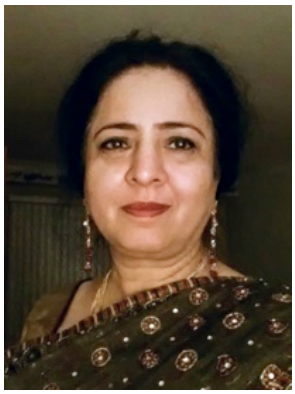
Professer Sadhna JOSHI



Dr. Sadhna Joshi completed her B.Sc., M.Sc., Ph.D. and D.Sc. from the Université Paris Diderot, France. She joined Allelix Biopharmaceuticals, Mississauga, in **1983**, where she worked as a Senior Research Scientist and Principle Investigator on AIDS and Immune Regulation. In **1988**, she was hired by the University of Toronto, where she is working as Associate Professor in the Department of Molecular Genetics; she is also cross-appointed in the Department of Laboratory Medicine and Pathobiology.

For the past **30** years, research in her laboratory has been focused on the development of **genetic strategies for HIV treatment and prevention**.

For **treatment**, she is developing **gene therapy** whereby patients' own hematopoietic stem cells will be genetically modified to secrete antiviral proteins. Four of the proteins engineered in her laboratory were shown to neutralize/inactivate HIV and inhibit HIV infection. One of these proteins was shown by her team to control HIV replication in a "humanized" mouse model. This gene therapy approach is of interest as, if it works, a single gene delivery procedure could provide a **life-time treatment** for HIV-infected individuals. To further decrease the cost of HIV gene therapy and broaden treatment accessibility, she is also considering *in vivo* gene delivery into more accessible cells (*e.g.* muscle cells).

For **preventing HIV transmission**, the same antiviral proteins are secreted from strains of *Lactobacillus* that can colonize the vagina and gastrointestinal tract to develop **microflora defence**. As *Lactobacillus* is used to make yogurt, the engineered strains could be propagated and delivered orally. This could represent the most affordable, accessible, safe and easy-to-use preventive measure to block HIV transmission.

Dr. Joshi received **Professional Female of the Year 2013 Award** from Indo-Canada Chamber of Commerce (ICCC) in Toronto and **Bharat Gaurav Award** (Pride of India Award) in **2013** in New Delhi. In **2018**, she received **Achievement and Recognition Award** from Indian Canadian Organization and **Lifetime/Outstanding Achievement Award** from ICCC in Toronto and **Samaj Ratn Award** from Srishya Shring Sansthan in Bhilwara, Rajasthan.

In addition to her devotion to research and serving as a role model and mentor to her students, she is recognized for her dedication and efforts in promoting Indian culture and literature as well as for her exemplary and remarkable contributions to the ideals of Brahmans and Indo-Canadian community. She is editor-in-chief of the annual magazine published by Rajasthan Association of North America (RANA) Canada, since 2013. She was also the editor-in-chief of the souvenir book, **Incredible Indo-Canadians**, published by National Alliance of Indo-Canadians in honour of the Indian Prime Minister, Shri Narendra Modi's visit to Toronto, in 2015.

Dr. Joshi is the **Vice-President** of **Vishva Hindi Sansthan Canada**, since 2013. She actively participated in organizing a 5-day **International Hindi Literary Conference** in Brampton, in 2018. Recently, she became the **President** of **World Brahman Federation (WBF) Canada** and was handed over the "**Parshu Ram Astra**" from Professor Azad Kumar Kaushik, Founding President and Chairman of WBF Canada, at the Brahman Samagam 2018, held in Mississauga.

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Dr. Sadhna JOSHI, Ph.D., D.Sc.

CURRICULUM VITAE
April 2020

A. PERSONAL INFORMATION

Name	**Sadhna JOSHI**
Citizenship:	Canadian
Date of Birth:	22 February 1956
Present appointment:	Associate Professor,
Address:	Dept. of Molecular Genetics &
	Dept. of Lab. Medicine & Pathobiology
	Faculty of Medicine, University of Toronto
	150 College St, Rm 210
	Toronto, ON, M5S 3E2, Canada
	Tel: 416 978-2499 (off); 416 978-1256 (lab); 647 720-9778 (cell)
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	Email: sadhna.joshi.sukhwal@utoronto.ca, drjoshisadhna@gmail.com
	Web site: http://drsadhnajoshi.weebly.com/

B. BIBLIOGRAPHICAL INFORMATION

1. Degrees:

"Docteur ès Science" (D.Sc.), received in Jan 1983
"Etude *in vivo* et *in vitro* des Propriétés tRNA-like et Messagères des RNA de Virus des Plantes". Superviser: Dr. AL Haenni, "Laboratoire de Biochimie du Développement", Institut Jacques Monod, CNRS, University Paris VII (Denis Diderot)

"Docteur de Troisième Cycle" (PhD), received in Nov 1979
"Aminoacylation *in vivo* de l'ARN du Virus de la Mosaïc Jaune du Navet". Superviser: Dr. AL Haenni, "Laboratoire de Biochimie du Développement", Institute of Research in Molecular Biology, CNRS, University Paris VII (Denis Diderot)

"Diplôme d'Etudes Approfondies", received in June 1977
"Contribution à l'étude du Valyl-RNA de Turnip Yellow Mosaic virus (TYMV)". Superviser: Dr. AL Haenni, "Laboratoire de Biochimie du Développement", Institute of Research in Molecular Biology, CNRS, University Paris VII (Denis Diderot)

"Attestation d'Etudes Approfondies": The Eukaryotic Genome, received in June 1977 in Fundamental Biochemistry from University Paris VII (Denis Diderot)

"Maîtrise" (M.Sc.), received in June 1976 in Biochemistry from University Paris VII (Denis Diderot)

"Licence", received in June 1975 in Biochemistry from University Paris VII (Denis Diderot)

"Diplôme Universitaire des Etudes Scientifiques" (B.Sc.), received in June 1974 in Chemistry-Biology from University Paris VII (Denis Diderot)

2. Employment & Research Experience

Sept 2008 - present: Associate Professor, Department of Molecular Genetics, Faculty of Medicine, University of Toronto.

Mar 1999 - present: Associate Professor, Cross-appointment to the Department of Laboratory Medicine and Pathobiology, Faculty of Medicine, University of Toronto.

Feb 1989 - present: School of Graduate Studies, full member.

July 1996 – Aug 2008, Associate Professor & Director HIV Research Laboratory, Department of Medical Genetics and Microbiology, Faculty of Medicine, University of Toronto.

Nov 1988 - June 1996: Associate Professor & **Director, HIV research laboratory**, Department of Microbiology, Faculty of Medicine, University of Toronto. **Tenured (July 1991).**

March 1988 - Oct 1988: Senior Research Scientist & **Principle Investigator**, AIDS and Immune Regulation. Allelix Biopharmaceuticals, Mississauga (Canada).

Oct 1987 - Feb 1988: Principle Investigator, AIDS and Immune Regulation, Allelix Biopharmaceuticals, Mississauga, Canada.

Feb 1987 - Sept 1987: Research Scientist, Allelix Biochemicals, Mississauga, Canada.

Dec 1985 - Jan 1987: Research Scientist, Allelix Inc, Corporate Molecular Biology Division, Mississauga, Canada.

July 1983 - Nov 1985: Research Scientist, Allelix Inc, Plant Molecular Biology group, Agriculture Division, Mississauga, Canada.

June 1982 - June 1983: Post-doctoral fellow (preparing for "Docteur ès Science", received in Jan 1983) at "Institut Jacques Monod", Paris (France), in the laboratory of Prof. F Chapeville in the group of Dr. AL Haenni.

Sept - Oct 1981: "Institut de Biologie Moléculaire et Cellulaire", Strasbourg (France), in the laboratory of Prof. G Dirheimer in the group of Dr. G Keith.

Sept 1980 - May 1982: Post-doctoral fellow at the University of Leiden, Dept of Biochemistry, Leiden (The Netherlands), in the laboratory of Prof. L Bosch, in the group of Drs. CWA Pleij & L van Vloten-Doting.

Oct 1977: "Université Libre de Bruxelles", Bruxelles (Belgium), in the laboratory of Prof. H Chantrenne in the group of Drs. G Marbaix & G Huez.

Sept 1976 - Aug 1980: Preparing for "Doctorat de Troisième Cycle" at the "Institut Jacques Monod", Paris (France), in the laboratory of Prof. F Chapeville in the group of Dr. AL Haenni.

3. Honours & Awards

May 2019:	“Mahatma Gandhi Leadership Award - 2019” to be received at the House of Commons in London, UK.
Dec 2018:	“Samaj Ratn Award - 2018” from Srishya Shring Sansthan received on my behalf by Mr. Shailendra Derashri in Bhilwara, Rajasthan, India.
June 2018:	“Indo-Canada Chamber of Commerce – 2018 Lifetime/Outstanding Achievement Award,” received in Toronto.
Mar 2018:	“Achievement and Recognition Award - 2018” by Indian Canadian Organization, received in Toronto.

Sept 2013:	"Member of the Year Award" by Rajasthan Association of North America Canada, received in Toronto.
June 2013:	"Indo-Canada Chamber of Commerce – 2013 Female Professional of the Year Award," received in Toronto.
Jan 2013:	"Bharat Gaurav" Award – Pride of India Award received in New Delhi, India.
June 1982 - May 1983:	"Fondation pour la Recherche Médicale Française".
June 1980 - May 1982:	European Molecular Biology Organization. Long-term Post-doctoral fellowship.
Oct 1979 - May 1980:	International Cell Research Organization, UNESCO.
Oct 1977 - Sept 1979:	"Délégation Générale à la Recherche Scientifique et Technique". Ministry of Science and Industry, France.

4. Professional Affiliations and Activities

Professional affiliations

- School of Graduate Studies (full member, since Feb 1989).
- American Society of Gene and Cell Therapy (since June 2017)
- American Society for Virology (full member, 1989-1992).
- American Society for Microbiologists (1989-1996).
- Canadian Society for Microbiologists (1990-1996).
- University of Toronto Faculty Association (since Nov 1989).
- Canadian Association for HIV Research (since 1990).
- Canadian Association for HIV Researchers in Ontario (2005-2010).
- International Society for AIDS Research (since 1988).
- International Society for Gene Therapy and Molecular Biology (since Feb 1999).

Professional activities

- Member, Faculty Appointments Advisory Committee (Since Sept 2018).
- Reviewer, Ontario Graduate Students Applications (Since Mar 2018).
- Reviewer, School of Graduate Students Applications (Since Mar 2019).
- Reviewer, manuscripts for Future Virology (since Aug 2011).
- Reviewer, manuscripts for Molecular Therapy (since Nov 2010).
- Reviewer, manuscripts for RNA biology (since Nov 2010).
- Reviewer, manuscripts for J Medical Genetics and Genomics (since July 2010).
- Reviewer, manuscripts for Retrovirology (since July 2009).
- Reviewer, manuscripts for Nucl Acids Res (since June 2009).
- Reviewer, manuscripts for Human Gene Therapy (since 1999).
- Reviewer, manuscripts for Antisense Res & Development/Oligonucleotides (since 1995).
- President, World Brahman Federation, Canada (since Sept 2018).
- Vice President, Vishwa Hindi Sansthan, Canada (since June 2015).
- Chief Editor, Incredible Indo-Canadians published by National Alliance of Indo-Canadians (April 2015).
- Board of Director, Special Appointee, Rajasthan Association of North America (Sept 2013-Aug 2017).
- Chief Editor, Rajasthan Association of North America Annual Magazine (since Sept 2013).
- Editorial board of Genetic Disorders & Gene Therapy (since Sept 2013).
- Editorial board of J Antivirals and Antiretrovirals (since 2009).
- Editorial board of Gene Therapy & Molecular Biology (since May 2000).
- Editorial board of International Scholarly Research Network - AIDS (since Feb 2012).
- Member, Joint Health & Safety Committee, FitzGerald Bldg (Oct 1992-July 2018).
- Reviewer, Research and Teaching effectiveness for Dr. Rupert Kaul's Tenure (June 2007).
- Tenure Committee member for Dr. Scott D. Gray-Owen (Mar 2004)
- Departmental Teaching Evaluation Committee member for Dr. Keith Ireton's Tenure (Mar 2004).
- Member, Education Committee – basic science sector, Faculty of Medicine, Univ of Toronto (2002-2003).
- Member, Current Drugs' panel of evaluators. Current Drugs Ltd, London UK (1998-2003).
- Member, Infectious Diseases node of the Centre for Collaborative Drug Research, University of Toronto (2015-2017).
- Internal teaching evaluation committee member for Dr. A. Cochrane's Tenure (Feb 2000).
- Member, Search Committee for three tenure stream positions (Dept Medical Genetics and Microbiology; July 1996 - June 1998.

- Member, Graduate Advisory Committee (Dept Microbiology; Sept 1995-Aug 1997).
- WHMIS Trainer (Dept Microbiology; Aug 1992-July 1993).
- Member, MRC Development Grant Committee (Dec 1991-Nov 1992).
- Co-organizer, Dept of Microbiology Research Day (Nov 1990).
- Participated in organization of the Opening Ceremony for the HIV research laboratory (Sept 1990).
- Internal reading evaluation committee member for Dr. A Bognar's Tenure (Feb 1990).
- Co-organizer, seminar series on molecular biology of HIV-1, the Hospital for Sick Children (Dec 1989–Jan 1990).
- Internal reading evaluation committee member for Dr. J Silver's Promotion (Nov 1989).
- Member, Graduate Advisory Committee (Dept Microbiology; Sept 1989 - Aug 1992).
- Member, Bethune, Pakula, McPherson Awards Committee (Sept 1989).
- Served on various meetings regarding construction of the HIV research laboratory.

Peer Review Committee Member/Grant review panels

- Reviewer for **Canadian Foundation for AIDS Research** (CanFAR) (1990-2018).
- Reviewer for **Medical Research Council** (MRC) / **Canadian Institutes of Health Research** (CIHR) (since 1989).
- Member for **CIHR Peer Review Committee for Doctoral Research Award and Master's Award** for **CGA/DRA** (Biomedical and Clinical Research) (Sept 2010-Aug 2012).
- Reviewer for **Medical Research Council SIR grants of South Africa** (2009-2012).
- Reviewer for **Natural Sciences and Engineering Research Council** of Canada (2010-2013).
- Reviewer for **Canadian Red Cross, Research and Development Grants (CRC R&D)** (1997-2000).
- Reviewer for **Hospital for Sick Children Foundation** (1996-1999).
- Reviewer for **BC Health Research Foundation** (BCHRF) (1994-1997).
- Reviewer for **Ontario Ministry of Health** (OMH) (1989-1994).
- Reviewer for **National Health Research Development Program** (NHRDP) (1989-1999).
- Reviewer for **Ontario HIV Treatment Network** (OHTN) (2000-2010).
- Served on NHRDP AIDS review committee meeting (May 9-10, 1990).
  Total number of grants analyzed for above granting agencies >80.

C. ACADEMIC HISTORY

1. Research Endeavours

Sept 1976 - Aug 1980: *Institut Jacques Monod, Paris, with Drs. F Chapeville & AL Haenni*

- Developed a $tRNA^{Val}$ -dependent *in vitro* translation.
- Studied *in vivo* aminoacylation of TYMV RNA in *Xenopus laevis* oocytes.
- Studied *in vivo* aminoacylation of TYMV RNA in Chinese cabbage leaves.
- Developed conditions allowing sequencing of ^{3}H- or ^{14}C- labelled nucleic acids.
- Separated genomic and subgenomic RNAs of TYMV RNA.

