Engineering long-lasting joint lubrication by mimicking nature

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By finding a way to bind a slippery molecule naturally found in the fluid that surrounds healthy joints, Johns Hopkins researchers have engineered surfaces that have the potential to deliver long-lasting lubrication at specific spots throughout the body. The finding, described in the Aug. 3 online edition of *Nature Materials*, could eventually offer a new way to ease the pain of arthritic joints, keep artificial joints working smoothly or even make contact lenses more comfortable.

According to the investigators, scientists have long known that a biochemical known as hyaluronic acid (HA), found in abundance in joints' synovial fluid, is an important component for naturally lubricating tissues. One form of HA also reduces inflammation and protects cells from metabolic damage. Diseased, damaged or aging joints in hips, knees, shoulders and elbows often have far lower concentrations of HA, presumably because a protein that binds HA molecules to joint surfaces is no longer able to retain HA where it is needed. HA injections into painful joints, known as viscosupplementation, have become a popular way to treat painful joints in the past several years. But without a way to retain HA at the site, the body's natural cleaning processes soon wash it away.

Seeking a way to tackle this problem, a team led by Jennifer H. Elisseeff, Ph.D., professor at the Wilmer Eye Institute at Johns Hopkins and in the Johns Hopkins University departments of Biomedical Engineering and of Materials Science and Engineering, looked to molecules known as HA-binding peptides (HABpeps) that stick to HA.

In the laboratory, using HABpep as a chemical handle, the researchers used a second synthetic molecule, polyethylene glycol, to tie HA onto surfaces that included natural and artificial cartilage.

Tests on tissues and in animals show that the bound HA didn't easily wash away, and it reduced friction as successfully as when these tissues were immersed in a bath of HA. When the researchers injected a HABpep designed to attach to cartilage in rat knees, then injected HA, that HA stuck around 12 times as long as it did in rats that hadn't been given HABpep, suggesting that these peptides could be a promising addition to viscosupplementation.

Though this material still has some time before it might be available to patients, Elisseeff notes its promise as another way scientists have looked to nature as an inspiration to solve medical problems.

"What I like about this concept is that we're mimicking natural functions that are lost using synthetic materials," Elisseeff says.

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