University of Victoria | Graduate Studies

Notice of the Final Oral Examination for the Degree of Doctor of Philosophy

of

SAMANTHA VAN NEST

MSc (University of Victoria, 2013)
BSc (University of Manitoba, 2011)

"Applications of Raman Spectroscopy in Radiation Oncology: Clinical Instrumentation and Radiation Response Signatures in Tissue."

Department of Physics and Astronomy

Tuesday, August 21, 2018
10:00 A.M.
Elliott Building
Room 226

Supervisory Committee:
Dr. Andrew Jirasek, Department of Physics and Astronomy, University of Victoria (Supervisor)
Dr. William Ansbacher, Department of Physics and Astronomy, UVic (Member)
Dr. Michel Lefebvre, Department of Physics and Astronomy, UVic (Member)
Dr. Alexandre Brolo, Department of Chemistry, UVic (Non-Member)

External Examiner:
Dr. Sangeeta Murugkar, Department of Physics, Carleton University

Chair of Oral Examination:
Dr. Chris Upton, Department of Biochemistry and Microbiology, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

Radiation therapy plays a crucial role in the management of cancer, however, current standards of care have yet to account for patient specific radiation sensitivity. Raman spectroscopy is a promising technique for radiobiological studies as a way to measure radiation responses in biological samples and could provide a method for monitoring and predicting radiation response in patients. The work in this dissertation gives way to significant advances in the implementation of Raman spectroscopy for applications in radiation oncology. Specifically, instrumentation improvements for clinical implementation of RS were achieved through the investigation and development of Raman microfluidic systems. Unique magnesium fluoride based microfluidic systems were engineered and evaluated for applications in radiobiological studies. These systems were found to yield superior spectral quality over traditional microfluidic designs.

Furthermore, in order to assert RS as a key technique for clinical monitoring and prediction of radiation responses, human NSCLC and breast tumour xenograft models were investigated for Raman signatures of radiation response. These studies found that RS can identify unique and distinct signatures of radiation response in tumours that can be tracked over time. In particular, NSCLC tumours were found to have key radiation induced modulations in cell cycle and metabolic linked spectral features including glycogen. Breast adenocarcinoma tumours were found to exhibit distinct fluctuations in spectral features linked to cell cycle as well as protein content. In the case of NSCLC, radiation response signatures were found to be linked to tumour regression and hypoxic status of the tumour- a key factor that dictates radiation resistance in the disease.

This work provides the first application of RS to measure radiation response signatures of tumours irradiated *in vivo*. These results show that RS is a versatile technique that can offer insight into radiation induced molecular changes that are unique to the type of cancer and can be monitored over several days following radiation exposure. Together with improved instrumentation for radiobiological studies using microfluidics, the work presented in this dissertation further emphasizes the key role RS can have in radiation oncology and personalization of radiation therapy.