Understanding Tissue Engineering Structure Storage at Low-Temperature

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Abstract

With the goal of generating biological replacements to preserve, enhance, or restore tissue function, tissue engineering is a fast-growing area. The study of tissue storage at low temperatures began in the late 1800s. Improved freezing precision and control, as well as more useful tissue engineering storage, are the main goals of recent developments in the cryopreservation of tissues, especially bones and organs.

The goal of this project is to create a dynamic model using an idealized environment that induces temperature and cryopreservation agent behavior. This entails modifying important variables including the size of the vessel and the cooling surface application. As part of the project, practical testing will be carried out on designated testbed systems to verify the real-world correlation with the computer modeling.

Samples such as collagen, cryoprotective solution, and water were cooled during this experiment. Using a -81 freezer, the samples were cooled to -40 degrees, and thermocouples and a data logger (PicoLog) were used to monitor the temperature and cooling rate in the cryopreservation vials. Ansys Workbench -2024 R2 was used to construct a computational model for transient thermal analysis. Sample analysis revealed that the concentration of the cryoprotectant and the velocity of cooling down lowered the formation of harmful ice crystals. The stimulation met the values with the experiment setup with a few challenges. The study improves the practical usefulness of tissue-engineered products in regenerative medicine by enhancing the understanding and control of essential factors involved in cryopreservation.