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Heart Tissue Cultured on Spinach Leaves

Researchers have turned to the vascular system of plants to solve a major bioengineering problem blocking the regeneration of human tissues and organs. In a series of experiments, the researchers cultured beating human heart cells on spinach leaves that were stripped of plant cells. Their work is described in the paper "Crossing kingdoms: Using decelluralised plants as perfusable tissue engineering scaffolds" published online in advance of the May 2017 issue of the journal Biomaterials.

See Also: Organ-on-a-Chip Mimics Heart's Biomechanical Properties

Current bioengineering techniques, including 3D printing, can't fabricate the branching network of blood vessels down to the capillary scale that is required to deliver the oxygen, nutrients and essential molecules required for proper tissue growth. To solve this problem, a multidisciplinary research team at Worcester Polytechnic Institute (WPI), the University of Wisconsin-Madison, and Arkansas State University-Jonesboro have successfully turned to plants.

In their study, researchers flowed fluids and microbeads similar in size to human blood cells through the spinach vasculature, and they seeded the spinach veins with human cells that line blood vessels. This proof-of-concept study opens the door to using multiple spinach leaves to grow layers of healthy heart muscle to treat heart attack patients.

Removal of plant cells from spinach leaves is done by flowing or "perfusing" a detergent solution through the leaves' veins. When the plant cells are washed away what remains is a framework made primarily of cellulose, a natural substance that is not harmful to people. Cellulose is biocompatible and has been used in a wide variety of regenerative medicine applications, such as cartilage tissue engineering, bone tissue engineering, and wound healing, the researchers explain.

In addition to spinach leaves, the research team successfully removed cells from parsley, Artemesia annua (sweet wormwood), and peanut hairy roots. They expect the technique will work with many plant species that could be adapted for specialised tissue regeneration studies. "The spinach leaf might be better suited for a highly-vascularised tissue, like cardiac tissue, whereas the cylindrical hollow structure of the stem of Impatiens capensis (jewelweed) might better suit an arterial graft. Conversely, the vascular columns of wood might be useful in bone engineering due to their relative strength and geometries," the authors wrote.

The team has a lot more work to do, but so far the results of the study are "very promising," according to Glenn Gaudette, PhD, professor of biomedical engineering at WPI and corresponding author of the paper. "Adapting

abundant plants that farmers have been cultivating for thousands of years for use in tissue engineering could solve a host of problems limiting the field." Using plants as the basis for tissue engineering also has economic and environmental benefits.

At WPI, the research continues along several lines, Gaudette said, with studies to optimise the decellularisation process and further characterise how various human cell types grow while they are attached to, and are potentially nourished by, plant-based scaffolds. Also, engineering a secondary vascular network for the outflow of blood and fluids from human tissue will be explored.

Source: Worcester Polytechnic Institute
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