MedicalXpress

A step closer to bio-printing transplantable tissues and organs

June 30 2014

Researchers have made a giant leap towards the goal of 'bio-printing' transplantable tissues and organs for people affected by major diseases and trauma injuries, a new study reports.

Scientists from the Universities of Sydney, Harvard, Stanford and MIT have bio-printed artificial vascular networks mimicking the body's circulatory system that are necessary for growing large complex tissues.

"Thousands of people die each year due to a lack of organs for transplantation," says study lead author and University of Sydney researcher, Dr Luiz Bertassoni.

"Many more are subjected to the surgical removal of tissues and organs due to cancer, or they're involved in accidents with large fractures and injuries.

"Imagine being able to walk into a hospital and have a full organ printed – or bio-printed, as we call it – with all the cells, proteins and blood vessels in the right place, simply by pushing the 'print' button in your computer screen.

"We are still far away from that, but our research is addressing exactly that. Our finding is an important new step towards achieving these goals.

"At the moment, we are pretty much printing 'prototypes' that, as we improve, will eventually be used to change the way we treat patients

worldwide."

The research challenge – networking cells with a blood supply.

Cells need ready access to nutrients, oxygen and an effective 'waste disposal' system to sustain life. This is why 'vascularisation' – a functional transportation system – is central to the engineering of biological tissues and organs.

"One of the greatest challenges to the engineering of large tissues and organs is growing a network of blood vessels and capillaries," says Dr Bertassoni.

"Cells die without an adequate blood supply because blood supplies oxygen that's necessary for cells to grow and perform a range of functions in the body."

"To illustrate the scale and complexity of the bio-engineering challenge we face, consider that every cell in the body is just a hair's width from a supply of oxygenated blood.

"Replicating the complexity of these networks has been a stumbling block preventing tissue engineering from becoming a real world clinical application."

But this is what researchers have now achieved.

What the researchers achieved

Using a high-tech 'bio-printer', the researchers fabricated a multitude of interconnected tiny fibres to serve as the mold for the artificial blood vessels.

They then covered the 3D printed structure with a cell-rich protein-based material, which was solidified by applying light to it.

Lastly they removed the bio-printed fibres to leave behind a network of tiny channels coated with human endothelial cells, which self organised to form stable blood capillaries in less than a week (see diagram below).

The study reveals that the bioprinted vascular networks promoted significantly better cell survival, differentiation and proliferation compared to cells that received no nutrient supply.

Significance of the breakthrough

According to Dr Bertassoni, a major benefit of the new bio-printing technique is the ability to fabricate large three-dimensional micro-vascular channels capable of supporting life on the fly, with enough precision to match individual patients' needs.

"While recreating little parts of tissues in the lab is something that we have already been able to do, the possibility of printing three-dimensional tissues with functional blood capillaries in the blink of an eye is a game changer," he says.

"Of course, simplified regenerative materials have long been available, but true regeneration of complex and functional organs is what doctors really want and patients really need, and this is the objective of our work.

Provided by University of Sydney