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Electronics and biology merge to form cyborg tissue

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Researchers grows sensor wire mesh in cyborg tissue



Singapore: A multi-institutional research team has developed a method for embedding networks of biocompatible nanoscale wires within engineered tissues. These networks, which mark the first time that electronics and tissue have been truly merged in three dimensions (3D), allow direct tissue sensing and potentially stimulation.

The researcher team, led by Dr Daniel Kohane, Department of Anesthesia, Boston Children's Hospital; Dr Charles M Lieber, Harvard University; and Dr Robert Langer, ScD, Massachusetts Institute of Technology; reported their work online in *Nature Materials*.

One of the major challenges in developing bioengineered tissues is creating systems to sense what is going on chemically and electrically within a tissue, after it has been grown or implanted. Researchers have struggled to develop methods to directly stimulate engineered tissues and measure cellular reactions. Using heart and nerve cells as their source material and a selection of biocompatible coatings, the team successfully engineered tissues containing embedded nanoscale networks without affecting the cells' viability or activity.

The researchers could detect electrical signals generated by cells deep within the engineered tissues and measure changes in those signals in response to cardio or neurostimulating drugs, with the help of the networks. Furthermore, the team demonstrated that they could construct bioengineered blood vessels with embedded networks and use those networks to measure pH changes within and outside the vessels, as would be seen in response to inflammation, ischemia and other biochemical or cellular environments.

With the autonomic nervous system as inspiration, a postdoctoral fellow in the Dr Kohane's lab, Dr Bozhi Tian, and his collaborators built mesh-like networks of nanoscale silicon wires. These were about 80 nm in diameter and were shaped like flat planes or in a cotton-candy like reticular conformation. The networks were porous enough to allow the team to seed them with cells and encourage those cells to grow in 3D cultures.

Dr Lieber said that, "The current methods we have for monitoring or interacting with living systems are limited. We can use electrodes to measure activity in cells or tissue, but that damages them. With this technology, for the first time, we can work at the same scale as the unit of biological system without interrupting it. Ultimately, this is about merging tissue with electronics in a way that it becomes difficult to determine where the tissue ends and the electronics begin."

The team members see multiple future applications for this technology, from hybrid bioengineered cyborg tissues that sense changes within the body and trigger responses from other implanted therapeutic or diagnostic devices, to development of lab-on-a-chip systems that would use engineered tissues for screening of drug libraries. The study was supported by the National Institutes of Health, the McKnight Foundation and Boston Children's Hospital.