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Shape-Memory Sponge Hydrogel for Tissue Engineering Applications (2011-088, 08-036)

Hydrophilic Biomaterial with Shape-Memory Sponge Characteristics for Tissue Replacement

Market Overview

This hydrogel composite is composed of elastin, glycosaminoglycan and collagen (EGC) that exhibits unique shape-memory sponge characteristics. This ECG hydrogel has broad applications in tissue engineering and biomaterials, specifically regarding its use as a nucleus pulposus (NP) replacement material. Spinal disk degeneration begins within the NP and, if not treated, can lead to detrimental changes to the Intervertebral Disc (IVD) structures. Current treatment options, such as total disk replacement, suffer from drawbacks including adjacent segment degeneration and subsidence. In order to improve these treatments, Clemson University Researchers developed the ECG hydrogel that could replace degenerating NP tissue with a mimetic surrogate material. This ECG hydrogel offers significant benefits including: extreme resiliency and water absorption capabilities, resistant to accelerated degradation, and moldable to patient NP anatomy. Overall, Clemson's breakthrough technology represents a resilient and hydrophilic biomaterial with shape-memory sponge characteristics that would offer a true solution to IVD degeneration via tissue replacement and regeneration.

Application

Tissue engineering,
IVD degeneration treatment

Stage of Development

Validated Prototype; *in vivo* and *in vitro* testing

Advantages

- Exhibits shape-memory sponge characteristics, resembling native NP by releasing water and deforming under compression, re-absorbing water and then re-establishing initial dimensions quickly
- ECG hydrogel exhibits hydrophilic and absorbent properties, making it cell-friendly and giving it the ability to be sterilized
- Utilizes PCG crosslinking, resulting in a formation method involving partial enzymatic degradation

Technical Summary

This sponge hydrogel biomaterial is developed via the assembly of purified proteins (soluble elastin and type I collagen) and glycosaminoglycans (chondroitin-6-sulfate and hyaluronic acid). These components are chemically crosslinked together using carbodiimide and pentagalloyl glucose based chemistries, followed by an enzymatic treatment which creates a hydrophilic, formable, and extremely resilient 3-D matrix.

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The biomaterial can take any shape and form depending on the target application. The resultant biomaterial can be deformed under large loads while concomitantly expelling the water naturally contained within the hydrogel; however once the load is removed, the biomaterial immediately recovers its original shape and re-absorbs its original water content in a similar manner to a sponge. This shape-memory biomaterial can be chemically sterilized and is conducive to use with cells if desired.

App Type	Country	Serial No.	Patent No.	CURF Ref. Number	Inventors
Utility	United States	13/713,685 13/530,624	9,283,301 9.005,289	2011-088 08-036	Dan Simionescu, Jeremy Mercuri

About the Inventors

Dr. Jeremy Mercuri is an Assistant Professor of Bioengineering at Clemson University. Prior to joining Clemson, he was a senior research engineer at Stryker and a research engineer at Medtronic Spinal & Biologics. Among his accomplishments, Dr. Mercuri holds two issued patents and several applications. He founded the Laboratory of Orthopaedic Tissue Regeneration and Orthobiologics at Clemson in August 2013 where he focuses on the development of regenerative medicine technologies. His research expertise lies in biomaterials development and the application of stem cells towards orthopaedic tissue engineering and regenerative medicine.

Dr. Dan Simionescu is an Associate Professor of Bioengineering at Clemson University. He earned his Ph.D. in Biology from the Institute of Cellular Biology and Pathology, Bucharest, Romania. Dr. Simionescu currently serves as the Director of the Laboratory for Regenerative Medicine at Greenville Hospital System and also the Biocompatibility and Tissue Regeneration Laboratory at Clemson University. He holds over 10 issued patents and several applications. His research interests focus on minimally invasive therapy and tissue regeneration.

For More Information

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