Ph.D. Candidate

Sana Jahedi

Graduate Academic Unit

Mathematics and Statistics

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March 30, 2022

12:00 p.m. (Atlantic)

Virtual Defence

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Examining Board:
Dr. Edward Wilson-Ewing (Mathematics & Statistics)
Dr. Branimir Cacic (Mathematics & Statistics)
Dr. Aurora Nedelcu (Biology)
Dr. James Watmough, (Mathematics & Statistics) Supervisor

External Examiner: Dr. Morgan Craig
Professeure adjointe
Département de mathématiques et de statistique
Université de Montréal

The Oral Examination will be chaired by:
Dr. Patricia Evans, Associate Dean of Graduate Studies

BIOGRAPHY

Universities attended (with dates & degrees obtained):

2015 – present	Ph.D. candidate, University of New Brunswick
2012	Master of Pure Mathematics, Shahid Beheshti
2009	Bachelor of Pure Mathematics, ALzahra University

Publications:

Sana Jahedi, James Yorke. When the best pandemic models are the simplest, Biology 2020, 9(11), 353; https://doi.org/10.3390/biology9110353

Sana Jahedi, Lin Wang, James Watmough, Fighting cancer with oncolytic viral therapy: identifying threshold parameters for success, (2021), preprint https://doi.org/10.1101/2021.07.19.452846

Sana Jahedi, Kamran Kaveh, James Watmough, Targeting Cancer Stem Cells: A modelling approach, (2022), preprint.

Sana Jahedi, Lin Wang, James Watmough, Enhancer or Burden: Effect of virus-specific immune response on oncolytic viral therapy, (2022), preprint.

Sana Jahedi, Timothy Sauer, James Yorke. Structured system of nonlinear equations, (2022), preprint.

Sana Jahedi, Timothy Sauer, James Yorke. Global properties of solutions of system of equations, (2022), preprint.

Presentations in Conferences, Seminars and Colloquiums:

The equations of nature reveal the nature of equations, CMS (Canadian Mathematical Society) summer meeting, June 2021.

Oncolytic viral therapy; a computational modelling approach, York university, CDM (Canadian center for disease modeling) Incubation Day, February 2021.

When the best pandemic models are the simplest, AARMS COVID-19 seminar series, July 2020.

Covid-19 Containment methods, Howard university, July 2020.

Intraguild Predation, University of New Brunswick, June 2019.

Bogdanov-Taken Bifurcations, University of New Brunswick, February 2019.

Asymptotics of Speed in Large Drift, University of New Brunswick, November 2018.

Asymptotics of Eigenvalue in Large Drift, University of New Brunswick, September 2018.

Assessing oncolytic viral therapy and its barriers:
a mathematical approach

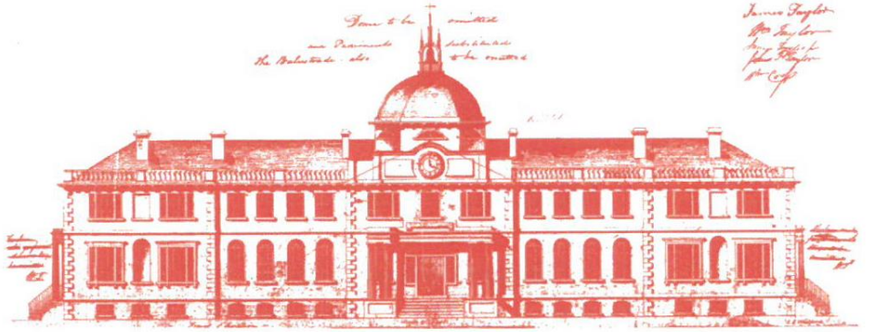
Abstract

Oncolytic viral therapy is a targeted therapy in which natural or genetically modified viruses are used specifically to target cancer cells and not harm healthy cells. Despite some promising results in in vitro and in vivo studies of oncolytic viruses, many questions about treatment regimens and outcomes remain unanswered. Mathematical modelling can be helpful to shed light on understanding cancer cell dynamics and treatment outcomes.

Firstly, we propose a set of ordinary differential equations that describes the interactions between cancer cells and the free virus during oncolytic viral therapy. Then, using stability and sensitivity analysis, we predict possible treatment outcomes. Then, by focusing on infection-related parameters such as the virulence level of the virus, the viral time scale and the infection transmission rate, and identifying thresholds on these parameters, we identify the type of virus that can lead to optimal treatment outcome.

Some research suggests that a virus-specific immune response, the type of immune response that becomes activated to prevent infection spread, may burden the success of oncolytic viral therapy. Extending our model, we propose models including the interactions with antibody molecules and the cytotoxic T cells during oncolytic viral therapy. We identify when each of the mentioned immune responses can be established by focusing on infection-related parameters. Our result shows virus-specific immune responses are not always detrimental: they can also be neutral or beneficial. Then by focusing on the virulence level of the free virus, we identify the extent to which the effect of a virus-specific immune response is detrimental and beneficial and show how the negative effect can be reduced or how beneficial results can be enhanced.

Due to properties such as self-renewal and long-lasting quiescence, cancer stem cells are responsible for tumour recurrence and the failure of many conventional therapies. Here, we assess the efficacy of targeting cancer stem cells with oncolytic viruses. We show that targeting cancer stem cells does not always enhance the treatment efficacy, and optimal stem cell specificity depends on the mitotic level of the infected cells. When infected cells are mitotic, the optimal result is obtained by perfect stem cell targeting.



Home of the School of Graduate Studies, Sir Howard Douglas Hall was designed by J.E. Woolford in 1825 and is the oldest university building in Canada still in use.

The University of New Brunswick recognizes that the university sits on traditional Wolastoqey territory. The river that runs right by our university – the St. John River – is also known as Wolastoq, along which live the Wolastoqiyik -- the people of the beautiful and bountiful river.

UNIVERSITY OF NEW BRUNSWICK

SCHOOL OF GRADUATE STUDIES

ORAL EXAMINATION

Sana Jahedi

IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY