# Preservation Strategies for Viable Musculoskeletal Allografts (2024-041)

Novel preservation method of vitreous grafts for knee menisci, osteochondral allografts, and temporomandibular joints.

## Market Overview

The shortage of suitable donor grafts from the knee and temporomandibular joints (TMJ) impedes treatments for millions of patients. Currently, to address this need, fresh-frozen and cryopreserved allographs are used as valuable alternatives for transplantation when fresh donor grafts are unavailable. While these grafts provided essential support for patients with immediate need, long-term clinical outcomes still present a challenge. In specific, the formation and growth of ice crystal formation during fresh-freezing and conventional cryopreservation processes result in substantial cell loss. This leads to limitations in preserving viable cells and overall unfavorable long-term outcomes. Clemson researchers have pioneered the development of vitreous grafts for knee menisci, osteochondral allografts, and TMJ discs. This novel method applies vitrification for the first time in these tissue types in order to preserve viable allografts for long-term storage. Furthermore, each step of the vitrification process is optimized to develop the ideal preservation protocol for each specific tissue type.

## Technical Summary

The vitreous grafts are created by transitioning donor tissues into an amorphous solid vitreous state during cooling, effectively preventing ice crystal formation at cryogenic temperatures, with the aid of high concentration cryoprotective agents (CPAs). Typically, the complete vitrification procedure involves selecting appropriate CPAs, adding CPAs to the tissues, cooling, storage, warming, removing CPAs from the tissues, and tissue recovery. A key benefit of this invention is the development of the optimal preservation protocol for each specific tissue type. The novel method leads to more favorable long-term clinical outcomes for patients in need of knee menisci, osteochondral allografts, and TMJ disc grafts.

### Application

Musculoskeletal allograft preservation

### Development Stage

TRL 4/5

### Advantages

- Novel method to preserve viable allografts for long-term storage.
- Vitrification used for the first time in grafts for knee menisci, osteochondral allografts, and TMJ discs.
- Process optimized for each specific tissue type.
- Prevents ice crystal formation and growth during fresh-freezing and conventional cryopreservation.

## About the Inventors

### Dr. Shangping Wang

Assistant Professor of Bioengineering at Clemson University

Dr. Wang received her Ph.D. in Regenerative Sciences from Hannover Medical School, Germany in 2015 and joined Clemson University in 2020. Dr. Wang's research interests center around the development of long- term preservation technologies for viable large-sized tissues and organs, with the ultimate goal of advancing graft transplantation in the clinic. Her laboratory has been supported by multiple funding agencies, including NIH SC TRIHM, NIH SBIR, DoD, and MTF Biologics.

### Dr. Hai Yao

Professor of Bioengineering and Associate Department Chair for Clemson University-MUSC Bioengineering Program

Dr. Hai Yao received his PhD in Biomedical Engineering from the University of Miami. Dr. Hai serves on or leads several expert panels, including the NIH Temporomandibular Joint (TMJ) expert panel and an Engineering Panel for the National Research Council of the National Academies. His research interests include the biomechanical function, degeneration and regeneration of skeletal systems, including temporomandibular joint (TMJ) and spine intervertebral disc (IVD).

### Dr. Yongren Wu

Assistant Professor of Bioengineering at Clemson University and Adjunct Assistant Professor of Orthopedics and Physical Medicine at the Medical University of South Carolina

Dr. Yongren Wu received his PhD in Bioengineering from Clemson University in 2013. As PI of the Orthopedic Bioengineering Laboratory, his team pursues a multi-scale, systems-level understanding of mechano-adaption mechanisms in the soft tissue and bone interface for better diagnosis, treatment, and rehabilitation of musculoskeletal disease. Dr. Wu's lab has been funded by multiple agencies including NIH (NIGMS), NIH SBIR, SC INBRE, Cervical Spine Research Society (CSRS), and Musculoskeletal Transplant Foundation (MTF).

### Dr. Peng Chen

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Dr. Peng Chen received his PhD in Biomedical Engineering from Clemson University in 2020. He currently works as a postdoctoral research associate in the Tissue Biomechanics Laboratory in the Clemson University-MUSC Bioengineering joint program.

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