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Gold nanofibers in engineered heart tissue can enhance electrical signalling, researchers find

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Heart tissue sustains irreparable damage in the wake of a heart attack. Because cells in the heart cannot multiply and the cardiac muscle contains few stem cells, the tissue is unable to repair itself—it becomes fibrotic and cannot contract properly.

In their search for innovative methods to restore heart function, scientists have been exploring cardiac "patches" that could be transplanted into the body to replace damaged heart tissue. Now, in his Tissue Engineering and Regenerative Medicine Laboratory, Dr. Tal Dvir and his PhD student Michal Shevach of Tel Aviv University's Department of Molecular Microbiology and Biotechnology and the Center for Nanoscience and Nanotechnology, together with their colleagues are literally setting a gold standard in cardiac tissue engineering.

To meet one of the biggest challenges in the development of cardiac patches—ensuring that engineered tissue can mimic the heart's coordinated electrical system, which controls heartbeat and rhythm—they integrated cardiac cells with nanofibers made of gold particles to form functional engineered tissues. Their goal is to optimize electrical signalling between cells.

Gold has been found to increase the connectivity of biomaterials, explains Dr. Dvir. With the addition of the gold particles, cardiac tissues

contract much faster and stronger as a whole, he reports, making them more viable for transplants. The research was recently published in the *Journal of Materials Chemistry B*.

Lending nature a helping hand

On their surface, heart cells contain proteins that are responsible for transferring electrical signals. But the process of tissue engineering itself leads to the loss of these proteins. And while the cells will start to produce them again naturally, says Dr. Dvir, they take time to develop—time which a patient may not have. Gold nanofibers can fill the role of electrical connectors until the cells are able to produce their own connectors once more.

New tissues are created by placing cells taken from patients or animals onto a three-dimensional scaffolding made of biomaterials – any matter or surface that interacts with biological systems – which organize the cells into the proper formation as they grow. Dr. Dvir and his team used various chemical and physical processes to integrate gold nanoparticles into their scaffolds. The cells then interacted with each other through these gold nanoparticles.

The researchers used a scanning electron microscope and various measures of electrical activity in order to observe the nanoparticles on the fibers and check conductivity. Cells placed on the gold-embedded scaffolding had significantly stronger contractions compared to those on a scaffolding without gold. Importantly, the cells contracted in unison, demonstrating effective electrical signalling between them.

A golden opportunity

Because 50 percent of heart attack victims die within five years of their

initial attack, new treatment options are sorely needed. A functioning, transplantable tissue could not only save lives, but improve a patient's quality of life overall.

Having demonstrated the electrical signalling capability of these gold infused cardiac patches, Dr. Dvir will next evaluate their potential to improve function after heart attack through pre-clinical tests in the lab and, eventually, clinical trials with patients. He says that the ideal method would be to use a patient's own cells when building the new tissue, therefore avoiding the risk of rejection.

Provided by Tel Aviv University