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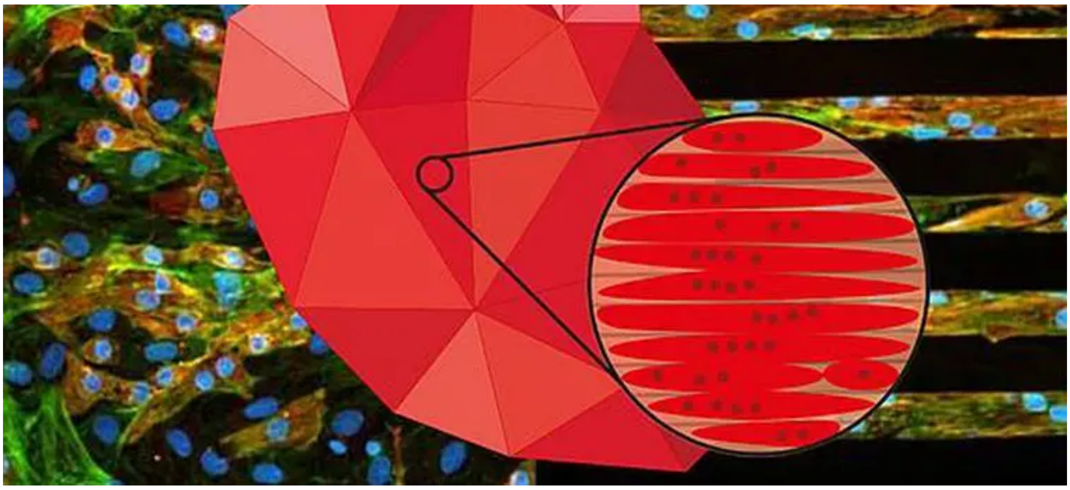
Origami-inspired heart patch developed by Basel researchers



▲ A new biomedical innovation – inspired by the folded sheets of traditional Japanese origami – has just taken its first steps in Basel laboratories.

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Development has begun in canton Basel City on a patch made of paper and cells designed to mitigate the consequences of a heart attack.

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Titanium plates for broken bones, chips and wires for damaged spines, and now origami inside the heart. Contemporary medicine continues to evolve, and a biomedical innovation – inspired by the folded sheets of traditional Japanese origami – has just taken its first steps in Basel laboratories.

The project is the result of an extensive collaboration between the research groups of Anna Marsano and Andrea Banfi at the University of Basel, Maurizio Gullo of the University of Applied Sciences and Arts Northwestern Switzerland (FHNW), the Swiss Nanoscience Institute (SNI) and the company OMYA International AG. The team of biomedical engineers and nanoscience specialists published the results of their initial experiments in the journal *ACS Biomaterials Science and Engineering* in March. Their goal: to develop a medical device for treating patients suffering from heart muscle infarction.

Origami for the heart

Researchers have grown some of the various types of tissue that make up the heart on small cellulose sheets. Thanks to an accordion-like folding structure, these sheets can contract and expand with the heart muscle. In the future, this device could be implanted in hearts damaged by heart attacks to replace dead cells – acting as a kind of patch. For now, these are purely laboratory experiments, but this is how the long journey begins, taking a pioneering biotechnological idea from a researcher’s mind to a tool in a doctor’s hands.

The project aims to develop a treatment for hearts affected by ischaemia – a partial or total blockage of the artery supplying blood and oxygen to the heart, impairing its function. If the artery is obstructed, heart tissue is deprived of essential nutrients and oxygen, leading to severe and sometimes irreversible damage. This is a common issue in Switzerland, where heart conditions remain the leading cause of death. As a result, the heart loses its ability to pump efficiently.

▲ In Switzerland, heart conditions remain the leading cause of death. RSI

"The heart has a very limited capacity for repair and regeneration. If not treated properly, this damage can worsen over time and lead to heart failure," explains Anna Marsano of the Department of Biomedicine at the University of Basel. "Our work focuses on generating reliable in vitro cardiac models – using only lab-grown cells – to study the mechanisms of damage and identify possible strategies for regeneration. The ultimate goal is to restore the heart's pump function."

Mitigating the consequences of a heart attack

Typically, if a cardiac arrest is treated promptly, it is not fatal. However, subsequent heart attacks carry significantly higher risks. "That's why it's essential to restore cardiac function," says Maurizio Gullo, who leads a research group at FHNW and is a member of the Swiss Nanoscience Institute. "A person's heart may still pump after a heart attack, but if it doesn't function optimally, it can lead to serious health problems." Current treatments include drug therapies and, where necessary, surgical procedures such as the insertion of stents to keep coronary arteries open.

So far, the researchers have demonstrated that cells grown on cellulose coated with a special gelatine can contract and stretch in a way that mimics the myocardium, the heart's muscle tissue. "At present, we have just one layer of vascular cells and one layer of cardiac cells," explains Antonio Sileo, a researcher in

Marsano's group. "The next step will be to add additional layers and make the patch fully functional. Then we'll move to testing on small animals, such as mice, then larger ones, such as pigs, and eventually clinical trials on humans. But that's still a long way off."

Pure cellulose paper

To meet the complex demands of this biotechnological endeavour, the cellulose sheets were meticulously folded in miniature moulds. "We explored various approaches and found that the folding pattern was essential to achieve the desired contraction," says Sileo.

The cellulose itself was specially developed by OMYA International AG. "It's not like standard writing paper, which contains additives, glues and bleaching agents," explains Gullo. "It's made from pure cellulose fibres – more similar to the paper produced long ago."

The material has two key functions: first, to support the layers of cells and enable them to contract, and second, to provide structural integrity so that surgeons can handle the tissue during operations.

Predicting the future of research and innovation – particularly in medicine – is notoriously difficult, as the time between proof of concept and clinical application can span decades. Nevertheless, far from media hype, this is how the therapies of the future are born: from a successful test-tube experiment.

Translated from Italian using DeepL/amva/ts

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