UNC CHARLOTTE
The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

Senior Design Project Description

Company Name	UNCC Biomedical Engineering	**Date Submitted**	08/03/2018
Project Title	Cryopreservation of large volumes of hepatocytes (BIO_CRYO)	**Planned Starting Semester**	Fall 2018

Personnel

Discipline	Number	Discipline	Number
Mechanical (Biomedical)	6	Electrical	
Computer		Systems	
Other			

Company and Project Overview:

Currently there are ~120,000 people on the waitlist for a life-saving organ transplant, and many more could medically benefit, if more organs could be made available. A major challenge is the very short time (hours) that organs remain viable after donation, which prevents organs from being stored or 'banked' for future use. The Charlotte Banks initiative (www.charlottebanks.org), headquartered at UNC Charlotte, is focused on overcoming the technical hurdles to organ banking by developing preservation technologies that can extend the time during which tissues and organs can be preserved. This can be achieved by a number of means, including optimization of cold and warm storage for short-term storage, or by low temperature freezing or ice-free vitrification methods for long-term storage. The goal of the current project is to develop a method to cryopreserve large volumes of encapsulated liver (hepatocyte) cells using vitrification methods, and in doing so, advance towards preservation of larger volume complex tissues, including whole livers.

Project Requirements:

Project objectives and the desired output – describing the scope and specifications for what the project team will actually be designing and producing.

The project can be broken down into 4 sub-projects that are complementary and will be guided by an overall team vision but can progress in parallel; A) Development of methodology to encapsulate liver cells/create liver spheroids. B) Development of a low-toxicity low viscosity preservation solution for hepatocytes/liver spheroids. This sub-project will investigate which cryoprotectant solution has the least toxicity on hepatocytes, while remaining within the viscosity limits that enable it to be delivered into tissues using peristaltic pumps. The outcome will be assessed by viability, plateability, and function. C) Development of a pumping system to enable delivery and wash-out of preservation solution under controlled temperature conditions. Optimized diffusion times will be determined using both FTIR-ATR experimental data and mathematical simulations based on irreversible thermodynamics and mass transfer models. D) Development of vitrification methodology to enable ice-free preservation of encapsulated liver cells in high volumes.

Optimization will be guided by heat transfer models and experimental data.

Expected Deliverables/Results:

- Project A:
  - Methodology to enable reproducible production of alginate-encapsulated liver spheroids.
- Project B:
  - A low-toxicity low viscosity vitrification solution for hepatocytes
- Project C:
  - A computer controlled dual pump system to deliver cryoprotectant to encapsulated spheroids with verification from FTIR-ATR Spectroscopy
  - Mass transfer model to predict protection distribution in tissue
- Project D:
  - Experimental methodology to enable reproducible vitrification of encapsulated liver cells in high volumes.
  - Heat transfer model to predict thermal profiles in treated samples

Disposition of Deliverables at the End of the Project:

Hardware developed is the property of the Industry Supporter. Please specify what disposition you would like for the hardware developed by the Project team. Typically the work product is displayed at the last Expo then immediately handed over to the supporter unless arrangements have been made to deliver at a future date.

List here any specific skills, requirements, knowledge needed or suggested (If none please state none):

- Project A: Experience with cell culture and aseptic technique desired but not essential
- Project B: Experience in wet lab and microscopy desired but not essential
- Project C: LabView, Computational modeling
- Project D: Computational modeling, heat transfer