Oct 1977: *"Université Libre de Bruxelles", (Belgium), with Drs. G Marbaix & G Huez*

- Learned microinjections in *Xenopus laevis* oocytes.

Sept 1980 - May 1982: *University of Leiden, (The Netherlands), with Drs. L Bosch, CWA Pleij & L van Vloten-Doting*

- Detected TMV 30 kD protein in infected tobacco leaves.
- Characterized TMV intermediate length RNA-2 and its translation *in vitro* and *in vivo.*
- Studied age dependence of Cowpea protoplasts for spermidine uptake and for AMV infection.
- Detected non-structural AMV RNA-coded proteins present in tobacco leaves.
- Characterized a non-suppresser tRNA allowing read-through of a 150 kD protein encoded by TYMV RNA.

Sept 1981 - Oct 1981: *"Institut de Biologie Moléculaire et Cellulaire", Strasbourg, with Dr. G Keith*

- Sequenced a non-suppresser tRNA allowing read-through of the 150 kD protein encoded by TYMV RNA.

Sept 1981: *EMBO Advanced Laboratory Course, Basel (Switzerland)*

- Attended a course on plant cell culture techniques for molecular biologists.

June 1982 - June 1983: *"Institut Jacques Monod", Paris with Drs. F Chapeville & AL Haenni*
- Determined the size of the tRNA-like region of TYMV RNA required for recognition by tRNA-specific enzymes.
- Investigated the reason for abnormal protein migration of *in vitro* translation products synthesized in the presence of canavanine.

July 1983 - Nov 1985: *Allelix Inc Mississauga, Canada, Plant Molecular Biology Division*
- Developed plant virus based vectors.
- Developed plant protoplast microinjection technology.

Dec 1985 - Feb 1987: *Allelix Inc, Mississauga, Canada Corporate Molecular Biology Division*
- Cloned and characterized *Serratia liquefaciens* chitinase and chitobiase genes as well as genes regulating their expression.
- Optimized chitinase secretion during fermentation of genetically improved strains of *S. liquefaciens*.
- Set up collaboration with Dr. Boller, University of Basel (Switzerland), and obtained putative cDNA clones and antibodies for cloning and characterization of *Phaseolus vulgaris* β-1,3 glucanase gene. This gene was to be used for making transgenic *Brassica napus* plants.

Feb 1987 - Oct 1988: *Allelix Biopharmaceuticals, Mississauga, Canada*
- Set up an AIDS research program for Theracine Inc.
- Set up an AIDS and immune regulation program at Allelix.
- Participated in writing of proposals for central nervous system, tissue repair, and cancer research at Allelix.
- Developed viral inhibition therapy against AIDS (gene therapy using retroviral vectors expressing antisense and sense RNA molecules).
- Co-ordinated expression of soluble CD4 protein (in *E. coli*, yeast, fungus, and insect cells) for use in clinical trials and for designing drugs interfering with CD4/gp120 interaction.
- Co-ordinated characterization and cloning of a novel interleukin X of human origin.

Since Nov 1988: *Faculty of Medicine, University of Toronto.*
- Established an AIDS Research program and obtained research funds.
- Set up the HIV research laboratory (Health & Welfare equipment grant).
- Developed retroviral vectors for use in anti-HIV-1 gene therapy (allowing high level constitutive, constitutive and Tat-inducible, or Tat and Rev-inducible expression of anti-HIV-1 genes).
- Developed and tested retroviral/lentiviral vectors expressing anti-HIV-1 genes encoding anti-sense and sense RNAs, ribozymes, *trans*-dominant negative mutants of HIV-1 proteins, targeted/packageable RNases, toxins, and secreted antiviral proteins for inhibition of HIV replication via gene therapy.

I began research in **1976** at **Institut Jacques Monod, Paris, France** with the study of the **molecular biology of plant viruses**. My main interest has been to define the strategies used for modulation of viral gene expression. I have demonstrated that in order to regulate their gene expression, the Alfalfa mosaic virus (AMV) can make use of a frameshift mechanism and that the Tobacco mosaic virus (TMV) can make use of uncapped RNAs. Using radiolabelling and western blot analysis, I demonstrated that the 30-35 kD non-structural proteins of TMV and AMV are produced early during the virus life cycle. I have also participated in purification and sequencing of a non-suppresser tRNA (a $tRNA_3^{Lys}$) that enabled read-through of a “non-stop” codon present at the end of an open reading frame encoding the Turnip yellow mosaic virus (TYMV) 150 kD protein. In addition, I developed a $tRNA^{Val}$-dependent *in vitro* translation system, and purified the $tRNA^{Val}$ and the tRNAs lacking $tRNA^{Val}$.

I have demonstrated that the tRNA-like region at the 3' end of TYMV RNA is aminoacylated *in vivo* upon microinjection in *Xenopus laevis* oocytes and in infected Chinese cabbage leaves. Using a modified RNA fingerprinting technique, I defined the lengths of tRNA-like regions that are required for aminoacylation by aminoacyl-tRNA synthetases and adenylation by tRNA nucleotidyl-transferase in tymo-, bromo- and cucumoviruses. This study elucidated the secondary structures formed by these tRNA-like regions and also led to the discovery of pseudoknot structures in RNA molecules. In TYMV RNA, the 3' half of the tRNA-like region forms the aminoacyl arm and the 5' half of this tRNA-like region forms the anticodon arm. Using this tRNA-like region as a model, I showed in an unambiguous manner that only the aminoacyl arm is recognized by the tRNA nucleotidyl-transferase, and both the aminoacyl and the anticodon arms are recognized by

aminoacyl-tRNA synthetases. These studies could not be performed with a tRNA since both the 3' and 5' regions of a tRNA are involved in the formation of aminoacyl arm. Conditions for sequencing tRNA-like molecules labelled with ^{3}H or ^{14}C were established for the above fingerprinting experiments. Conditions were also developed for analysis and complete separation of viral genomic and subgenomic RNAs, with no loss of yield or infectivity. As well, conditions were developed for RNA and protein analysis by horizontal polyacrylamide gel electrophoresis.

In **1983**, I joined **Allelix Inc, Mississauga** where we set-up **plant protoplast microinjection technology**. Conditions were developed for controlled cell wall regeneration and nuclear staining, as well as for cytoplasmic microinjection of biologically active RNA molecules. I was among the **first** to have developed cytoplasmic and nuclear microinjections in plant protoplasts.

In **1985**, I became interested in the **control of fungal infections**. I cloned, characterized and purified *Serratia liquefaciens* chitinolytic (chitinase, chitobiase, activator, and repressor) genes that confer fungal resistance. Chitinase and chitobiase overproducing strains were generated, the enzymes were characterized, and large-scale purification methods were set up, and the proteins were purified for commercialization. Two patents were issued. These genes were used for making fungus-resistant transgenic plants.

In **1987**, I became interested in **HIV/AIDS** research and was appointed **principal investigator for AIDS and Immune Regulation** at Allelix Biopharmaceuticals. AIDS is caused by HIV. $CD4^{+}$ cells are the targets of HIV infection. In this capacity, I was responsible for identification and cloning of a novel interleukin (IL-X) from human blood, giving rise to antigen-independent maturation of cytotoxic T lymphocytes (in the absence of T helper cells). The application of this protein was sought for autoimmune diseases. For developing drugs that target receptors, Allelix was interested in cloning receptors that are poorly expressed. I therefore also developed Moloney murine leukemia virus (MoMuLV)-based packaging vectors for cloning "silent" genes.

My **HIV/AIDS** research was focused on the development of anti-HIV proteins that may be used to inhibit HIV infection upon injection into HIV-positive individuals. To infect these cells, this HIV requires the CD4 receptor. A secreted form of this molecule, referred to as soluble (s)CD4, was expressed in yeast, *Escherichia coli*, and insect cells. Two patents were issued and this project was subsequently funded by NIAID; **$ 4,000,000** were awarded in total of which **$ 600,000** were allotted to Allelix Biopharmaceuticals. However, instead of injected the protein for the life of the infected individuals, I then became interested in developing HIV gene therapy. Gene therapy (referred to as viral inhibition therapy against AIDS, VITA) consists of modifying the infected individuals own cells to express molecules that inhibit HIV infection. In 1987, I was **the first to have conceived the idea and begin research on HIV-1 gene therapy**. This project was funded by MRC (CIHR).

Gene therapy to treat HIV-infected individuals

In **November 1988**, I was appointed **Associate Professor** at the Department of Microbiology and subsequently the Department of Medical Genetics and Microbiology at the **University of Toronto**. Research in my laboratory has focused on the development of effective HIV-1 gene therapy strategies. Interfering proteins (*trans*-dominant negative mutants, targeted/packageable RNases, and secreted anti-HIV proteins) and RNAs (ribozymes, antisense RNAs, sense/decoy RNAs, and group II introns) were designed to target HIV DNA, RNA or proteins. The results are described below.

Interfering RNA-based strategies

- ***Hammerhead ribozymes:*** We were among the **first** to demonstrate the feasibility of a HIV-1 RNA-specific ribozyme approach. We designed a hammerhead ribozyme (Rz_{leader}) against a highly conserved region within the HIV-1 5' leader sequence and expressed it under control of MoMuLV 5' LTR, HSV *tk*, SV40, CMV, and HSV *tk*-TAR promoters. Virus replication was best inhibited (for 22 days) when this ribozyme was expressed under control of the HSV *tk*-TAR promoter from the MoTiN vector. This promoter was obtained by fusing the HSV *tk* promoter to the HIV-1 Tat mRNA leader sequence (nt +1 to ATG), which includes the TAR element responsible for Tat-induction. It was designed to allow constitutive gene expression with upregulation of interfering RNA level in HIV-infected cells.

The MoTiN vector was then used to develop five additional vectors, each expressing a monomeric ribozyme targeted against a highly conserved sequence within the *gag*, *RT*, *pro*, *tat*, or *env*-coding region of HIV-1 RNA. Of these, Rz_{Env} conferred the best protection followed by Rz_{Pro}. Virus production from these cells was delayed for 21 and 18 days, respectively. Rz_{Env} and Rz_{Pro} were also shown to inhibit HIV-1 replication in peripheral blood T lymphocytes. Breakthrough of HIV replication from Rz_{Pro}-expressing cells was shown to take place despite continued production of active ribozyme and lack of mutations within the ribozyme target site in the HIV-1 RNA.

Since the cellular $tRNA_3^{Lys}$ is packaged by HIV, ribozymes were expressed as part of this tRNA to allow HIV-1 RNA cleavage both in the cell and the virion. $tRNA_3^{Lys}$-based ribozyme expression cassettes (expressing ribozymes as part of the anticodon loop of the $tRNA_3^{Lys}$) were isolated *via in vitro* selection. These $tRNA_3^{Lys}$-Rzs were as active as a linear ribozyme targeted against the same site and as stable as $tRNA_3^{Lys}$. Retroviral vectors expressing six of these *in vitro* selected $tRNA_3^{Lys}$-Rzs were engineered and were tested for inhibition of HIV-1 replication. However, virus replication was only inhibited for a short period (1-2 weeks). We therefore concluded that monomeric ribozymes do not confer long-term inhibition.

Multimeric hammerhead ribozymes targeting HIV-1 RNA: To further improve the ribozyme-based strategy, we used an MoMuLV-based MoTiN vector designed by us to allow constitutive and Tat-inducible expression of a multimeric ribozyme, $Rz_{1\text{-}9}$. It targets 9 conserved sites within the *env*-coding region of HIV-1 RNA (B clade). We demonstrated that this ribozyme confers 99-100% inhibition of HIV-1 replication for the duration of the experiment (2 months).

Although HIV-1 provirus DNA was detected, HIV-1 RNA could not be observed, suggesting a post-transcriptional block. We have also shown that this ribozyme can inhibit virus replication in transduced $CD4^+$ peripheral blood T cells challenged with laboratory and clinical isolates of HIV-1. $Rz_{1\text{-}9}$ is only targeted against the HIV-1 B clade, and therefore anticipating future clinical applications, we developed another multimeric ribozyme, **$Rz_{1\text{-}14}$**. This multimeric ribozyme targets the *env*-coding region (9 sites) of HIV-1 RNA from clade B, and the 5' leader region (1 site) and the *pro*- (1 site), *pol*- (2 sites), and *vif*- (1 site) coding regions of HIV-1 RNA from *all major clades*. We used the mouse stem cell virus (MSCV)-based MGIN vector to compare $Rz_{1\text{-}9}$ and $Rz_{1\text{-}14}$. $Rz_{1\text{-}14}$ conferred **99% inhibition** of HIV-1 (NL4-3; MOI of 0.5) replication for the duration of the experiment (2 months).

Multimeric hammerhead ribozyme targeting CCR5 mRNA: Since CCR5 co-receptor is required for HIV-1 infection through all routes of transmission (mucosal and intravenous), downregulation of CCR5 mRNA should prevent HIV-1 entry. We developed a multimeric hammerhead ribozyme, **$Rz_{1\text{-}7}$**, that targets 7 unique sites within the CCR5 mRNA. To express this multimeric ribozyme, we used the MSCV-based MGIN vector and an HIV-1-based HEG1 vector (developed in our group). We demonstrated that ribozyme expression from both these vectors decreases surface CCR5 expression (90-99%) and confers inhibition of R5 HIV-1 (BaL; MOI of 2) replication (99-100%) for the duration of experiment (2-3 months). PM1 cells used in this study also contain the CXCR4 co-receptor. Therefore, significant inhibition of R5 HIV-1 replication for a sustained period of time suggests that escape viruses with altered tropism for CXCR4 co-receptor were not generated. Note that the **extent of inhibition** observed in our experiments is **much better (99-100%)** and the **duration much longer (2-3 months)** than those reported by others for mono- or trimeric ribozymes, shRNAs, or antisense RNA targeted against the CCR5 mRNA. Since this co-receptor is shared by HIV-2, $Rz_{1\text{-}7}$ is also expected to inhibit HIV-2 replication. This strategy is unique in the sense that it would confer protection against all major clades of HIV-1 and HIV-2 that initiate transmission, by preventing viral entry, during the first round of infection. This is clearly an advantage over most other anti-HIV gene therapy strategies that inhibit HIV replication post-integration.

We are now testing whether intracellular expression of $Rz_{1\text{-}7}$ targeting CCR5 mRNA and $Rz_{1\text{-}14}$ targeting 14 highly conserved sites within the HIV-1 RNA can inhibit HIV-1 entry and replication in transduced $CD4^+$ T cells and monocytes/macrophages, as well as in the $CD4^+$ T lymphoid and myeloid progeny cells that differentiate from transduced $CD34^+$ stem/progenitor cells.

- ***Sense/decoy RNAs:*** RNAs containing a single TAR element or one or two copies of RRE were not very effective. The MoTiN vector developed in our laboratory was used to express a sense TAR-RRE-Ψ^e ($TR\Psi^{e+}$) RNA, containing the TAR element and the extended Ψ (Ψ^e) signal, which includes RRE. This RNA conferred **~95% inhibition** of HIV-1 replication for the duration of the experiment (78 days). We have shown that it can also be packaged by HIV-1. Progeny virus infectivity was significantly decreased, suggesting that this interfering RNA is co-packaged with HIV-1 RNA. The fact that co-packaging of non-viral RNAs can be used as an efficient means to confer resistance against retroviruses was also demonstrated by using an MoMuLV-based system.

As a follow up of this strategy, we developed self-propagating vectors expressing multimeric hammerhead ribozymes targeting HIV-1 RNA. An HIV-1-based HEG1 vector was engineered in our laboratory to allow constitutive and Tat-inducible expression of a multimeric ribozyme, $Rz_{1\text{-}10}$, and an HIV-2-based HEG2 vector was engineered to allow constitutive and Tat-inducible expression of $Rz_{1\text{-}14}$. The MGIN vector was also modified to contain the Ψ signal of HIV-1, and was used to express a multimeric ribozyme targeting HIV-1 RNA. However, multimeric ribozyme expression from these vectors did not inhibit virus replication. Based on these and other published reports, we believe that sense-sense interactions leading to vector

RNA dimerization with itself or with HIV-1 RNA prevent ribozyme turn-over as well as the sense/antisense interactions required for the activity of the ribozymes. Since the multimeric ribozymes were shown to be active when expressed from MoTiN or MGIN vectors, and the HEG1 vector expressing anti-CCR5 ribozyme could confer excellent inhibition of HIV-1 replication, we believe that inclusion of HIV-1 Ψ signal prevents ribozymes from cleaving HIV-1 RNA, but not CCR5 mRNA. It is conceivable that sense-sense interactions leading to vector RNA dimerization with itself or with HIV-1 RNA prevent ribozyme turn-over as well as the sense/antisense interactions required for ribozyme activity. These results are consistent with those from other investigators. Based on these findings, we believe that ribozymes and antisense RNAs should not be expressed as part of RNAs containing the HIV-1 Ψ signal. To allow ribozyme expression from an RNA lacking the HIV-1 Ψ signal, $Rz_{1\text{-}14}$ was cloned in the self-inactivating SIN-EF-G-I vector. From this vector, $Rz_{1\text{-}14}$ production in the target cells would only occur for from an internal promoter. As the HIV-1 Ψ signal will not be present, we anticipate that this vector design will not prevent $Rz_{1\text{-}14}$ from inhibiting HIV-1 replication.

• ***Antisense RNAs:*** Antisense RNAs were designed against the HIV-1 PBS, the region 5' to the PBS, RRE, Ψ-*gag* region, and 5' leader-*gag*-*env* coding region. The best inhibition of HIV-1 replication was conferred by the antisense Ψ-gag^{-} RNA targeted against the HIV-1 packaging (Ψ) signal and the entire *gag*-coding region and another antisense RNA targeted against the 5' leader and the *gag*- and *env*-coding regions. These antisense RNAs conferred 98-100% inhibition of HIV-1 replication for the duration of the experiment (30-80 days). Antisense Ψ-*gag* RNA was also shown to inhibit HIV replication in human peripheral blood T lymphocytes. The progeny viruses produced in these experiments packaged the antisense RNAs. The infectivity of these progeny viruses was further shown to be decreased, compared to controls. This is the first demonstration of an antisense RNA packaging and interference at the level of virion infectivity. Therefore, we developed a combination strategy to take advantage of the inhibitory potential of antisense RNAs and multimeric ribozymes, and to allow $Rz_{1\text{-}9}$ and $Rz_{1\text{-}14}$ to be packaged within the virions. However, an additive effect was not observed. **An antisense RNA developed in my group** was also compared by Systemix (now owned by **Novartis**) with several other anti-HIV-1 genes available at the time, including a monomeric hairpin ribozyme and a *trans*–dominant negative mutant of Rev (Rev M10), which were tested in clinical trials. **Our antisense RNA conferred the best protection**. They then developed many other similar-length antisense RNAs targeting other sites within the HIV-1 RNA, which were also shown to inhibit HIV-1 replication. Our antisense RNA was also shown by them to have a more than additive effect in conjunction with anti-viral drugs, demonstrating the feasibility of a combined gene–drug therapy approach.

• ***Group II introns:*** Using modified mobile group II introns from *Lactococcus lactis*, we have assessed the feasibility of developing a novel gene therapy strategy to inhibit HIV-1 replication at **the DNA level**. The Ll.LtrB-derived introns used in our study can splice from the RNA and insert into a **specific** DNA target site. We have shown that insertion of modified group II introns, in an infectious HIV-1 provirus DNA clone, can confer **100%** inhibition of virus replication at the level of integrase activity, required during the 2nd round of infection. However, for gene-modified cells to have a survival advantage, it is crucial that virus replication be inhibited during the first round of infection. Therefore, we have now developed two group II introns to either prevent HIV-1 transcription or cleave the transcripts soon after their synthesis. These introns will be tested for inactivation of reverse transcribed or integrated HIV-1 provirus DNA.

Interfering protein-based strategies

• ***Trans-dominant negative mutants (TDMs) of HIV proteins:*** Retroviral vectors were developed to allow either Tat-inducible or Tat- and Rev-inducible expression of TDMs of HIV-1 *tat* and *rev* genes, either individually or together. Tat-inducible co-expression of both Tat and Rev mutants was shown to confer the best protection, as no virus could be detected for 30 days post-HIV challenge. Retroviral vectors allowing Tat- and Rev-inducible co-expression of either WT (control) or TDM forms of *gag* and *env* genes were also constructed. Both vectors were shown to inhibit HIV-1 replication. The mechanism underlying resistance seems to be through an antisense RNA that was expressed from these vectors.

• ***Targeted and packageable RNases:*** We were the **first to engineer and demonstrate the feasibility of developing a targeted RNase** (Tat-RNase H) that could specifically recognize and cleave HIV-1 RNA. Tat-RNase H was engineered by precisely fusing the TAR RNA-binding domain of Tat with the RNase H domain of HIV-1 reverse transcriptase. The resulting protein was shown to specifically recognize and cleave HIV-1 TAR RNA *in vitro*. However, it did not inhibit HIV-1 replication. We then designed another targeted RNase (Tev-RNase-T1) by fusing the TAR and RRE RNA-binding domains of HIV-1 Tev protein

with RNase T1. At low concentrations, Tev-RNase T1 was shown to possess cleavage specificity for the target RNA. However, at higher concentrations, non-specific cleavage was also observed. Interestingly, no cytotoxicity was observed, and MoTN-TevT1 was shown to delay HIV-1 replication by 1-2 weeks in both MT4 cells and in human peripheral blood T lymphocytes. This is the first demonstration of the feasibility of an HIV-1 RNA-specific targeted RNase approach. We also developed MoMuLV-based vectors expressing a virion encapsidated RNase (Gag-RNase T1) to cleave virion RNA.

• ***Soluble (s)CD4, sCD4-scFv$_{17b}$ and sCD4-FI$_{T45}$:*** In addition to the molecules described above, which must be expressed intracellularly to inhibit HIV-1 entry and replication in the gene-modified cells, we are now developing HIV-1 gene therapy strategies using anti-HIV proteins that would, upon secretion from producer cells, prevent HIV-1 entry in both **gene modified and unmodified target cells**. These proteins would bind to the incoming virus and render it inactive.

Entry is mediated by interaction of the viral envelope (Env) glycoprotein, gp120, first with the CD4 receptor and then with CCR5 or CXCR4 co-receptors on the target cells, followed by a conformational change within the Env gp41 that initiates fusion between viral and cellular membranes. Two domains within the Env gp120 protein can be targeted to inhibit viral entry: the CD4 receptor-binding domain and the co-receptor-binding domain. The domain that can be targeted within gp41 is the fusion domain. Interfering proteins targeting each of these domains have been described. **sCD4** binding to the virus would prevent its binding to the CD4 receptor on the target cells. While at Allelix Inc, I was the first to coordinate sCD4 expression in *E. coli*, yeast and insect cells. Two patents were issued and this project was subsequently funded by NIAID. We can now produce **3000 times more sCD4 than previous reported**. This protein was further modified to develop **two bifunctional anti-HIV proteins**. **sCD4-scFv$_{17b}$**, which consists of soluble CD4 (sCD4) fused to a single chain antibody derived from 17b monoclonal antibody (scFv$_{17b}$), targets the receptor- and co-receptor-binding-sites on gp120. Binding of the sCD4 moiety to gp120 exposes the co-receptor binding domain prematurely, allowing interaction with scFv$_{17b}$ and preventing the virus from interacting with the target cells. **sCD4-FI$_{T45}$** consists of sCD4 fused with an improved fusion inhibitor FI$_{T45}$, targeting fusion between viral and cellular membranes. sCD4-FI$_{T45}$ would target receptor binding as well as fusion during viral entry. We have developed lentiviral vectors with codon-optimized genes encoding these proteins. **sCD4 and the two bifunctional proteins** were secreted from gene-modified cells at a concentration sufficient to inhibit HIV-1 infection of peripheral blood mononuclear cells by **>99%**. Based on this data, it seems feasible that therapeutic concentrations can be achieved *via* gene therapy. This inhibition was significantly **better than with the FDA-approved fusion inhibitor**, T$_{20}$, that is presently used for HIV treatment.

Significance of our contributions to HIV treatment: We have developed several important genes that confer excellent inhibition of HIV-1 replication. These genes express antisense RNAs, a multimeric hammerhead ribozyme, Rz$_{1-14}$, targeted against 14 sites within the HIV-1 RNA, and a multimeric hammerhead ribozyme, Rz$_{1-7}$, targeted against 7 sites within the CCR5 mRNA. In addition, we have developed targeted RNases to specifically inactivate HIV-1 RNA within the cell, and have demonstrated the feasibility of developing a mobile group II intron-based approach for targeting HIV-1 provirus DNA. All of these strategies are aimed at expressing interfering RNAs/proteins intracellularly to protect the gene-modified cells.

Gene therapy using sCD4 and sCD4-derived bifunctional anti-HIV proteins that could be secreted from a producer cell, such as hematopoietic stem/progenitor cells or CD4$^+$ T cells (for treatment), has a significant advantage over other strategies as it would also confer protection to all target cells including that that are not subject to gene modification. The therapy would consist of genetically modifying autologous cells with lentiviral vectors encoding secreted the anti-HIV proteins. Upon reinfusion and differentiation, these cells would give rise to gene-modified progeny cells. Secretion from all gene-modified progeny cells (*e.g.* antibody-producing B cells) would yield levels of antiviral proteins sufficient to inhibit HIV infection of target cells in the circulation. Local secretion from gene-modified cells would also inhibit HIV infection in organs (*e.g.* gut) that drugs or recombinant proteins fail to reach. Systemic inhibition of HIV infection would allow reconstitution of a functional immune system. To further decrease the cost of HIV-1 gene therapy and broaden treatment accessibility, *in vivo* gene delivery into more accessible producer cells (e.g. muscle cells) is also being envisaged.

A one-time gene delivery procedure will obviate the need for life-long therapy with drugs and provide a highly efficient treatment leading to a functional cure for HIV-infected individuals. Since these proteins are designed to inhibit entry and replication of all major clades of HIV, we are hopeful that they will be beneficial for prevention and treatment of HIV-positive individuals. **The knowledge acquired**

during the course of this project will also be applicable for the treatment of other genetic diseases, where a secreted factor must be provided.

Microflora defense to prevent HIV infection

HIV can be transmitted through sexual intercourse, from mother to child, and via blood or blood products. Heterosexual and homosexual transmission occurs through infection of target cells, *i.e.* dendritic cells and $CD4^+$ T cells, present in the mucosal epithelium of vagina and gastrointestinal tract. Blocking infection of these cells may inhibit viral transmission. However, an anti-HIV vaccine is not available and may not be available in the foreseeable future, and current anti-retroviral drugs and microbicides require topical administration on an ongoing basis and are not very effective at preventing transmission.

We are developing genetically engineered strains of Lactobacillus (generally present in the mucosal flora of healthy individuals) secreting sCD4-$scFv_{17b}$ and sCD4-FI_{T45} to colonize the mucosal flora of vagina and gastrointestinal tract. Upon colonization of the associated organs, the genetically engineered strains of Lactobacillus will secrete these proteins in the local environment and prevent transmission. Both of these proteins were already designed and shown to confer **>99%** inhibition of HIV infection (see above).

Genetically engineered strains of Lactobacillus (generally present in the mucosal flora of healthy individuals) expressing sCD4-$scFv_{17b}$ and sCD4-FI_{T45} could be used to colonize the mucosal flora of the vagina and gastrointestinal tract. Upon colonization of the associated organs, the genetically engineered strains of Lactobacillus will secrete these proteins in the local environment. Binding of sCD4-derived fusion proteins to HIV-1 Env will neutralize the two forms of HIV that infect cells, R5 and X4 HIV-1. Inhibition of HIV-1 infection in vagina and gastrointestinal tract would prevent HIV transmission.

Significance of our contributions to HIV prevention: The **microflora defense strategy** is designed to prevent HIV-1 transmission by blocking HIV-1 infection of target cells in the mucosal epithelium of the vagina and gastrointestinal tract. The genetically engineered Lactobacillus could be administered every 2-3 weeks to colonize the mucosal flora. If sufficient levels of the secreted proteins are not detected, antibiotics may be used to select genetically engineered strains. An added advantage of using Lactobacillus is that the engineered strains could be **propagated and delivered (orally or topically) in the form of yogurt**. As such, this may represent **the most affordable, accessible, nutritious, safe and easy to use preventive measure for blocking heterosexual and homosexual transmission of HIV in humans**.

2. Research Awards

a) Projects Sponsored by Allelix

1. Levy A, **Joshi S** & Wosnick MA (1985)
Development of herbicide-resistant *Brassica napus* (*part of the Allelix PILP proposal*).

2. **Joshi S** (1987)
Cloning and characterization of β-1,3 glucanase cDNA clone and cloning of regulatory regions controlling β-1,3 glucanase and chitinase expression from *Phaseolus vulgaris* (*part of the Allelix PILP proposal*).

3. **Joshi S** (1987)
Heparinase minus, Heparinase overproducing flavibacterium for heparinase production.

4. **Joshi S** (1987)
Cloning and characterization of human interleukin X allowing antigen-independent stimulation of cytotoxic T lymphocytes.

5. **Joshi S** (1987)
Inhibition of interaction between HIV and T4 lymphocytes (*part of NIAID grant proposal*).

b) **Active Participation in Research Grants funded while at Allelix**

1. **PILP** grant for making β-1,3 glucanase resistant *Brassica napus*.
$ 1.2 million awarded to Allelix Agriculture.

2. **NIAID** grant for drug screening/design to interfere with CD4-gp120 interaction.
$ 4 million total; **$ 600,000** awarded to Allelix Biopharmaceuticals.

c) **Research Grants Obtained while at the University of Toronto**

Total funds received since 1988: >*$ 3,000,000.00*

1. **Joshi S,** RW Davies & A Bernstein
Viral Inhibition Therapy Against AIDS.
MRC grant of **$ 240,000** for Jan 1988 - June 1991.
A special committee was set up to assess only this particular grant, which was written upon MRC (CIHR)'s request.

2. **Joshi S**
Intracellular immunization using retroviral vectors causing cell death upon HIV-1 infection.
Dean's fund for new staff: **$ 4,000** for Jan 1989 - April 1989.

3. **Joshi S**
Development and testing of vectors conferring resistance to HIV.
Connaught Fund Phase I competition for new staff: **$ 10,000** for March 1989 - Sept 1989.

4. Chan VL, **Joshi S** & Carver JP
Reverse transcriptase and antiviral therapy in AIDS.
NHRDP grant of **$ 267,000** for Aug 1989 - July 1992.

5. **Joshi S**
Equipment grant, HIV Research Laboratory.
Health & Welfare grant of **$250,000** for March 1989 - April 1992.

6. **Joshi S**
Retroviral vector development to confer resistance against HIV-1.
NHRDP grant of **$162,000** for Dec 1989 - March 1994.

7. **Joshi S** & Bernstein A
Development of gene therapy for the treatment of HIV-1 infections in AIDS patients.
MRC grant of **$530,000** for July 1991 - June 1994.

8. **Joshi S**
Anti-HIV-1 gene therapy using specific ribozymes and *trans*-dominant mutants.
MRC/NHRDP grant of **$295,000** for July 1994 - Dec 1997; extended until March 1998.

9. **Joshi S**
Anti-HIV-1 gene therapy in "humanized" mice and further development of retroviral vectors expressing improved anti-HIV-1 gene(s) selected during directed evolution *in vitro* and *in vivo*.
NHRDP grant of **$255,000** Dec 1994 - Nov 1997; extended until June 1998.

10. **Joshi S**
Anti-HIV-1 gene therapy using interfering RNAs.
MRC grant of **$11,349** for July 1998 - June 1999.

11. **Joshi S**
Interfering RNA-based strategies for anti-HIV gene therapy.
MRC grant of **$340,000** July 1998 – Sept 2001.

12. **Joshi S**
Gene therapy against HIV-1 using anti-HIV-1 ribozymes to inhibit virus replication.
CIHR grant of **$11,000** Oct 2001- Sept 2002.

13. **Joshi S**
HIV gene therapy using multimeric hammerhead ribozymes: a preclinical characterization.
OHTN "top up" grant of **$27,000** April 2002 – March 2003.

14. Cvitkovitch D, Cybulsky M, Downey G, Ellen R, Glogauer M, **Joshi S**, Kapus A, Seth A & Sodek J
"Purchase of a Flow Cytometer."
CIHR equipment grant of **$157,199** Sept 2002 – Aug 2005.

15. **Joshi S**
Preclinical characterization of HIV-1 gene therapy using multimeric hammerhead ribozymes.
CIHR grant of **$272,000** July 2002 – June 2005; extended till March 31, 2007.

16. **Joshi S**
Genetic therapies for HIV prevention and treatment.
Gelda Scientific private funding of **$10,000** for Jan 2009 - Dec 2009.

17. **Joshi S** & Read S
Preclinical characterization of multimeric ribozymes as potential preventive and therapeutic agents for HIV-1 infection.
CIHR – HIV/AIDS Research Initiative grant of **$236,234**; Mar 2009 – Mar 2013.

18. **Joshi S** & Read S
A microbiota defense against HIV infection
CANFAR grant of **$25,000**; Sept 2012 – Aug 2014.

19. Branch D, Cochrane A, Gray-Owen S, **Joshi S**, Kaul R, Mac Donald K, Ostrowski M, Watts T, Zandstra P & Zuniga-Pflucker JC.
A small animal model of human HIV-1 infection to accelerate the pre-clinical development of novel therapeutics and vaccines.
University of Toronto Department of Medicine Integrated Challenge Grant of **$250,000**; May 2013 – Apr 2015.

20. **Joshi S** & Read S
Bifunctional antiviral proteins for HIV prevention and treatment
CANFAR grant of **$25,000**; July 2014 – June 2015.

21. **Joshi S**
Exploring commercialization opportunities for soluble CD4.
I had previously filed two patents for soluble CD4 expression. It is secreted from the genetically engineered 293T cells engineered in my laboratory at ~3000 times higher concentration than previously reported. It is sold at **$9000 per mg**; our gene-modified 293T cells secrete this much protein in **one 25 ml flask in 4-5 days**.

22. **Joshi S**
Exploring funding opportunities with CytoDyn Inc & Progenesis Technologies for further improving a secreted single chain antibody that was designed in my laboratory based on the monoclonal antibody Pro140 developed by this company.

23. **Joshi S** & Read S
In vitro characterization of bi-functional entry inhibitors.
CANFAR grant of **$25,000**; Sept 2015 – Aug 2016.

24. **Joshi S**
Genetic strategies for HIV treatment and prevention.
Private funding grant of **$10,000**; Sept 2016 – Aug 2017.

25. **Joshi S**, Read S & Zúñiga-Pflücker JC
Control of HIV infection by gene therapy with secreted bifunctional antiviral proteins.
CANFAR grant of **$25,000**; Sept 2017 – present.

d) **Active participation in grants submitted on behalf of the department**

1. **L'Anson Funds** to hire 1 Assistant Professor performing AIDS research within the Department of Microbiology.

2. **Billes Funds** to hire 1 Assistant Professor performing AIDS research within the Department of Microbiology.

3. Patent Awards

1. **Joshi S**
Cloning of *Serratia liquefaciens* chitobiase gene and production of *Serratia liquefaciens* over-producing mutants. Filed in USA, July 1987.

2. **Joshi S** & Kozlowski M
Cloning of *Serratia liquefaciens* chitinase genes and production of *Serratia liquefaciens* over-producing mutants. Filed in USA, July 1987.

3. **Joshi S**, Wong WKR, Bozzato RP, Kronis KA & Grolla A
Process for preparing biologically active fragments of the glycoprotein CD4. # 07/296, 107 filed in USA. Jan 1989.

4. **Joshi S**, Wong WKR, Bozzato RP, Kronis KA & Grolla A
Process for preparing biologically active fragments of the glycoprotein CD4. # 557, 397 filed in Canada. Jan 1988

5. **Joshi S**
Inhibition of HIV-1 multiplication in mammalian cells. # 08/223560 filed in USA. March 1994.

6. **Joshi S**
Inhibition of HIV-1 multiplication in mammalian cells. Filed in Canada and Europe, May 1995.

4. Intellecual Property Disclosures

1. **Joshi S** & Nazari R
A modified group II intron-based gene therapy strategy to inhibit HIV replication at the DNA level. Filed in Aug 2006.

2. **Joshi S** & Nazari R
Gene therapy to inhibit R5-tropic HIV-1 entry. Filed in Aug 2006.

3. **Joshi S**
Soluble CD4 expression and secretion form letiviral vectors to block HIV infection of gene-modified and unmodified target cells Filing in progress.

4. **Joshi S**
Expression and secretion of bi- and tri-functional antiviral proteins from gene-modified producer cells to block HIV infection of gene-modified and unmodified target cells via gene therapy

5. **Joshi S**
A secreted single chain antibody targeting CCR5 to block HIV infection of gene-modified and unmodified target cells

D. SCHOLARLY/RESEARCH ACHIEVEMENT & CREATIVE PROFESSIONAL ACTIVITY

1. Refereed Publications

a) Articles in refereed journals

1. **Joshi S**, Haenni AL, Hubert E, Huez G & Marbaix G
In vivo aminoacylation and "processing" of Turnip Yellow Mosaic Virus RNA.
Nature 275: 339-341, 1978.

2. **Joshi S** & Haenni AL
Fluorographic detection of Nucleic Acids labelled with weak β-emitters in gels containing high acrylamide concentrations.
FEBS Lett 118:43-46, 1980.

3. **Joshi S**, Chapeville F & Haenni AL
Length requirements for tRNA-specific enzymes and cleavage specificity at the 3' end of Turnip Yellow Mosaic Virus RNA.
Nucl Acids Res 10:1947-1962, 1982.

4. **Joshi S**, Chapeville F & Haenni AL
Turnip Yellow Mosaic Virus RNA is aminoacylated *in vivo* in Chinese cabbage leaves.
EMBO J 1:935-938, 1982.

5. Haenni AL, **Joshi S** & Chapeville F
tRNA-like structures in the genome of RNA viruses.
Progress in Nucleic Acid Res and Mol Biol 27:85-104, 1982.

6. **Joshi S**, Pleij CWA, Haenni AL, Chapeville F & Bosch L
Properties of the tobacco mosaic virus intermediate length RNA-2 and its translation.
Virology 127:100-111, 1983.

7. **Joshi S**, Pleij CWA, Haenni AL & Bosch L
Age dependence of Cowpea protoplasts for uptake of spermidine and infectibility by alfalfa mosaic virus.
Plant Mol Biol 2:89-94, 1983.

8. **Joshi S**, Joshi RL, Chapeville F & Haenni AL
tRNA-like structures of plant viral RNAs: conformational requirements for adenylation and aminoacylation.
EMBO J 2:1123-1127, 1983.

9. **Joshi S**, Joshi RL, Haenni AL & Chapeville F
tRNA-like structures in genomic RNAs of plant viruses.
Trends Biochem Sci 8:402-404, 1983.

10. **Joshi S**, Neeleman L, Pleij CWA, Haenni AL, Chapeville F, Bosch L & van Vloten Doting L
Non-structural Alfalfa Mosaic virus RNA-coded proteins present in tobacco leaf tissue.
Virology 139:231-242, 1984.

11. **Joshi S** & Haenni AL
Plant RNA viruses: Strategies of expression and regulation of viral genes.
FEBS Lett 177:163-174, 1984.

12. **Joshi S** & Wosnick MA
A centrifugal method for separation of plant viral genomic and subgenomic RNAs.
FEBS Lett 239:45-49, 1988.

13. **Joshi S**, Kozlowski M, Selveraj G, Iyer VN & Davies RW
Cloning and characterization of the chitobiase and chitinase genes of *Serratia liquefaciens*.
J Bact 170:2984-2988, 1988.

14. **Joshi S**, Kozlowski M, Richens S & Comberbach DM
Chitinase production during fermentation of genetically improved *Serratia liquefaciens*.
Enzyme and Microbial Technologies 11:289-296, 1989.

15. **Joshi S** & Vicentini A
Controlled cell wall regeneration for efficient microinjections of *Nicotiana tabacum* var. Carlson protoplasts.
Plant Cell Reports 9:117-120, 1990.

16. **Joshi S**, van Brunschot A, Robson I & Bernstein A
Efficient replication, integration, and packaging of retroviral vectors with modified long terminal repeats containing the packaging signal.
Nucl Acids Res 18:4223-4226, 1990.

17. **Joshi S**
A putative approach for cloning "silent" genes using retroviral vectors.
Medical Hypothesis 36:242-245, 1991.

18. **Joshi S**, van Brunschot A, van der Elst I, Asad S, Read SE & Bernstein A
Inhibition of HIV-1 multiplication by anti-sense and sense RNA expression.
J Virol 65:5524-5530, 1991.

19. Weerasinghe M, Liem SE, Asad S, Read SE & **Joshi S**
Resistance to HIV-1 infection in human $CD4^+$ lymphocyte-derived cell lines using retroviral vectors expressing an HIV-1 RNA-specific ribozyme.
J Virol 65:5531-5534, 1991.

20. Davison L, van Brunschot A, van der Elst I & **Joshi S**
A retroviral vector to allow constitutive and Tat-inducible gene expression for anti-HIV gene therapy.
Mol Biol (Life Sci Adv) 12:185-189, 1993.

21. Liem SE, Ramezani A, Li X & **Joshi S**
The development and testing of retroviral vectors expressing *trans*-dominant mutants of HIV-1 proteins to confer anti-HIV-1 resistance.
Human Gene Therapy 4:625-634, 1993.

22. Srulovicz M, Liem SE & **Joshi S**
RNA and protein separation on denaturing polyacrylamide gels poured and electrophoresed horizontally.
Mol Biol (Life Sci Adv) 13:125-127, 1994.

23. Cohli H, Fan B, Joshi RL, Ramezani A, Li X & **Joshi S**
Inhibition of HIV-1 multiplication in a human $CD4^+$ lymphocytic cell line expressing antisense and sense RNA molecules containing HIV-1 packaging signal and Rev response element(s).
Antisense Res & Develop 4:19-26, 1994.

24. Chia WK, Nisbet-Brown E, Li X, Salit I, **Joshi S** & Read SE
Lack of correlation between phenotype activation markers of $CD8^+$ lymphocytes and CTL function in HIV-1 infection: Evidence for rescue with rIL-2.
Viral Immun 7:81-95, 1994.

25. Melekhovets YF & **Joshi S**
Fusion with an RNA binding domain to confer target RNA specificity to an RNase: design and engineering of Tat-RNase H that specifically recognizes and cleaves HIV-1 RNA *in vitro*.
Nucl Acids Res 24:1908-1912, 1996.

26. **Joshi S** & Joshi RL
Molecular biology of HIV-1.
Transfusion Science 17:351-378, 1996.

27. Ramezani A & **Joshi S**
Comparative analysis of five highly conserved target sites within the HIV-1 RNA for their susceptibility to hammerhead ribozyme-mediated cleavage *in vitro* and *in vivo*.
Antisense & Nucl Acid Drug Dev 6:229-235, 1996.

28. Ramezani A, Marhin W, Weerasinghe, M & **Joshi S**
A rapid and efficient system for rapid screening of HIV-1 Pol mRNA-specific ribozymes.
Can J Microbiol 43:93-96, 1997.

29. Lee-Ruff E, Ostrowski M, Ladha A, Stynes DV, Vernik I, Jiang JL Wqn WQ, Ding SF & **Joshi S**
Synthesis and HIV-inhibition of 2',3'-dideoxy-3'-*C*-hydroxymethyl nucleosides.
J Med Chem 39:5276-5280, 1997.

30. Ramezani A, Ding SF & **Joshi S**
Inhibition of HIV-1 replication by retroviral vectors expressing mono- and multimeric hammerhead ribozymes.
Gene Therapy 4:861-867, 1997.

31. **Joshi S**, Ding SF & Liem SE
Co-packaging of non-vector RNAs generates replication-defective retroviral vector particles: A novel approach for blocking retrovirus replication
Nucl Acids Res 25:3199-3203, 1997.

32. Ding SF, Noronha J & **Joshi S**
Co-packaging of sense and antisense RNAs: a novel strategy for blocking HIV-1 replication.
Nucl Acids Res 26:3270-3278, 1998.

33. Ramezani A & **Joshi S**
Development of hammerhead ribozymes for HIV-1 gene therapy: principal and progress.
Review Article.
Gene Ther Mol Biol 3:271-280, 1999.

34. Medina MF & **Joshi S**
Design and characterization of $tRNA_3^{Lys}$-based hammerhead ribozymes.
Nucl Acids Res 27:1698-1708, 1999.

35. Singwi S, Ding SF, Ramezani A & **Joshi S**
Targeted RNases: a feasibility study for use in HIV gene therapy.
Gene Therapy 6:913-921, 1999.

36. Medina MF & **Joshi S**
RNA polymerase III-driven expression cassettes in human gene therapy. *Review article.*
Current Opinion in Molecular Therapeutics 1:580- 594 (1999).

37. Medina MF & **Joshi S**
Ribozyme-dependent inactivation of *lac*Z mRNA in *E. coli*: a feasibility study to set up a rapid *in vivo* system for screening HIV-1 RNA-specific ribozymes.
Gene Ther Mol Biol 4:109-118 (1999).

