New method for magnetic manipulation of cells

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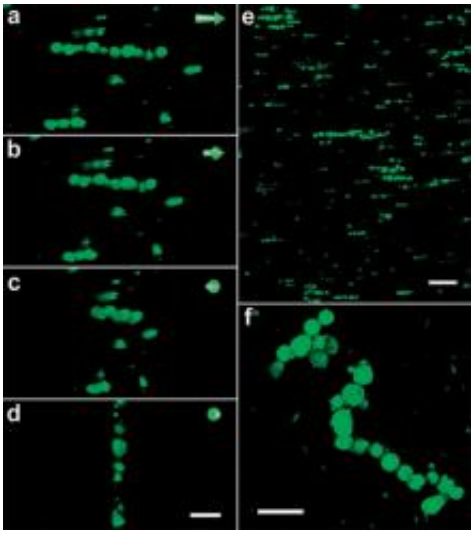

These images reveal cells chained in BSA-ferrofluid. Images (a) through (d) are of cells under a magnetic field forming oriented linear chains. The arrow indicates the direction of the magnetic field. Image (e) is a low magnification view of cells under magnetic field. Image (f) is a view of cell chains one hour after the magnetic field has been removed.

(PhysOrg.com) -- Magnetic technology could help address a major problem that bioengineers face as they try to create new tissue: getting human cells to not only form structures, but to stimulate the growth of blood vessels to nourish their growth.

A team of investigators from Case Western Reserve University, Duke

University and University of Massachusetts, Amherst, created an environment where magnetic particles suspended within a special liquid solution acted like molecular sheep dogs, nudging free-floating human cells to form chains in response to external magnetic fields. These chains, the researchers said, could potentially be integrated into approaches for creating human tissues and organs.

These cells not only naturally adhere to each other upon contact, the researchers said, but the aligned cellular configurations that form may promote or accelerate the creation and growth of tiny blood vessels.

“The cells have receptors on their surfaces that have an affinity for other cells,” said Melissa Krebs, a third-year biomedical engineering graduate student at Case Western Reserve University. “They become sticky and attach to each other. When endothelial cells get together in a linear fashion, as they did in our experiments, it may help them to organize into tiny tubules.”

The iron-containing nanoparticles used by the researchers are suspended within a liquid known as a ferrofluid. One of the unique properties of these ferrofluids is that they become highly magnetized in the presence of external magnetism, which allows researchers to readily manipulate the chain formation by altering the strength of the magnetic field.

At the end of the process, the nanoparticles are simply washed away, leaving a linear chain of cells. That the cells remain alive, healthy, and relatively unaltered without any harmful effects from the process is one of the major advances of the new approach over other strategies using magnetism.

“Others have tried using magnetic particles either within or on the surface of the cells,” explained Randall Erb, a fourth-year graduate student in the laboratory of Benjamin Yellen, assistant professor of

Mechanical Engineering and Materials Science, at Duke University's Pratt School of Engineering and Krebs' brother. "However, the iron in the nanoparticles can be toxic to cells. Also, the process of removing the nanoparticles afterward can be harmful to the cells and their function."

The key ingredient for these studies was the synthesis of non-toxic ferrofluids. Researchers developed a method for coating the magnetic nanoparticles with bovine serum albumin (BSA), a protein derived from cow blood. BSA is a stable protein used in many experiments because it is biochemically inert. In these experiments, the BSA shielded the cells from the toxic iron.

"The other main benefit of our approach is that we are creating three-dimensional cell chains without any sophisticated techniques or equipment," Krebs said. "Any type of tissue we'd ultimately want to engineer will have to be three-dimensional."

For their experiments, the researchers used human umbilical vein endothelial cells. Others types of cells have also been used, and it appears to the researchers that this new approach can work with any type of cell.

"While still in the early stages, we have shown that we can form oriented cellular structures," said Eben Alsberg, assistant professor of Biomedical Engineering and Orthopaedic Surgery at Case Western Reserve. "The next step is to see if the spatial arrangement of these cells in three dimensions will promote vascular formation. A major current hurdle in tissue engineering is vascularization, and we hope that this technology may help to address the problem."

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Provided by Case Western Reserve University (news : web)