

# Magnetic field and hydrogels could be used to grow new cartilage

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Using a magnetic field and hydrogels, a team of researchers in the Perelman School of Medicine at the University of Pennsylvania have demonstrated a new possible way to rebuild complex body tissues, which could result in more lasting fixes to common injuries, such as cartilage degeneration. This research was published today in *Advanced Materials*.

"We found that we were able to arrange objects, such as [cells](#), in ways that could generate new, complex tissues without having to alter the cells themselves," said the study's first author, Hannah Zlotnick, a graduate student in Bioengineering who works in the McKay Orthopaedic Research Laboratory at Penn Medicine. "Others have had to add [magnetic particles](#) to the cells so that they respond to a [magnetic field](#), but that approach can have unwanted long-term effects on cell health. Instead, we manipulated the magnetic character of the environment surrounding the cells, allowing us to arrange the objects with magnets."

In humans, tissues like cartilage can often break down, causing joint instability or pain. Often, the breakdown isn't in total, but covers an area, forming a hole. Current fixes are to fill those holes in with synthetic or biologic materials, which can work but often wear away because they are not the same exact material as what was there before. It's similar to fixing a pothole in a road by filling it with gravel and making a tar patch: the hole will be smoothed out but eventually wear away with use because it's not the same material and can't bond the same way.

What complicates fixing cartilage or other similar tissues is that their make-up is complex.

"There is a natural gradient from the top of cartilage to the bottom, where it contacts the bone," Zlotnick explained. "Superficially, or at the surface, cartilage has a high cellularity, meaning there is a higher number of cells. But where cartilage attaches to the bone, deeper inside, its cellularity is low."

So the researchers, which included senior author Robert Mauck, Ph.D., director of the McKay Lab and a professor of Orthopaedic Surgery and Bioengineering, sought to find a way to fix the potholes by repaving them instead of filling them in. With that in mind, the research team found that if they added a magnetic liquid to a three-dimensional hydrogel solution, cells, and other non-magnetic objects including drug delivery microcapsules, could be arranged into specific patterns that mimicked natural [tissue](#) through the use of an external magnetic field.

After brief contact with the magnetic field, the hydrogel solution (and the objects in it) was exposed to [ultraviolet light](#) in a process called "photo crosslinking" to lock everything in place, and the magnetic solution subsequently was diffused out. After this, the engineered tissues maintained the necessary cellular gradient.

With this magneto-patterning technique, the team was able to recreate articular cartilage, the tissue that covers the ends of bones.

"These magneto-patterned engineered tissues better resemble the native tissue, in terms of their cell disposition and mechanical properties, compared to standard uniform synthetic materials or biologics that have been produced," said Mauck. "By locking cells and other drug delivering agents in place via magneto-patterning, we are able to start tissues on the appropriate trajectory to produce better implants for cartilage repair."

While the technique was restricted to in vitro studies, it's the first step toward potential longer-lasting, more efficient fixes in living subjects.

"This new approach can be used to generate living tissues for implantation to fix localized [cartilage](#) defects, and may one day be extended to generate living joint surfaces," Mauck explained.

**More information:** Hannah M. Zlotnick et al, Magneto-Driven Gradients of Diamagnetic Objects for Engineering Complex Tissues, *Advanced Materials* (2020). [DOI: 10.1002/adma.202005030](https://doi.org/10.1002/adma.202005030)

Provided by Perelman School of Medicine at the University of Pennsylvania

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