

IIT Guwahati develops silk patch to repair damaged heart tissue

The 3D patch has high cell density, a foremost requirement for heart tissue

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Scientists at the Indian Institute of Technology (IIT) Guwahati have fabricated a 3D cardiac tissue patch using silk protein membranes seeded with heart muscle cells. The patch can potentially be used for regenerating damaged heart tissue.

"The 3D patch that we fabricated can be implanted at the site of damage to help the heart regain normal function. It can also be used for sealing holes in the heart," says Biman Mandal from the Department of Biosciences and Bioengineering, IIT Guwahati, who led the research.

Cardiac tissue gets permanently damaged when oxygen supply is reduced or cut off during a heart attack. The damaged portion gets scarred and does not contract and relax, which over time leads to a change in the shape of the heart and reduced pumping capacity.

While currently available grafts fail to mimic the structure and the function of the native heart tissue as well as maintain high cell numbers, the patch developed by the IIT Guwahati researchers scores over these on many counts. The results were published in the *Journal of Materials Chemistry B*.

The team led by Prof. Mandal tested both mulberry (*Bombyx mori*) and non-mulberry (*Antheraea assama*) silk to fabricate the membrane. Silk proteins extracted from raw silk were used for fabricating the membrane by using a mould. The nano-groove structure on the mould was transferred to the silk membrane and this helped guide the heart muscle to grow in a linear fashion and parallel to each other thus mimicking the heart tissue structure. "We focused on developing a silk-based tissue engineered membrane which will allow the cardiac cells to grow while maintaining the structural anisotropy," says Prof. Mandal.

Seeding the silk

Heart cell lines and cells taken from the heart tissue were used



Crucial support: "The 3D patch that we fabricated can be implanted at the site of damage to help the heart regain normal function," say Prof. Biman Mandal (left) and Shreya Mehrotra. ■ SPECIAL ARRANGEMENT

for seeding the silk membrane. The presence of certain cell-binding protein sequences (RGD motifs) and greater surface roughness of the non-mulberry silk, which is endemic to north-east India (locally called muga silk), facilitated better anchorage and cell binding. "The cells grew and proliferated, filling the membrane 7-10 days after it was seeded," he says.

As heart tissue continuously contracts and relaxes, the engineered tissue should have good elasticity. "The muga silk exhibited good elasticity and mechanical strength comparable to native heart tissue as we used only 2% silk proteins to make the

membrane," says Shreya Mehrotra, Department of Biosciences and Bioengineering and first author of the paper. "When tested on mice, we found the muga silk was immunologically compatible and hence not rejected by the immune system," she adds.

Making a 3D patch

The single membranes with proliferating cells were then stacked one over the other to form a 3D patch. "In 5-6 days, the cells present on top of the membrane bound to the membrane above it leading to the layers sticking to each other," Prof. Mandal says.

"Stacking the membranes to form a 3D patch overcomes the

drawbacks of current scaffolds used for cardiac tissue engineering in terms of creating a high cell dense anisotropic patch, a foremost requirement for this tissue," he stresses.

The silk in the patch supports the cells till the newly formed cardiac tissue integrates with the native heart tissue and degrades once the integration takes place. "This method is better than the conventional direct delivery of cardiac cells to repair the damaged portion of the heart as the cells get washed out from the injected site," says Ms. Mehrotra.

The team will carry out animal studies in collaboration with AIIMS.