Building Artificial Organs from Nanomaterials

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Source: University College London

A team of scientist built an artificial trachea from nanomaterials and stem cells. In the future, bypass grafts, tracheae, osagphagous and heart valves might be made of nanocomposites, too.

In December 2011, Jungebluth et al. reported in **Lancet** about a patient with recurring cancer of the trachea. Usual surgery methods were running out of options, so the airways were replaced “with a tailored bioartificial nanocomposite previously seeded with autologous bone-marrow mononuclear cells via a bioreactor for 36 h.”

To create the new organ, the patient was scanned to get an exact 3-d image of his trachea. From the 3-d scan the scientists first constructed a glass model of the affected trachea. The model was then used to shape the synthetic scaffold that was then seeded with the stem cells. Findings after 5 months were as good as it gets: “We noted an extracellular matrix-like coating and proliferating cells including a CD105+ subpopulation in the scaffold after the reseeding and bioreactor process. There were no major complications, and the patient was asymptomatic and tumour free 5 months after transplantation. The bioartificial nanocomposite has patent anastomoses, lined with a vascularised neomucosa, and was partly covered by nearly healthy epithelium,” the report states. The seeded stem cells did their job and had specialized into cells functioning just as they were supposed to.

“We are currently working on bypass grafts, tracheae, osagphagous and heart valves”, explains Alexander M. Seifalian, co-author of the Lancet study and Professor of Nanotechnology & Regenerative Medicine, University College London, about the state of the developments in creating artificial organs. And getting them to work in patients obviously is no science fiction anymore. “Tracheae, bypass grafts, tear ducts, noses and ears are already working in patients”, lists professor Seifalian who will give a presentation on **Nanomedicine at MEDTEC Europe.** “So this is already a lab to patient process.” And since the patient’s own stem cells are used there is no rejection by the body and no immune-suppressive drugs are needed.

He expects the artificial trachea being part of common medical practice in around two years, where the other organs on his list might take up to five years, “depending on the funding.” But he wouldn’t want to stop there. Asked about the limits of this technology he won’t accept any but the brain as a whole. “Let’s take on other solid organs such as liver and kidney. We might be looking at a 10 year timeframe before they will get to the patients, but they are surely possible.”

The nanocomposite materials especially developed by Seifalian and his colleagues are for special purposes: “We developed and patented two different kinds of these materials, one non-biodegradable, and the other one bio-degradable. The latter is meant for usage in children, where the organs still have to grow.” Making the nanocomposite materials biodegradable will allow the body to absorb them over time and replace them with its own cells.

The unique properties of nanomaterials, materials of which a single unit is sized between 1 and 1000 nanometers (10-9m), have caused quite a stir in the medical research community. The use of

nanomaterials or nanoelectronic biosensors opened a wide field of possible applications for this still rather new technology, ranging from visualization over surgery and cancer treatment to tissue engineering including the development of whole new organs.

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