University of Victoria | Graduate Studies

Notice of the Final Oral Examination for the Degree of Master of Science

of

MEGHAN HALL

BSc (University of Victoria, 2013)

"Mathematical Model of Growth and Neuronal Differentiation of Human Induced Pluripotent Stem Cells Seeded on Melt Electrospun Biomaterial Scaffolds"

Department of Mathematics and Statistics

Friday, July 29, 2016
10:00 A.M.
David Strong Building
Room C114

Supervisory Committee:
Dr. Roderick Edwards, Department of Mathematics and Statistics, University of Victoria (Co-Supervisor)
Dr. Stephanie Willerth, Department of Mathematics and Statistics, UVic (Co-Supervisor)

External Examiner:
Dr. Mohsen Akbari, Department of Mechanical Engineering, UVic

Chair of Oral Examination:
Dr. Tim Pelton, Department of Curriculum and Instruction, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

Human induced pluripotent stem cells have two main properties: pluripotency and self-renewal. Physical cues presented by biomaterial scaffolds can stimulate differentiation of hiPSCs to neurons. In this work, we develop and analyze a mathematical model of aggregate growth and neural differentiation on melt electrospun biomaterial scaffolds. An ordinary differential equation model of population size of each cell state (stem, progenitor, differentiated) was developed based on experimental results and previous literature. Analysis and numerical simulations of the model successfully capture many of the dynamics observed exerimentally. Analysis of the model gives optimal parameter sets, that correspond to experimental procedures, to maximize particular populations. The model indicates that a physiologic oxygen level (_5%) increases population sizes compared to atmospheric oxygen levels (_21%). Model analysis also indicates that the optimal scaffold porosity for maximizing aggregate size is approximately 63%. This model allows for the use of mathematical analysis and numerical simulations to determine the key factors controlling cell behavior when seeded on melt electrospun scaffolds.