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Tissue engineers get $1.7 million NIH grant to study cartilage repair

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Rice University has received a $1.7 million grant from the National Institute of Arthritis and Musculoskeletal and Skin Diseases to develop biodegradable plastics that can be injected in place of damaged or missing cartilage, acting as a template for the regrowth of healthy cartilage.

The research addresses a persistent and widespread problem: There is no synthetic alternative to human cartilage, which often is unable to heal itself following injury. As a result, millions of Americans suffering from arthritis and joint injuries have limited treatment options.

“Over the years, doctors have tried many methods to replace injured cartilage,” said Antonios Mikos, the John W. Cox Professor in Bioengineering and Chemical Engineering and principal investigator of the project. “They can use grafts — either from the patient’s own body or from donors. Another option is to perform surgery to encourage the body to regrow its own cartilage or to inject cartilage cells straight into the injury. However, all of the current therapies have associated limitations.”

At this time, most treatment options for damaged cartilage involve surgery, and in many cases, the replacement cartilage is weaker and more susceptible to re-injury than native tissue.

A common current treatment is an allograft — a transplant involving donor tissue from another person. Mikos’ tissue engineering team hopes to develop new, noninvasive treatment options that eliminate the need for large surgeries and avoid problems associated with allografts, such as tissue rejection and disease transmission.

They envision doing this by harvesting a few of the patient’s own bone marrow cells and using those to grow more. These marrow cells will be included in the biodegradable polymer that is injected into the wound.

The polymer is a polyester of fumaric acid — a natural metabolite — and can be administered as a liquid that turns into a semi-rigid gel after several minutes in the body. This semi-rigid filler, known as a scaffold, acts as a template for newly grown cartilage. The scaffold is designed to break down over time as new cartilage fills the wound.

There are several different kinds of cartilage in the body. Mikos’ research will focus on articular cartilage, the kind that covers the ends of bones in joints. The scaffold, which will be injected into the defect in the articular cartilage, will be seeded with adult precursor cells from the bone marrow.

These undeveloped cells may become chondrocytes — the type of cells found in cartilage — in the presence of biochemical triggers found inside the joint. Ideally, these cells could even develop into different variants of chondrocytes, depending upon where they are located in the wound.

For example, those closest to the bone would form a calcified type of cartilage that bonds directly to bone, while those at the surface would form a thin sheen of tissue with the incredible strength needed to withstand the shear forces where the bones meet.

The five-year grant will fund studies to find the optimum formulation for the polymer scaffold.

Mikos' group must strike a balance, finding a material that is strong enough to do the job, while retaining the ability to be dissolved by chondrocyte enzymes that form when new cartilage grows.

Ultimately, the group hopes to produce a two-layered scaffold that will promote cartilage formation in the top half and bone formation in the lower half.
