Nanochip could heal injuries or regrow organs with one touch, say researchers

A tiny device that sits on the skin and uses an electric field to reprogramme cells could be a breakthrough in the way we treat injured or ageing tissue

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A novel device that reprogrammes skin cells could represent a breakthrough in repairing injured or ageing tissue, researchers say.

The new technique, called tissue nanotransfection, is based on a tiny device that sits on the surface of the skin of a living body. An intense, focused electric field is then applied across the device, allowing it to deliver genes to the skin cells beneath it – turning them into different types of cells.

That, according to the researchers, offers an exciting development when it comes to repairing damaged tissue, offering the possibility of turning a patient’s own tissue into a “bioreactor” to produce cells to either repair nearby tissues, or for use at another site.

“By using our novel nanochip technology, injured or compromised organs can be replaced,” said Chandan Sen, from the Ohio State University, who co-led the study. “We have shown that skin is a fertile land where we can grow the elements of any organ that is declining.”

The ability for scientists to reprogram cells into other cell types is not new: the discovery scooped [John Gurdon and Shinya Yamanaka the Nobel Prize in 2012](https://www.theguardian.com/science/2012/oct/08/nobel-prize-briton-science-teacher) and is currently under research in myriad fields, including [Parkinson’s disease](https://www.theguardian.com/science/2009/mar/01/stem-cells-breakthrough).

“You can change the fate of cells by incorporating into them some new genes,” said Dr Axel Behrens, an expert in stem cell research from the Francis Crick Institute in London, who was not involved in the Ohio research. “Basically you can take a skin cell and put some genes into them, and they become another cell, for example a neuron, or a vascular cell, or a stem cell.”

But the new approach, says Sen, avoids an intermediary step where cells are turned into what are known as pluripotent stem cells, instead turning skin cells directly into functional cells of different types. “It is a single step process in the body,” he said.

Furthermore, the new approach does not rely on applying an electric field across a large area of the cell, or the use of viruses to deliver the genes. “We are the first to be able to reprogramme [cells] in the body without the use of any viral vector,” said Sen.

The new research, published in the journal [Nature Nanotechnology](http://nature.com/articles/doi:10.1038/nnano.2017.134), describes how the team developed both the new technique and novel genes, allowing them to reprogramme skin cells on the surface of an animal in situ.

“They can put this little device on one piece of skin or onto the other piece of skin and the genes will go there, wherever they put [the device],” said Behrens.

The team reveal that they used the technique on mice with legs that had had their arteries cut, preventing blood flow through the limb. The device was then put on the skin of the mice, and an electric field applied to trigger changes in the cells’ membrane, allowing the genes to enter the cells below. As a result, the team found that they were able to convert skin cells directly into vascular cells -with the effect extending deeper into the limb, in effect building a new network of blood vessels.

“Seven days later we saw new vessels and 14 days later we saw [blood flow] through the whole leg,” said Sen.

The team were also able to use the device to convert skin cells on mice, into nerve cells which were then injected into the brains of mice who had experienced a stroke, helping them to recover.

“With this technology, we can convert skin cells into elements of any organ with just one touch. This process only takes less than a second and is non-invasive, and then you’re off,” said Sen.

The new technology, said Behrens is an interesting step, not least since it “avoids all issues with rejection”.

“This is a clever use of an existing technique that has potential applications – but massive further refinement is needed,” he said, pointing out that there are standard surgical techniques to deal with blockages of blood flow in limbs.

What’s more, he said, the new technique is unlikely to be used on areas other than skin, since the need for an electric current and the device near to the tissue means using it on internal organs would require an invasive procedure.

“Massive development [would be] needed for this to be used for anything else than skin,” he said.

But Sen and colleagues say they are are hoping to develop the technique further, with plans to start clinical trials in humans next year.