38. Lamothe B & **Joshi S**
Current developments and future prospects for HIV gene therapy using interfering RNA-based strategies. *Review article.*
Front Biosci 5:527-555 (2000).

39. Singwi S & **Joshi S**
Potential nuclease-based strategies for HIV gene therapy. *Review article.*
Front Biosci 5:556-579 (2000).

40. Arora A, Nazari R, Lamothe B, Singwi S & **Joshi S**
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Complete inhibition of HIV-1 entry and replication using multimeric hammerhead ribozymes.
The 16th Annual Canadian Conference on HIV/AIDS Research, Toronto, Canada, Apr 2007.

101. Nazari R., Ameli M. & **Joshi S**
Inhibition of HIV-1 replication using modified group II introns.
The 10th OHTN research day, Toronto, Canada, Nov 2008.

102. Nazari R., Ameli M. & **Joshi S**
Inhibition of HIV-1 entry using a multimeric hammerhead ribozyme.
The 10th OHTN research day, Toronto, Canada, Nov 2008.

103. Nazari R, Ameli M & **Joshi S**
A novel group II intron-based gene therapy strategy to inactivate HIV DNA.
BIT Life Sciences' 2nd Annual World Summit of Antivirals. Beijing, China. July 18-25, 2009.

104. Nazari R, Ameli M & **Joshi S**
Inhibition of HIV-1 entry using a multimeric hammerhead ribozyme
BIT Life Sciences' 2nd Annual World Summit of Antivirals. Beijing, China. July 18-25, 2009.

105. **Joshi S**
HIV-1 gene therapy strategies.
BIT Life Sciences' 2nd Annual World Summit of Antivirals. Beijing, China. July 18-25, 2009.

106. Falkenhagen A & **Joshi S**
A microflora defense strategy to prevent HIV-1 transmission.
3rd National Conference on HIV/AIDS Therapy – Current Practices and Future Options. Mumbai, India, Jan 8-9, 2011.

107. Falkenhagen A & **Joshi S**
Gene therapy approaches for the treatment of HIV-1 infections.
3rd National Conference on HIV/AIDS Therapy – Current Practices and Future Options. Mumbai, India, Jan 8-9, 2011.

108. Falkenhagen A & **Joshi S**
The introduction of secretory sCD4-17b and scAb PRO140 via gene therapy as a means to reduce HIV entry.
20th Annual Canadian Conference on HIV/AIDS Research. Toronto, Canada, April 2011.

109. Falkenhagen A, Chen J, Ameli M, Asad S, Read SE & **Joshi S**
Development and testing of a novel gene therapy strategy using secreted proteins.
14th Annual Meeting, American Society of Gene and Cell Therapy. Seattle, WA, USA, May 2011.

110. Falkenhagen A, Asad S, Read SE & **Joshi S**
Gene therapy using secreted anti-HIV proteins to protect unmodified target cells.
21st Annual Canadian Conference on HIV Research. Montreal, Canada. April 2012.

111. Falkenhagen A, Malm M, Singh J, Asad S, Read S, Zúñiga-Pflücker JC & **Joshi S**
Gene therapy based on secreted anti-HIV proteins to replace continuous drug administration. **Oral Presentation.**
22nd Annual Canadian Conference on HIV/AIDS Research. Vancouver, BC, Canada. April 2013.

112. Falkenhagen A, Malm M, Singh J, Asad S, Read S, Zúñiga-Pflücker JC & **Joshi S**
Gene therapy based on secreted anti-HIV proteins to replace continuous drug administration. I**nteractive poster presentation.**
The 2013 OHTN Research Conference, Toronto, ON, Canada. Nov 2013.

113. Falkenhagen A, Singh J, Asad S, Read SE, Zúñiga-Pflücker JC & **Joshi S**
Secreted antiviral proteins for HIV gene therapy. **Oral Presentation**.
The OHTN Back to Basic Conference, Toronto, ON, Canada. Nov 2014.

114. Falkenhagen A, Singh J, Asad S, Read SE, Zúñiga-Pflücker JC & **Joshi S**
Secreted antiviral proteins for HIV gene therapy.
The OHTN Back to Basic Conference. Toronto, ON, Canada. **3 minute thesis**. Nov 2014.

115. Falkenhagen A, Singh J, Asad S, Read SE, Zúñiga-Pflücker JC & **Joshi S**
Control of HIV infection by gene therapy based on secreted anti-HIV proteins to replace continuous drug administration.
The 24th Annual Canadian Conference on HIV/AIDS Research, Toronto, ON, Canada, April 2015.

116. Falkenhagen A, Singh J, Asad S, Read SE, Zúñiga-Pflücker JC & **Joshi S**
Control of HIV infection by gene therapy with a secreted entry inhibitor.
Can J Infect Dis & Micro volume 26, p50b, 2015.
24th Annual Canadian Conference on HIV/AIDS Research, Toronto, ON, Canada. May 2015.

117. Falkenhagen A, Singh J, Malm M, Asad S, Read SE, Zúñiga-Pflücker JC & **Joshi S**
Secreted antiviral proteins for HIV gene therapy. **Oral Presentation.**
Canada India Healthcare Forum, Toronto, ON, Canada. May 2015.

118. Singh J, Falkenhagen A, **Joshi S** & Zúñiga-Pflücker JC
Evaluation of a gene therapy strategy based on secreted anti-HIV proteins in humanized mice.
5th Intl Conference on humanized mice. Zurich, Switzerland. Jan 28-30. 2016.

119. Falkenhagen A, Singh J, Asad S, Leontyev D, Read SE, Zúñiga-Pflücker JC & **Joshi S**
Control of HIV infection *in vivo via* gene therapy with a secreted entry inhibitor. **Oral Presentation.**
25th Annual Canadian Conference on HIV/AIDS Research, CAHR. Winnipeg, Manitoba. May 12-15, 2016.

120. **Joshi S**
Genetic strategies for HIV treatment and prevention. **Oral Presentation.**
Canada India Healthcare Forum, New Delhi, India. Mar 2017.

2. <u>Presentations at the Departmental/University Research Day</u>

1. **Joshi S**, van Brunschot A, Robson I & Bernstein A
Packaging retroviral vectors for cloning "silent" genes.
Microbiology Research Day, Toronto, Nov 1990

2. **Joshi S**
New Molecular Approaches for AIDS therapy.
Microbiology Research Day, Toronto, Nov 1990

3. Ramezani A, Noronha J, Lombardi R & **Joshi S**
Anti-HIV-1 gene therapy.
U of T Research Day, Toronto, Oct 1993.

4. **Joshi S**, Liem SE, Cohli H, Fan B, Sun de la Cruz C, Ramezani A, Weerasinghe M & Li X
Inhibition of HIV-1 multiplication in a human $CD4^+$ lymphocyte derived cell line transformed with retroviral vectors expressing anti-HIV-1 RNA and protein molecules.
Microbiology Research Day, Toronto, March 1993.

5. Spanglet O & **Joshi S**
Development and testing of retroviral vectors allowed Tat- or Tat- and Rev-inducible gene expression.
Annual Medical Student Research Day, Toronto, Jan 1994.

6. Noronha J & **Joshi S**
The use of HIV-1 packaging signal in anti-HIV-1 gene therapy.
Microbiology Research Day, Toronto, March 1994.

7. Lombardi R, Liem, SE & **Joshi S**
Anti-HIV-1 gene therapy using *trans*-dominant mutants.
Microbiology Research Day, Toronto, March 1994.

8. Ramezani A, Medina MF & **Joshi S**
Anti-HIV-1 specific hammerhead ribozymes.
Microbiology Research Day, Toronto, March 1994.

9. Noronha J & **Joshi S**
Development and testing of retroviral vectors expressing HIV-1 packaging signal.
Microbiology Research Day, Toronto, March 1995.

10. Lombardi RA & **Joshi S**
Anti-HIV-1 gene therapy using *trans*-dominant mutant Gag and Env proteins.
Microbiology Research Day, Toronto, March 1995.

11. Medina MF & **Joshi S**
Hammerhead tRNA-ribozymes against HIV-1.
Microbiology Research Day, March 1995.

12. Ramezani A & **Joshi S**
Anti-HIV-1 gene therapy using hammerhead ribozymes.
Microbiology Research Day, Toronto, March 1995.

13. Ding S-F, Lombardi RA, Ramezani A & **Joshi S**
Inhibition of HIV-1 replication in a human $CD4^+$ lymphoid cell line stably transduced with a bicistronic retroviral vector expressing HIV-1 Gag and Env *trans*-dominant mutants
Microbiology Research Day, Toronto, March 1996.

14. Ladha A & **Joshi S**
An indicator suicide cell system for anti-Tat drug screening.
Microbiology Research Day, March 1996.

15. Noronha J, Ramezani A & **Joshi S**
The use of HIV-1 packaging signal in anti-HIV-1 gene therapy
Microbiology Research Day, Toronto, March 1996.

16. Medina MF & **Joshi S**
Hammerhead tRNA-ribozymes against HIV-1.
Microbiology Research Day, March 1996.

17. Ramezani A, Ding S-F & **Joshi S**
Hammerhead ribozymes for use in HIV-1 gene therapy.
Microbiology Research Day, Toronto, March 1996.

18. **Joshi S** & Medina MF
In vitro selection of $tRNA_3^{Lys}$ based ribozymes for use in anti-HIV-1 gene therapy.
Medical Genetics & Microbiology Research Day, Barry, Sept 1996.

19. **Joshi S**
Ribozymes and ribonucleases for use in anti-HIV-1 gene therapy.
Medical Genetics & Microbiology Research Day, Barry, Sept 1996.

20. Ramezani A & **Joshi S**
Ribozyme-mediated inhibition of HIV replication.
Microbiology Research Day, Toronto, May 1997.

21. Medina MF & **Joshi S**
In vitro selection of $tRNA_3^{Lys}$-based hammerhead ribozymes.
Microbiology Research Day, Toronto, May 1997.

22. Singwi S & **Joshi S**
HIV-1 virion RNA inactivation via gene therapy using a packageable RNase.
Microbiology Research Day, Toronto, March 1997.

23. Medina MF & **Joshi S**
Hammerhead $tRNA_3^{Lys}$-based Ribozymes against HIV-1
Medical Genetics & Microbiology Research Day, Toronto, Sept 1997.

24. Ramezani A & **Joshi S**
Hammerhead ribozyme mediated HIV gene therapy
Medical Genetics & Microbiology Research Day, Toronto, Sept 1997.

25. Ramezani A, Ding SF & **Joshi S**
Mono- and multimeric hammerhead ribozymes for use in HIV gene therapy.
Infectious Diseases Clinical Microbiology Research Day, Toronto, May 1998.

26. Medina MF & **Joshi S**
In vitro selection and characterization of hammerhead $tRNA_3^{Lys}$-based ribozymes against HIV1 RNA.
Infectious Diseases Clinical Microbiology Research Day, Toronto, May 1998.

27. Ma X, Ho E, Medina MF & **Joshi S**
Multimeric ribozymes against CCR5 RNA: a novel strategy to inhibit HIV replication.
Infectious Diseases Clinical Microbiology Research Day, Toronto, May 1998.

28. Singwi S & **Joshi S**
RNase based strategies for intracellular and intravirion cleavage of HIV RNA.
Infectious Diseases Clinical Microbiology Research Day, Toronto, May 1998.

29. Ding SF, Noronha J, Jain A, Ma X & **Joshi S**
Co-packaging of sense and antisense RNAs: a novel strategy for blocking HIV-1 replication.
Infectious Diseases Clinical Microbiology Research Day, Toronto, May 1998.

30. Ramezani A & **Joshi S**
Hammerhead ribozyme-mediated HIV-1 gene therapy.
Molecular and Medical Genetics Retreat, Toronto, Sept 1998.

31. Medina MF & **Joshi S**
Design, characterization and testing of $tRNA_3^{Lys}$-based hammerhead ribozymes.
Molecular and Medical Genetics Retreat, Toronto, Sept 1998.

32. Ma X, Ho E & **Joshi S**
Inhibition of HIV replication through the cleavage of the CCR5 mRNA by engineered multimeric ribozymes.
Molecular and Medical Genetics Retreat, Toronto, Sept 1998.

33. Singwi S, Ding SF, Ramezani A & **Joshi S**
HIV-1 RNA inactivation via gene therapy using RNases.
Molecular and Medical Genetics Retreat, Toronto, Sept 1998.

34. Ding SF, Noronha J & **Joshi S**
Co-packaging of sense and antisense RNAs: a novel strategy for blocking HIV-1 replication.
Molecular and Medical Genetics Retreat, Toronto, Sept 1998.

35. Medina MF & **Joshi S**
Hammerhead $tRNA_3^{Lys}$-based ribozymes against HIV-1 RNA.
Microbiology and Infectious Diseases Research Day, Toronto, June 1999.

36. Singwi S & **Joshi S**
HIV RNA inactivation via gene therapy using RNases.
Microbiology and Infectious Diseases Research Day, Toronto, June 1999.

37. Ramezani A & **Joshi S**
Multimeric hammerhead ribozymes for use in HIV-1 gene therapy.
Molecular and Medical Genetics Retreat, Toronto, Sept 1999.

38. Medina MF & **Joshi S**
Design, characterization and testing of $tRNA_3^{Lys}$-based hammerhead ribozymes.
Molecular and Medical Genetics Retreat, Toronto, Sept 1999.

39. Singwi S, Ramezani A, Ding SF & **Joshi S**
HIV-1 RNA inactivation via gene therapy using RNases.
Molecular and Medical Genetics Retreat, Toronto, Sept 1999.

40. Nazari R, Ma XZ, Ho E & **Joshi S**
Gene therapy via coreceptor downregulation to prevent infection by all major subtypes of HIV-1.
4th Annual Graduate Student Research Day, Laboratory Medicine & Pathobiology, Toronto, March 2001.

41. Arora A, Nazari R, Lamothe B, Singwi S & **Joshi S**
HIV gene therapy using RNase-based strategies.
Department of Laboratory Medicine & Pathobiology Research Day, Toronto, April 2001.

42. Nazari R, Ma XZ & **Joshi S**
Co-receptor downregulation to prevent HIV-1 infection.
5th Annual Graduate Student Research Day, Laboratory Medicine and Pathobiology, Toronto, March 2002, (**award winner**).

43. Nazari R, Kraft J & **Joshi S**
Development of a novel anti-HIV-1 gene therapy strategy using modified group II introns.
5th Annual Graduate Student Research Day, Laboratory Medicine and Pathobiology, Toronto, March 2002.

44. **Nazari** R & **Joshi S**
Ribozyme-mediated downregulation of CCR5 co-receptor expression to prevent HIV-1 infection.
Microbiology & Infectious Disease Research Day, Toronto, June 2002.

45. Nazari R, Kraft J & **Joshi S**
A novel anti-HIV-1 gene therapy strategy using modified group II introns.
Microbiology & Infectious Disease Research Day, Toronto, June 2002.

46. Arora A & **Joshi S**
Development of HIV-1 based vector expressing multimeric hammerhead ribozyme targeted against HIV-1.
Molecular and Medical Genetics Retreat, Barrie, Canada, Sept 2002.

