UNIVERSITY OF MINNESOTA
Driven to Discover℠

Bioink composition suitable for creating cardiac tissues

A material composition suitable for 3D printing of biological structures containing stem cells.

Technology No. 20180234

IP Status: PCT Patent Application Filed; **Application #:** PCT/US2019/057009

Applications

- Preparation of cardiac tissue mimics for applications in
  - drug discovery,
  - medical devices,
  - tissue replacement, and
  - *in vitro* studies,
- 3D bioprinting of biological structures

Overview

Researchers at Prof. Ogle's System Regeneration Lab have developed a novel bioink composition that supports 3D printing of biological structures. Creation of biological structures that functionally and structurally mimic native human tissues and organs has been the holy grail of tissue engineering, and 3D bioprinting is being actively investigated as a means to achieve this. One of the critical challenges with bioprinting lies in formulating a bioink composition that is both suitable for printing and able to support cell proliferation. This requirement is particularly difficult to achieve when stem cells are to be grown and differentiated within the printed structures. Requirements such as cell expansion after printing, timely delivery of differentiation factors, prevention of undesired modifications, and capacity to support cells through the differentiation process, all pose additional challenges.

This novel bioink composition developed at the University of Minnesota has been shown to be suitable for 3D printing to create biological structures consisting of stem cells. The researchers have demonstrated that structures printed using this bioink can

- support stem cell maintenance and expansion for at least 21 days
- facilitate delivery of growth factors through the media

- support stem cell differentiation into cardiomyocytes, and
- maintain structural integrity for over 365 days after printing.

More importantly, the differentiated cardiomyocytes were shown to exhibit functional properties that are characteristic of cardiac cells. The centimeter-scale complex printed prototype structure was also shown to exhibit collective functionality such as synchronous beating and calcium transients throughout the structure. Lastly, the low viscosity bioink is noted to be suitable for extrusion printing, stereolithography, or freeform reversible embedding of suspended hydrogels. Watch this video showing macroscale contraction of a 3D printed heart-like construct.

Key Benefits & Differentiators

- Cardiac differentiation and electromechanical coupling are allowed to happen in situ
- Functional properties of stem cells and differentiated cells are maintained
- Structurally intact complex structures can be printed/fabricated
- Cell proliferation properties comparable to traditional cell culture methods
- Physical properties of bioink prevents cell death caused due to shear force during printing
- Bioink components amenable to cellular degradation and remodeling

Phase of Development

Bioink prepared and tested. Differentiation of stem cells to cardiomyocytes shown within centimeter-scale printed structures.

Researchers

Brenda Ogle, PhD
Professor and Department Head, Biomedical Engineering
External Link (cse.umn.edu)

Publications

In Situ Expansion, Differentiation and Electromechanical Coupling of Human Cardiac Muscle in a 3D Bioprinted, Chambered Organoid
Circulation Research ,

Ready for Licensing

This technology is now available for license! The University is excited to partner with industry to see this innovation reach its potential. Please contact us to share your business' needs and your licensing interests in this technology. The license is for the sale, manufacture or use of products claimed by the patents.