Can Manmade Tissue Mend Broken Hearts and Other Bodyparts?

An implantable synthetic tissue created in a lab may one day allow doctors to repair damaged hearts, muscles and vocal cords.

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The human body is a biological masterpiece that requires rugged internal components that can withstand the daily strains triggered by the mechanics of movement. Like any machine, it sometimes breaks down and must be repaired. A new, penetrable synthetic tissue that allows live cells to grow and travel through the body to regenerate damaged organs may one day make such repairs easier, according to study findings published in the journal Advanced Science, reports McGill University in a press release.

In medicine, researchers are studying porous double-network injectable hydrogels as a less invasive way to channel blood flow to tissues and organs via spidery networks of capillary blood vessels. However, these gels must be porous while simultaneously withstanding the constant motion required for heart, vocal cord and muscle tissues to function properly.

For the McGill University study, researchers synthesized three different kinds of hydrogels: nanoporous single-network gels, porous single-network gels and porous double-network gels. Next, they assessed the durability of each using a device that mimicked the human vocal cord's vibrations of 120 times per second for more than 6 million cycles. Of the three types of hydrogels, the porous double-network gels exhibited the best permeability, stretchability and resistance to breakage needed to handle this strenuous workload.

"We were incredibly excited to see it worked perfectly in our test," said Guangyu Bao, a PhD student in the university's department of mechanical engineering and one of the study's authors. "Before our work, no injectable hydrogels possessed both high porosity and toughness at the same time. To solve this issue, we introduced a pore-forming polymer to our formula.

"People recovering from heart damage often face a long and tricky journey. Healing is challenging because of the constant movement tissues must withstand as the heart beats. The same is true for vocal cords. Until now, there was no injectable material strong enough for the job," continued Bao. "The results are promising, and we hope that one day the new hydrogel will be used as an implant to restore the voice of people with damaged vocal cords—for example, laryngeal cancer survivors."

In addition to its ability to support cellular growth, survival and function, researchers suggested that the tough hydrogel may potentially be used for drug delivery, tissue engineering and the generation of tissue models for drug screening. They also proposed developing lungs with the hydrogel to test COVID-19 drugs.

The inquiry offers a good example of how materials science, mechanical engineering and bioengineering can work together to produce innovative substances that interact well with human biological systems.

“We are looking forward to translating them into the clinic,” said Jianyu Li, PhD, an assistant professor at McGill and one of the study’s leaders.

To learn more about how bioengineering intersects with regenerative medicine, read "The Power of Print."