47. Nazari R & **Joshi S**
Inactivating HIV-1 at the DNA Level: New Tool, New Target.
6th *Annual Graduate Student Research Day,* Laboratory Medicine and Pathobiology, Toronto, March 2003.

48. Nazari R & **Joshi S**
Downregulation of CCR5 expression by multimeric hammerhead ribozyme inhibits the HIV-1 infection.
7th Annual Graduate Student Research Day, Department of Laboratory Medicine & Pathobiology, Toronto, Canada, Feb. 2004 (**award winner**).

49. Nazari R & **Joshi S**
Targeting HIV-1 proviral DNA by modified group II introns.
7th Annual Graduate Student Research Day, Department of Laboratory Medicine & Pathobiology, Toronto, Canada, Feb. 2005.

50. Nazari R, Shams A & **Joshi S**
Can HIV-1 provirus DNA be inactivated *via* intron insertion?
Molecular and Medical Genetics Retreat, Barrie, Canada, Sept 2005.

51. Nazari R, Ameli M & **Joshi S**
HIV-1 entry to lymphoid cell lines is blocked by downregulation of CCR5-expression using multimeric hammerhead ribozymes.
Microbiology & Infection Disease Research Day, Toronto, June 2005.

52. Nazari R, Sharma S & **Joshi S**
Targeting HIV-1 proviral DNA by modified group II.
Microbiology & Infection Disease Research Day, Toronto, June 2005.

53. Nazari R & **Joshi S**
Is it possible to target HIV-1 provirus DNA for gene therapy purposes?
The 8th Annual Graduate Student Research Day, Department of Laboratory Medicine & Pathobiology, Toronto, Canada, Mar 2006.

54. Nazari R & **Joshi S**
Ribozyme-mediated inhibition of HIV-1 entry.
Microbiology & Infection Disease Research Day, Faculty of Medicine, University of Toronto, Toronto, Canada, May 2006.

55. Nazari R & **Joshi S**
Inactivation of HIV-1 provirus DNA: A novel strategy to inhibit HIV-1 replication.
Microbiology & Infection Disease Research Day, Faculty of Medicine, University of Toronto, Toronto, Canada, May 2006.

56. Nazari R, Ameli M & **Joshi S**
Development and testing of mobile group II introns for use in HIV-1 gene therapy
Molecular and Medical Genetics Retreat, Barrie, Canada, Sept 2006.

57. Nazari R, Ameli M & **Joshi S**
Inhibition of HIV-1 replication using multimeric hammerhead ribozymes
Molecular and Medical Genetics Retreat, Barrie, Canada, Sept 2006.

58. Nazari R, Ameli M & **Joshi S**
Development and testing of mobile group II introns for use in HIV-1 gene therapy.
World AIDS day, Toronto, Canada, Dec 2006.

59. Nazari R, Ameli M & **Joshi S**
Inhibition of HIV-1 replication using multimeric hammerhead ribozymes
World AIDS day, Toronto, Canada, Dec 2006.

60. Nazari R, Ameli M & **Joshi S**
Utilizing a mobile group II intron to inactivate HIV-1 integrase at DNA level.
The 9th Annual Graduate Student Research Day, Dept of Laboratory Medicine & Pathobiology, Toronto, Canada, Mar 2007.

61. Nazari R, Ameli M & **Joshi S**
Complete inhibition of HIV-1 replication following group II intron insertion into the HIV-1 provirus DNA.
University of Toronto Academic Research Day, Microbiology and I*nfectious Diseases*, Toronto, Canada, May 2007.

62. Nazari R, Ameli M & **Joshi S**
Complete inhibition of HIV-1 infection following ribozyme-mediated downregulation of CCR5 mRNA.
University of Toronto Academic Research Day, Microbiology and I*nfectious Diseases*, Toronto, Canada, May 2007.

63. Nazari R, Ma XZ, Ameli M & **Joshi S**
Inhibition of HIV-1 entry using vectors expressing a multimeric hammerhead ribozyme targeting the CCR5 mRNA
U of T Infectious Diseases/Microbiology Research Day, Toronto, Canada, May 2008.

64. Nazari R & **Joshi S**
Exploring the potential of using group II introns to inactivate HIV-1
U of T Infectious Diseases/Microbiology Research Day, Toronto, Canada, May 2008.

65. Iqbal U, Waechter A, Ameli M & **Joshi S**
Genetic interventions for HIV prevention and treatment.
Graduate student recruitment day, Department of Molecular Genetics, Toronto, Canada, March 2009.

66. Iqbal U, Chen J, Meng J, Waechter A, Ameli M & **Joshi S**
Genetic strategies for prevention and treatment of HIV-1 infection.
U of T Infectious Diseases/Microbiology Research Day, Toronto, Canada, June 2009.

67. Iqbal, U, Nazari R, Ameli M & **Joshi S**
Complete inhibition of HIV-1 replication following insertion of group II introns at two different sites within an infectious HIV-1 provirus DNA clone.
U of T Infectious Diseases/Microbiology Research Day, Toronto, Canada, June 2009.

68. Falkenhagen A, Chen J, Iqbal U, Meng J, Ruberry M, Arora P, Mazur K, Ameli M & **Joshi S**
Genetic strategies for prevention and treatment of HIV-1 infection
Molecular Genetics Retreat, Toronto, Canada, Oct 2009.

69. Falkenhagen A, Chen J, Meng J, Mazur K, Ameli M & **Joshi S**
Genetic strategies for HIV-1 prevention and treatment.
The 13th Annual Graduate Student Research Day, Dept of Lab Medicine & Pathobiology, Toronto, Canada, Mar 2010.

70. Falkenhagen A, Asad S, Read SE & **Joshi S**
Development and testing of a novel gene therapy strategy using secreted proteins to block HIV-1 entry into gene-modified and unmodified target cells.
14th Annual Graduate Student Research Day, Laboratory Medicine and Pathobiology, Toronto, Canada, Mar 2011.

71. Falkenhagen A, Ameli M, Asad S, Read SE & **Joshi S**
Genetic strategies for HIV prevention and treatment.
Molecular Genetics Retreat, Toronto, Canada, Sept 2011.

72. Falkenhagen A, Asad S, Read SE & **Joshi S**
Genetic interventions for HIV prevention and treatment.
Graduate student recruitment day, Department of Molecular Genetics, Toronto, Canada, Mar 2012.

73. Falkenhagen A, Ameli M, Asad S, Read SE & **Joshi S**
Avoiding the pills: Engineering cells to secrete anti-HIV proteins. **Award winner.**
15th Annual Graduate Student Research Day, Laboratory Medicine & Pathobiology, Toronto, Canada, Mar 2012.

74. Falkenhagen A, Ameli M, Asad S, Read SE & **Joshi S**
Gene therapy based on secreted anti-HIV proteins to place continuous drug administration.
16th Annual Graduate Student Research Day, Laboratory Medicine & Pathobiology, Toronto, Canada. Mar 2013.

75. Falkenhagen A, Singh J, Asad S, Read SE, Zúñiga-Pflücker JC, **Joshi S**
Secreted antiviral proteins for HIV gene therapy.
Molecular Genetics Retreat, Orillia, ON, Canada. Sept 2014.

76. Falkenhagen A, Singh J, Asad S, Read SE, Zúñiga-Pflücker JC & **Joshi S**
Control of HIV infection by gene therapy with secreted entry inhibitors. **Oral Presentation**.
18th Annual LMP Graduate Research Conference, Toronto, ON, Canada. April 2015.

77. Falkenhagen A, Singh J, Ameli M, Asad S, Read SE, Zúñiga-Pflücker JC, **Joshi S**
Control of HIV infection by gene therapy with a secreted entry inhibitor.
Molecular Genetics Retreat, Orillia, ON, Canada. Sept 2015.

78. Falkenhagen A, Singh J, Asad S, Leontyev D, Read SE, Zúñiga-Pflücker JC & **Joshi S**
Control of HIV Infection In Vivo via Gene Therapy with a Secreted Entry (**oral presentation**).
ID Clinical Research Forum at the Hospital for Sick Children, Toronto, ON, Canada. March 2016.

79. Falkenhagen A, Singh J, Asad S, Read SE, Zúñiga-Pflücker JC & **Joshi S**
In vivo control of HIV infection via gene therapy with a secreted entry inhibitor.
U of T Infectious Diseases/Microbiology Research Day, Toronto, Canada, June 2017.

Poster Judge at the Departmental/University Research Day

1. *Molecular Genetics Retreat, Toronto*, Canada, Sept 2011.

2. *15th Annual Graduate Student Research Day, Laboratory Medicine & Pathobiology,* Toronto, Canada, Mar 2012.

3. *18th Annual LMP Graduate Research Conference*, Toronto, Canada. April 2015.

3. Invited Lectures and Presentations at Scientific Meetings

1. IV International Congress of Virology. Den Haag (Holland), Sept 1978.

2. French-Polish Conference: "Structure, Transcription et Traduction des Gènes". Paris (France), April 1980.

3. II International Colloquium on Endocytobiology. Tübingen (Germany), April 1983.

4. III International Symposium: The Molecular Genetics of Plant-Microbe Interactions. Montreal, July 1986.

5. 193rd ACS National Meeting, Modifications & applications of industrial polysaccharides. Denver, Colorado, April 1987.

6. I Canadian Conference on AIDS. Toronto, Jan 1988.

7. North American Model United Nations Conference. Toronto, Feb 1990.

8. Chair and Speaker, Microbiology Research Day. Toronto, Nov 1990.

9. Post-Amsterdam HIV Res priorities, global perspective-local initiatives. Toronto, Feb 1993

10. Gene Therapy in Canada, Toronto, June 1995.

11. *Seventh International Symposium of Society of Chinese Association of Bioscientists in America*, Toronto, July 1997.

12. *Keystone Symposium on Molecular and Cellular Biology: Gene therapy strategies for hematopoietic cells*, Lake Tahoe, Jan 1998.

13. *Cold Spring Harbor Laboratory*, Gene Therapy, New York, Sept 1998.

14. *The 13th Annual Canadian Conference on HIV/AIDS Research* (CAHR), Montreal, May 2004.

15. *The 7th Ontario HIV Treatment Network Research Day,* Toronto, Canada, Nov 2004.

16. *CAHR-ACRV,* Québec City, Canada, May 2006 (*two presentations*).

17. *National AIDS Conference*, Mumbai, India, January 2007.

18. *The 16th Annual Canadian Conference on HIV/AIDS Research*, Toronto, Canada, Apr 2007.

19. *The 10th Ontario HIV Treatment Network Research Day,* Toronto, Canada, Nov 2008.

20. *BIT Life Sciences' 2nd Annual World Summit of Antivirals*. Beijing, China. July 18-25, 2009.

21. Speaker, *Molecular Genetics Retreat,* Barry, Canada, Sept 2010.

22. *Canada India Healthcare Forum*, Toronto, Canada. May 2015.

4. Seminars

1. *In vivo* aminoacylation of TYMV RNA.
"Institut de Recherche en Biologie Moléculaire", Paris (France), 1978.

2. Messenger and tRNA-like properties of Turnip Yellow Mosaic Virus RNA.
State University of Leiden, Dept of Biochemistry, Leiden (The Netherlands), May 1981.

3. Uptake of polyamines by Cowpea protoplasts.
Friedrich-Mischer-Institute, Basel (Switzerland), Sept 1981.

4. "Etude *in vivo* et *in vitro* des propriétés messagères et tRNA-like des RNA de virus de plantes".
"Institut National de la Recherche Agronomique", Versailles (France), Dec 1982.

5. "Structure tRNA-like des RNA de virus de plantes".
"Université Libre de Bruxelles", Bruxelles (Belgium), Feb 1983.

6. Transfer RNA-like structures in plant viral RNAs.
University of Wageningen, Wageningen (The Netherlands), Feb 1983.

7. tRNA-like structures.
State University of Leiden, Leiden (The Netherlands), Feb 1983.

8. "Les génômes des virus de plantes et leurs modalités d'expression".
Ecole Polytechnique, Palaiseau (France), March 1983.

9. tRNA-like structures at the 3' end of plant viral RNAs.
Institute of Biochemistry, University of Würzburg, Würzburg (Germany), April 1983.

10. tRNA-like structures.
University of Toronto, Toronto, May 1983.

11. Development of Microinjection Technology for plant cell transformation.
Allelix, Mississauga (Canada), 1985.

12. Cloning and characterization of chitinase and chitobiase genes and of their gene products.
Allelix, Mississauga (Canada), 1986.

13. AIDS Research at Allelix.
Mount Sinai Research Institute, Toronto, 1987.

14. Molecular biology of HIV-1 and molecular mechanisms of pathogenesis in AIDS.
Allelix, Mississauga (Canada), 1987.

15. Viral Inhibition Therapy against AIDS.
Allelix, Mississauga (Canada), 1987.

16. Novel Approaches for Cloning Receptor Genes.
Allelix, Mississauga (Canada), 1988.

17. AIDS Projects Summary: IL-X, CD4, and VITA.
Closed Seminar for Allelix Management and Consultants, Allelix, Mississauga (Canada), 1988.

18. Cloning and characterization of a novel interleukin, IL-X, allowing Antigen-independent activation of Cytotoxic T Lymphocytes in humans.
Closed seminar for Allelix and Cetus Management, Allelix, Mississauga (Canada), May 1988.

19. Anti-retroviral Therapy against AIDS.
University of Toronto, Toronto, May 1988.

20. New molecular approaches to AIDS therapy.
Mount Sinai Research Institute, Toronto, May 1989.

21. Anti-retroviral Therapies Against AIDS.
The Hospital for Sick Children, Toronto, Dec 1989.

22. Human immunodeficiency virus.
North American Model United Nations Conference. Toronto, Feb 1990.

23. Anti-sense RNA, sense RNA, and HIV-specific ribozymes to confer resistance against HIV-1 infection.
Queen's University, Kingston (Canada), Jan 1991.

24. Retroviral vectors conferring HIV-1 resistance for gene therapy against HIV-1 infections in AIDS patients.
Institut Jacques Monod, Paris (France), July 1991.

25. HIV and AIDS.
South Indians' Cultural Association. Toronto, Oct 1993.

26. Anti-HIV-1 gene therapy.
Hospital for Sick Children, Toronto , Jan 1994.

27. Gene therapy for the treatment of AIDS.
Institut Jacques Monod, Paris (France), April 1994.

28. Gene therapy.
Canadian AIDS Society -Therapies, Toronto, Sept 1994.

29. Anti-HIV-1 gene therapy.
Progenesis, California, Oct 1994.

30. Anti-HIV-1 gene therapy using ribozymes and RNases.
The Toronto Gene Therapy Network.
Princess Margaret Hospital, Toronto, July 1996.

