlefield bandages that stop hemorrhaging within seconds. Non-toxic and non-allergenic, with anti-fungal and anti-bacterial properties, chitosan also has the ability to rapidly clot blood. Because chitosan molecules carry a positive electrical charge and human DNA is negatively charged, they have a natural affinity for one another. Chitosan is also biodegradable, so it is eventually absorbed by the body.

TheinHan is using chitosan to build a three-dimensional framework, or scaffolding, for a substance that could eventually replace bone in the human body. "Natural bone is a composite of both organic and inorganic materials," said TheinHan. She combines chitosan with nanohydroxyapatite, a form of calcium phosphate that is created, atom by atom, in the lab. "We are trying to mimic the bone, to make this nanocomposite material as close as possible to natural bone."



Dr. Wah Wah TheinHan uses chitosan, a byproduct of crustacean shells, to help create bone-replacement material.

The scaffolding is freeze dried, so that all moisture is removed. TheinHan then places small sections of the scaffold in a Petri dish and adds a broth of special cells and nutrients. The cells are "preosteoblast cells from mice," she explained. These are early-stage cells, which, if left in the mouse, would become bone cells. It takes about a month for the scaffold and cells to become engineered tissue.

For decades, researchers have recognized the value of chitosan, but it has one major drawback: it is not as strong as bone. So, TheinHan is trying to find the right combination to create the ideal scaffolding material, one that equals the strength of natural bone and also serves



as a fertile medium for growing cells.

TheinHan compared the growth of cells on the nanocomposite scaffolds she developed to that of cells grown on scaffolds made of pure chitosan. After seven days, there were 150 times more cells growing on the

nanocomposite material. The results of the study, which TheinHan co-wrote with Dr. Devesh Misra, director of the Center for Structural and Functional Materials, were published in the scientific journal *Acta Biomaterialia* in December.

TheinHan is also exploring the use of chitosan to heal wounds and deliver drugs to specific sites in the body. ■