31. Anti-HIV gene therapy using ribozymes and RNases.
McGill AIDS Center, Jewish General Hospital, Montreal, March 1997.

32. HIV gene therapy.
Micro/ID seminar series. Jan 2000.

33. HIV-1 gene therapy at the pre-DNA, DNA, and post-DNA level.
Toronto HIV Group seminar series. June 2006.

34. HIV gene therapy using secreted entry inhibitors.
Canada India Healthcare Forum, New Delhi, India. Mar 2017.

35. HIV gene therapy using bifunctional antiviral proteins.
Apollo Hospitals, New Dehli, India, Feb 2018.

5. Meetings attended

1. IV International Congress of Virology. Den Haag (Holland), Sept 1978.

2. NATO-FEBS Workshop: Genome organization & expression in plants. Edinburgh (UK), July 1979.

3. French-Polish Conference: "Structure, transcription et traduction des gènes". Paris (France), April 1980.

4. EMBO-FEBS: tRNA Workshop. Strasbourg (France), July 1980.

5. V International Congress of Virology. Strasbourg (France), Aug 1981.

6. EMBO Advanced Laboratory Course: Plant Cell Culture Techniques for Molecular Biologists. Basel (Switzerland), Sept 1981.

7. I European Congress on Cell Biology. Paris (France), July 1982.

8. II International Colloquium on Endocytobiology. Tübingen (Germany), April 1983.

9. I Canadian Plant Molecular Biology Workshop. University of Guelph (Canada), May, 1985.

10. Nucleic Acid Technologies Foundation: Strategies for the Expression of Foreign Genes. Rensselaerville, New York, Oct 1985.

11. III International Symposium: The Molecular Genetics of Plant-Microbe Interactions. Montreal, (Quebec), July 1986.

12. 193rd ACS National Meeting, Modifications and Applications of Industrial Polysaccharides. Denver, Colorado (USA), April 1987.

13. A Roche-UCLA Symposia on Molecular and Cellular Biology: Mechanisms of Control of Gene Expression. Steamboat Springs, Colorado (USA), March-April 1987.

14. III International Conference on AIDS. Washington, DC (USA), June 1987.

15. AIDS Awareness Congress. Seabrook Island Resort, South Carolina (USA), Nov 1987.

16. Monokines. Hilton Head Island, South Carolina (USA), Dec 1987.

17. Ist Canadian Conference on AIDS. Toronto, Jan 1988.

18. Toronto AIDS Workshop. May 1988.

19. IV International Conference on AIDS. Stockholm (Sweden), June 1988.

20. V International Conference on AIDS. Montreal (Quebec), June 1989.

21. Anti-sense RNA and ribozymes as a therapeutic agent against HIV-1. Maryland (Washington, USA), June 1989.

22. North American Model United Nations Conference, Toronto, Feb 1990.

23. The Molecular Biology of Retroviruses. York University, Toronto, March 1990.

24. VI International Conference on AIDS. San Francisco (USA), June 1990.

25. VIII International Conference of Virology. Berlin (Germany), Aug 1990.

26. Canadian Society for Microbiology, London (Canada), June 1991.

27. VII International Conference on AIDS, Florence (Italy), June 1991.

28. VIII International Conference on AIDS, Amsterdam (The Netherlands), July 1992.

29. III International Symposium on Catalytic RNAs (Ribozymes) and Targeted Gene Therapy for the treatment of HIV infection. San Diego (California), Dec 1992.

30. Post-Amsterdam HIV Res priorities, global perspective-local initiatives. Toronto, Feb 1993.

31. I Annual HIV/AIDS Research Priority Setting Forum arranged by the AIDS Bureau, Ministry of Health, Toronto, March 1993.

32. II Annual HIV/AIDS Research Priority Setting Forum arranged by the AIDS Bureau, Ministry of Health, Toronto, March 1994.

33. Cold Spring Harbor Laboratory Meeting, Retroviruses, (New York) May 1994.

34. Fourth Annual Canadian Conference on HIV/AIDS Research, Toronto, June 1994.

35. Cold Spring Harbor Laboratory Meeting, Gene Therapy, (New York) Sept 1994.

36. Gene Therapy in Canada Symposium, Toronto, June 1995.

37. XI International Congress on AIDS, Vancouver (British Columbia) July 1996.

38. Cold Spring Harbor Laboratory, Gene Therapy, New York, Sept 1996.

39. *HIV Retreat,* Toronto, April 1997.

40. *Sixth Annual Canadian Conference on HIV/AIDS Research*, Ottawa, May 1997.

41. *Seventh International Symposium of Society of Chinese Assoc. of Bioscientists in America*, Toronto, July 1997.

42. *Keystone Symposium on Molecular and Cellular Biology: Symposium on Molecular and Cellular Biology: Gene therapy strategies for hematopoietic cells,* Lake Tahoe, Jan 1998.

43. *VIIth Annual Canadian Conference on HIV/AIDS Research*, Laval, Quebec, May 1998.

44. *American Society of Gene Therapy, Seattle, Washington DC*, May 1998.

45. *12th World AIDS Conference*, Geneva (Switzerland), June 1998.

46. *3rd Canadian Gene Therapy Symposium. Montreal,* June 1998.

47. *Cold Spring Harbor Laboratory, Gene Therapy*, New York, Sept 1998.

48. *The 5th Ontario HIV Treatment Network Research Day.* Toronto, Canada, Nov 2002.

49. *The HUPO 2nd Annual & IUBMB XIX Joint World Congress*, Montreal, Canada, Oct 2003.

50. *The 6th Ontario HIV Treatment Network Research Day.* Toronto, Canada, Nov 2003.

51. *The 13th Annual Canadian Conference on HIV/AIDS Research*, Montreal, Canada, May 2004.

52. *The 7th Ontario HIV Treatment Network Research Day.* Toronto, Canada, Nov 2004.

53. *The 8th Ontario HIV Treatment Network Research Day.* Toronto, Canada, Nov 2005.

54. *CAHR-ACRV,* Québec City, Canada, May 2006.

55. *XVI International AIDS Conference*, Toronto, Canada, Aug 2006.

56. The 9th Ontario HIV Treatment Network Research Day. Toronto, Canada, Nov 2006.

57. The 16th Annual Canadian Conference on HIV/AIDS Research, Toronto, Canada, Apr 2007.

58. The 10th Ontario HIV Treatment Network Research Day. Toronto, Canada, Nov 2008.

59. *BIT Life Sciences' 2nd Annual World Summit of Antivirals*. Beijing, China. July 2009.

60. Canada Gardiner Awards 50, Toronto, Canada, Oct 2009.

61. *20th Annual Canadian Conference on HIV/AIDS Research.* Toronto, Canada, April 2011.

62. *14th Annual Meeting, American Society for Gene and Cell Therapy.* Seattle, WA, USA, May 2011.

63. *20th Annual Canadian Conference on HIV/AIDS Research.* Toronto, Canada, April 2011.

64. *14th Annual Meeting, American Society for Gene and Cell Therapy.* Seattle, WA, USA, May 2011.

65. 21st Annual Canadian Conference on HIV Research. Montreal, Canada. April 2012.

66. The 2013 OHTN Research Conference, Toronto, ON, Canada. Nov 2013.

67. The OHTN Back to Basic Conference, Toronto, ON, Canada. Nov 2014.

68. 24th Annual Canadian Conference on HIV/AIDS Research, Toronto, ON, Canada. May 2015.

69. Canada India Healthcare Forum, Toronto, ON, Canada. May 2015.

70. Canada India Healthcare Forum, Delhi, India. Mar 2017.

F. TEACHING

1. Undergraduate & graduate courses taught

Year	Course #	Course Title	hours	Students
1988-1989:	MPL 1141Y/MPL 424Y*	Advanced Microbial Genetics	10 h	15-20
	MPL 440H	Biology of Animal Viruses	2 h	15-25
	MPL 2114H	Advances in Virology	2 h	5-10
1989-1990:	MPL 1141Y/MPL 424Y*	**Co-ordinator**, Advanced Microbial Genetics (While Dr. Chan was on Sabbatical)	22 h	15-20
	MPL 440H	Biology of Animal Viruses	2 h	15-25
	MPL 437H	Antimicrobial Agents	2 h	20-25
1990-1991:	MPL 1141Y/MPL 424Y*	Advanced Microbial Genetics	12 h	15-25
	MPL 437H	Antimicrobial Agents	2 h	15-25
	MPL 422	Microbiology Research Project		2
1991-1992:	MPL 1141Y/MPL 424Y*	Advanced Microbial Genetics	12 h	15-25
	MPL 437H	Antimicrobial Agents	2 h	15-25
	PAT 1018H	Mol Biol & Appl to Human Disease	2 h	15-25
	MPL 422	Microbiology Research Project		1
1992-1993:	MPL 1141Y/MPL 424Y*	Advanced Microbial Genetics	13 h	15-25
	MPL 437H**	**Co-ordinator**, Antimicrobial Agents	2 h	15-25
	MPL 422	Microbiology Research Project		3
1993-1994:	MPL 1141Y/MPL 424Y*	Advanced Microbial Genetics	14 h	15-25
	MPL 2111H,L*	Methods in Microbiology (RT)PCR	20 h	6
	MPL 437H**	**Co-ordinator**, Antimicrobial Agents	2 h	15-25
	PAT 1018H	Mol Biol & Appl to Human Disease	2 h	15-25
	MPL 422	Microbiology Research Project		3
1994-1995:	MPL 1141Y/MPL 424Y*	**Co-ordinator**, Advanced Microbial Genetics (While Dr. Chan was on Sabbatical)	18 h	15-25
	BCH 2021F	Protein-DNA interactions: Structure & Function	2 h	10-15
	MPL 2116H	Advanced research & reading course	N/A	3
	MPL 422	Microbiology Research Project		1
1995-1996:	MPL 440S*	Molecular Virology	21 h	15-25
	PAT 1018H	Mol Biol & Appl to Human Disease	2 h	15-25
	BIO 351Y	Introductory Virology	4 h	300
1996-1997:	MPL 2116H	Advanced research & reading course	N/A	1
	MPL 422	Microbiology Research Project		2
1997-1998:	MPL 445H	**Coordinator**, Genetic Engineering for prevention and treatment of disease	20 h	25
	PAT 1018H	Mol Biol & Appl to Human Disease	2 h	20
	MPL 422	Microbiology Research Project		1
	MGB 480	Special Project		1

* Responsible for designing part of the section taught by myself.
** Course coordinator after Dr. Kushner's retirement.

Year	Course #	Course Title	hours	Students
1998-1999:	MPL 445H	**Coordinator**, Genetic Engineering for prevention and treatment of disease	20 h	18
1999-2000:	MPL 445H	**Coordinator**, Genetic Engineering for prevention and treatment of disease	25 h	20
	PAT 1018H	Mol Biol & Appl to Human Disease	2 h	20
	MPL 422	Microbiology Research Project		2
	MGB 480	Special Project		1
2000-2001:	MBY 445H	**Coordinator**, Genetic Engineering for prevention and treatment of disease	25 h	26
2001-2002:	MBY 445H	**Coordinator**, Genetic Engineering for prevention and treatment of disease	25 h	26
	PAT 1018H	Mol Biol & Appl to Human Disease	2 h	8
	MPL 422	Microbiology Research Project		2
2002-2003:	MBY 445H	**Coordinator**, Genetic Engineering for prevention and treatment of disease	25 h	30
2003-2004:	MBY 445H	**Coordinator**, Genetic Engineering for prevention and treatment of disease	30 h	30
	PAT 1018H	Mol Biol & Appl to Human Disease	2 h	10
	MPL 422	Microbiology Research Project		1
2004-2005:	MGY 445H	**Coordinator**, Genetic Engineering for prevention and treatment of disease	30 h	27
	MGY 480	Special Project		2
2005-2006:	MGY 445H	**Coordinator**, Genetic Engineering for prevention and treatment of disease	30 h	40
	PAT 1018H	Mol Biol & Appl to Human Disease	4 h	12
	LMP 299Y	Research Project Opportunity #50		3
2006-2007:	MGY 445H	**Coordinator**, Genetic Engineering for prevention and treatment of disease	33 h	24
2007-2008:	MGY 445H	**Coordinator**, Genetic Engineering for prevention and treatment of disease	30 h	23
	PAT 1018H	Mol Biol & Appl to Human Disease	4 h	10
2008-2009:	MGY 445H	**Coordinator**, Genetic Engineering for prevention and treatment of disease	30 h	23
2009-2010:	MGY 445H	**Coordinator**, Genetic Engineering for prevention and treatment of disease	30 h	12
	MGY 480	Special Project		1
	HMB 397	Special Project		1
2010-2011:	MGY 445H	**Coordinator**, Genetic Engineering for prevention and treatment of disease	30 h	16
2011-2012:	MGY 445H	**Coordinator**, Genetic Engineering for prevention and treatment of disease	30 h	17

Year	Course #	Course Title	hours	Students
2012-2013:	MGY 445H	**Coordinator**, Genetic Engineering for prevention and treatment of disease	30 h	12
2013-2014:	MGY 445H	**Coordinator**, Genetic Engineering for prevention and treatment of disease	30 h	12
2014-2015:	MGY277H1	Intro Med Micro – Online Course	HIV/AIDS	300
2015-2016:	MGY277H1	Intro Med Micro – Online Course	HIV/AIDS	300
2016-2017:	MGY277H1	Intro Med Micro – Online Course	HIV/AIDS	300
2017-2018:	MGY277H1	Intro Med Micro – Online Course	HIV/AIDS	300
	MGY378H1	Microbiology II - Viruses	HIV/HBV HDV	95
2018-2019:	MGY277H1	Intro Med Micro – Online Course	HIV/AIDS	300
	MGY378H1	Microbiology II - Viruses	HIV/HBV HDV	108

Member of the graduate examination committees

M.Sc. Examinations

1. Nam Woo K, Nov 1988. Isolation and Characterization of the ribosomal RNA genes of *Campylobacter jejuni*. (Supervisor, Dr. VL Chan).

2. Dykshoorn P, April 1989. Identification of upstream activation sequence of the yeast pyruvate kinase gene. (Supervisor Dr. B McNeil).

3. Arko E, June 1989. Genetic characterization of a delayed host shutoff temperature-sensitive mutant of herpes simplex virus type-1. (Supervisor Dr. VL Chan).

4. Rotman T, June 1992. Role of verocytotoxin-1 in the pathogenesis of hemorrhagic coilitis and hemolytic uremic syndrome. (Supervisor, Dr. M Petric).

5. Soto E, Sept 1992. Restricted cytokine expression in Rheumatoid Arthritis. (Supervisor, Dr. E Fish).

6. Adams SL, Sept 1992. The molecular characterization of a gene for prokaryotic translation factor EF-P. (Supervisor, Dr. MC Ganoza).

7. Liem SE, Jan 1993. The development and testing of retroviral vectors expressing *trans*-dominant mutants of HIV-1 proteins to confer resistance against HIV-1. (Supervisor, Dr. S Joshi).

8. Banglmaier RW, Jan 1993. The development and testing of HIV-1-like retroviral vector particles. (Supervisor, Dr. S Joshi).

9. Li X, Jan 1993. Antibody dependent cellular cytotoxic response in AIDS patients. (Supervisor, Dr. SE Read).

10. De Abreu D, Sept 1993. Genetic approaches to the identification of functionally important regions of the *Neurospora* versus ribozyme. (Supervisor, Dr. R Collins).

11. Chen, HS, Sept 1993. Characterization of HIV reverse transcriptase by insertion mutagenesis. (Supervisor, Dr. VL Chan).

12. Ho C, Sept 1993. Development of HIV-1 reverse transcriptase activity assays. (Supervisor, Dr. VL Chan).

13. Beg S, Oct 1993. Cytokine regulation of cell proliferation. (Supervisor, Dr. E Fish).

14. Haddad GE, Sept 1994. Expression of HLA class II genes in transgenic mice. (Dept of Immunology).

15. Borkar M, Sept 1994. Cloning and characterization of an hsp70 gene in the steroid responsive fungus *Achlya ambisexualis*. (Supervisor, Dr. J Silver).

16. Lombardi RA, June 1996. *Trans*-dominant mutants of HIV-1 Gag and Env proteins for use in anti-HIV-1 gene therapy. (Supervisor, Dr. S Joshi).

17. Seguin B, May 1998. Control of HIV-1 RNA metabolism: the role of splice sites and intron sequences in unspliced viral RNA subcellular distribution. (Supervisor, Dr. A Cochrane).

18. Singwi S, Aug 1999. HIV gene therapy using nucleases. (Supervisor, Dr. S Joshi).

19. Moffett A, Sept 2005. β-Globin intronic elements and LCR activity. (Supervisor, Dr. J. Ellis).

Reclassification Examinations

20. Anderson A, Feb 1994. Using *in vitro* selection and *in vitro* evolution to study the structure and function of VS RNA. (Supervisor, Dr. R Collins).

21. Ramezani A, April 1995. Hammerhead ribozymes for use in anti-HIV gene therapy. (Supervisor, Dr. S Joshi).

22. Medina MF, Nov 1996. Development of $tRNA_3^{Lys}$-based hammerhead ribozymes for use in anti-HIV gene therapy. (Supervisor, Dr. S Joshi).

23. Soros VB, June 1997. Identification of the nuclear import system that HIV-1 Rev utilizes. (Supervisor, Dr. A Cochrane).

24. Pongoski J, June 1999. Strategies for modulating HIV-1 Rev function in eukaryotic cells. (Supervisor, Dr. A Cochrane).

25. Falkenhagen A, Sept 2011. A novel gene therapy strategy using secreted proteins to prevent HIV-1 entry in gene-modified and unmodified target cells. (Supervisor, Dr. S Joshi).

26. Mujib S, Aug 2013. Strategies to facilitate eradication of the HIV-1 latent reservoir. (Supervisor, Dr. M Ostrowski).

Ph.D. Examinations

27. Tonin P, Aug 1989. Characterization of genomic sequences co amplified with the M2 gene in hydroxyurea-resistant mammalian cells. (Supervisor, Dr. VL Chan). (Senate Exam).

28. Sit TL, Nov 1992. Cloning, sequencing and generation of infectious RNA transcripts from cDNA of Papaya mosaic potexvirus. (Supervisor, Dr. MG AbouHaidar). (Departmental Exam).

29. LeClerc D, Dec 1993. (Supervisor, Dr. MG AbouHaidar). (Senate Exam).
Detection of potato viruses in identification of the Potato Aucuba Mosaic Potex Virus Capsid protein gene region involved in coat protein mediated resistance.

30. Sung MK, Oct 1994. The biological activity of soybean saponins and its implications in colon carcinogenesis. (Supervisor, Dr. AV Rao). (Senate Exam).

31. Wong ZM, Nov 1994. Regulation of proteoglycans expressed in the intestine. (Supervisor, Dr. RN Buick). (Senate Exam).

32. Harford CA, Jan 1995. Metal binding motifs of proteins: Effects of metals on protein structure and function. (Supervisor, Dr. B Sarkar). (Senate Exam).

33. Chia WK, Feb 1995. Cell mediated cytolytic (CMC) activity in patients with HIV-1 infection. (Supervisor, Dr. SE Read). (Senate Exam; Internal Appraiser).

34. Skinner DM, Aug 1996. Dissociation of simple associative conditioning and higher order occasion setting. (Supervisor, Dr. D van der Kooy). (Senate Exam).

35. Der S, Oct 1996. Regulation of interferon-α genes. (Supervisor, Dr. A Lau) (Departmental Exam).

36. Seaboyer JA, July 1997. Second death in Venice: cognitive mapping in the venetian fiction of Jeanette Winterston, Ian McEwan and Robert Coover. (Supervisors, Dr. LAM Hutcheon & Dr. MJ Levene). (Senate Exam).

37. Kyriakopoulou G, Jan 1998. Cloning and characterization of an hsp70 transcript regulated by hormone and glucose depletion in *Achlya ambisexualis*. (Supervisor, Dr. JC Silver).

38. Kyriakopoulou G, April 1998. Molecular cloning of three different *Achlya ambisexualis* hsp70 cDNAs, and changes in the accumulation of hsp70 transcript populations during hyphal branching. (Supervisor, Dr. JC Silver). (Senate Exam).

39. Thorpe J, Jan 1999. Regulation of phenylalanine metabolism *in vivo*. (Supervisor, Dr. P Pencharz). (Senate Exam).

40. Medina MF, Nov 1999. Strategies for isolation and expression of ribozymes for use in anti-HIV-1 gene therapy (Supervisor, Dr. S Joshi) (Departmental Exam).

41. Medina MF, Jan 2000. Strategies for isolation and expression of ribozymes for use in anti-HIV-1 gene therapy (Supervisor, Dr. S Joshi) (Senate Exam).

42. Graziani-Bowering GM, May 2000. The expression and signal transduction of CD4, an HIV and interleukin-16 receptor, in monocytic cells (Supervisors, Dr. L Filion & Dr. M Kozlowski) (External examiner for the Senate Exam).

43. Mabee W, March 2001. Study of woody fiber in papermill sludge (Supervisors, Dr. DN Roy & Dr. K Goel) (Senate Exam).

44. Ramezani A, July 2001. Development and testing of mono- and multimeric hammerhead ribozymes for HIV-1 gene therapy. (Supervisor, Dr. S Joshi) (Departmental Exam).

45. Ramezani A, April 2002. Development and testing of mono- and multimeric hammerhead ribozymes for HIV-1 gene therapy. (Supervisor, Dr. S Joshi) (Senate Exam).

46. Raciborska D, July 2002. Department of Psychology (Senate Exam).

47. Gurfinkel D, Dec 2003. Dietary saponins, the relationship between chemical structure and carcinogenic activity. (Supervisor, Dr. AV Rao) (Departmental Exam).

48. Secker D, June 2006. Pediatric nutritional assessment: A comparison of clinical judgement and objective measures. (Supervisor, Dr. K Jeejeebhoy) (Senate Exam).

49. Kraetschmer N, Jan 2007. An examination of policy implications for scope of services and geography for telehealth. (Supervisor, Dr. R Deber) (Senate Exam).

50. Nazari R, May 2008. DNA and RNA inactivation strategies to prevent or inhibit HIV-1 replication via gene therapy. (Supervisor, Dr. S. Joshi) (Senate Exam).

51. Petherick LD, 2008. Whose knowledge counts and measuring it: he production of health discourse in Ontario's Grade 9 health and physical education curriculum, pedagogy, and embodies experience. (Supervisor, Dr. M MacNeill) (Senate Exam).

52. Khambalia AZ, Feb 2009. Periconceptional iron and folate supplementation improves iron and folate status before and after pregnancy among females in rural Bangladesh: A randomized controlled trial. (Supervisor, Dr. S. Zlotkin) (Senate Exam).

53. Keller BM, Apr 2009. An experimental investigation on reduced radiological penumbra of intermediate energy x-rays: implications for small field radiosurgery. (Supervisor, Dr. JP Pignol) (Senate Exam).

54. Xiao H, Sept 2009. Molecular mechanism of podosome formation and proteolytic function in human bronchial epithelial cells. (Supervisor, Dr. M Liu) (Senate Exam).

55. Hashmi JA, Nov 2009.Temporal dynamics of heat pain sensations. (Supervisor, Dr. K. Davis, Dept of Medical Science) (Senate Exam).

56. Glaholt MG, Dec 2009. Biases in looking behavior during visual decision making tasks. (Supervisor, Dr. E Reingold, Department of Psychology) (Senate Exam).

57. Colautti R, Dec 2009. Evolution of local adaptation during plant invasion: purple loosestrife (*Lythrum Salicaria - Lythraceae*) in eastern North America. (Supervisor, Dr. S Barrett) (Senate Exam).

58. Barichievy S, Jan 2010. Post-transcriptional inhibition of HIV-1 using combinatorial RNAi expression vectors. (Supervisor, Dr. MS Weinberg, Institute of Medical Sciences, University of the Witwatersrand, Johannesburg) (***External examiner***, Senate Exam).

59. Gladstone BM, Mar 2010. "All in the same boat": An analysis of a support group for children of parents with mental illnesses. (Co-supervisors, Drs. P McKeever & K Boydell, Dalla Lana School of Public Health, University of Toronto) (Senate Exam).

60. Ziethen A, Sept 2010. La poetique de l'espace (post)colonial dans le roman Senegalais et Mauricien au feminine. (Dept of French) (***Senate Exam***).

61. Benoit A, Jan 2011. Impaired IL-7/IL-7R signaling in HIV infection: Role of the transcriptional repressor GFII in suppressing IL-7R expression and driving the proliferation of human CD8+ T lymphocytes. (Supervisor, Dr. Marko Kryworuchko, Dept of Biochemistry, Microbiology, and Immunology, University of Ottawa) (***External examiner,*** Senate Exam).

62. Leung G, Mar 2011. Magnetic Resonance Imaging detected intraplaque haemorrhage as an endogenous imaging biomarker and therapeutic target. (Supervisor, Dr. A Moody, Dept of Medical Biophysics) (***Senate Exam***).

63. Neschadim A, Sept 2011. Development of novel cell fate control gene therapy for applications in cancer and immune disorders. (Supervisor, Dr. J Medin, Dept of Medical Biophhysics) (***Senate Exam***).

64. Kaludjerovic J, Nov 2012. Programming of bone and reproductive health by early life exponsure to soy isoflavones and/or folic acid in CD-1 mice. (Supervisor, Dr. R Vieth, Dept of Nutritional Sciences) (***Senate Exam***).

65. Tennier-Gigliotti J. Sept 2013. Le "vécrire" dans l'œuvre Romanesque de Marguerite Anderson. (Supervisor, Dr. M. O'Neill-Karch, Dept of French) (***Senate Exam***).

66. Kenneth Kin-Lap Tang, Sept 2014. Work disability among injured workers with chronic upper extremity disorders: measurement and mechanism. (Supervisor, Dr. D Beaton, Dept of Health Policy, Management and Evaluation) (***Senate Exam***).

67. Susana Wadgymar, June 2015. Climate change and reproductive phenology: context-dependent responses to temperature and implication for assisted colonization. (Supervisor, Dr. Art Weis, Dept of Ecology and Evolutionary Biology) (***Senate Exam***).

68. John Anderson, Nov 2015. Only time will tell: time-of-day and the cognitive neuroscience of executive control in aging. (Supervisor, Dr. L. Hasher; Dept of Psychology) (***Senate Exam***).

69. Hyun Hee Kim, Jan 2016. The cellular and molecular mechanisms of ischemia-reperfusion induced lung injury. (Supervisor, Dr. M. Liu, Dept of Physiology) (***Senate Exam***).

70. Hans Melo, Oct 2016. Evidence accumulation drives policy change in decision-making. (Supervisors, Drs. Aam Anderson & W. Cunningham, Dept of Psychology) (***Senate Exam***).

71. Jessica Robin, Nov 2016. The constructive role of spinal context in event memory. Supervisor, Dr. M. Moscovitch; Dept of Psyhology) (***Senate Exam***).

72. Kelvin Kar-Wing Chan, Nov 2016. Addressing uncertainties in health utilities. (Supervisors, Drs. E Pullenayegum & A Willan; Dept of Public Health Sciences) (***Senate Exam***).

73. Alexander Falkenhagen, Dec 2016. A novel gene therapy approach based on secreted antiviral proteins for the control of HIV replication. (Supervisor, Dr. S. Joshi; Dept of Lab Med & Pathobiol) (***Senate Exam***).

74. Lisa Wickerson, Oct 2018. Oxygenation during exercise in individuals with interstitial lung disease. (Supervisor, Dr. D Brooks; Dept of Rehabilitation Sciences Institute) (***Senate e*xam**).

75. Christopher Tait. June 2018. Dietary pattern food insecurity and type II diabetes risk: survey and health administration data in Ontario. (Supervisor, Dr. L Rosella; Dept of Public Health Science). (***Senate Exam***).

2. Research training for undergraduate students

Publications/Abstracts resulting from work performed by these students are not listed but can be provided upon request.

1. **Mr. Barry Love**, LSC, summer 1989
Development of a ribozyme-containing retroviral vector to confer intracellular immunity to HIV-1.

2. **Mr. Andrew Liaw**, LSC, summer 1989
Development of a cloning vector for use in construction of retroviral vectors that confer HIV-1 resistance.

3. **Ms. Laura Davison**, summer 1989
Development of human $CD4^+$ cell lines containing retroviral vectors to confer HIV-1 resistance.

4. **Ms. Batul Somani**, OWSP Jan - April 1990
   Development of retroviral vectors expressing *lac*Z gene.

5. **Ms. Nadia Toffoli**, summer 1990
   Retroviral vector development.

6. **Ms. Bernice Fan**, MPL 422, Sept 1990 - March 1991
   Development and testing of retroviral vectors containing HIV-1 packaging signal.

7. **Mr. Wilson Marhin**, MPL 422, Sept 1990 - March 1991; LSC, summer 1991.
   Development of HIV-1 RNA-specific ribozymes and their testing in bacterial cells.

8. **Mr. Jeffrey Noronha**, MPL 422, summer 1991.
   RT activity assays of retroviral vectors containing HIV-1 packaging signal.

9. **Mr. Charles Sun de la Cruz**, LSC, summer 1992.
   Development of retroviral vectors containing HIV-1 Gag, Env and Tat mRNA-specific ribozymes.

10. **Ms. Anita Kothari**, summer 1992.
    In vitro transcription and cleavage reactions.

11. **Mr. Volta Kai Tsoi**, summer 1992 & 1993.
    PCR reactions to detect the presence of human DNA in various organs from SCID mice injected with healthy human blood cells.

12. **Mr. Ali Ramezani**, MPL 422, summer 1992; Sept 1992 - Aug 1993.
    Development and testing of a second-generation retroviral vector.

13. **Mr. Jeffrey Noronha**, Sept 1992 - Aug 1993.
    Development and characterization of pseudotyped vector particles containing HIV-1 Env and MoMuLV Gag and Pol proteins.

14. **Ms. Deboleena Roy**, MPL 422, Sept 1992 - May 1993.
    PCR and restriction enzyme analysis to confirm the presence of anti-HIV genes within the gnome of transformed HIV-1 target cells.

15. **Mr. Steven Chadgimichaelidis**, MPL 422, Sept 1992 - May 1993.
    Development of a retroviral vector co-expressing Tat, Gag, Pro, RT and Env mRNA-specific ribozymes.

16. **Mr. Offir Spanglet**, LSA, summer 1993.
    Assessment of the Tat- or Tat- and Rev-inducible Expression of a Reporter Gene Cloned Parallel or Antiparallel to its Retroviral Vector.

17. **Mr. Kevin Leung**, LSA, summer 1993.
    Identification of alternate tRNA-PBS in MoMuLV-derived Vectors

18. **Ms. Karin Greiner**, MPL 422, Sept 1993 - May 1994.
    In vitro transcription and cleavage reactions using anti-HIV-1 specific hammerhead ribozymes.

19. **Ms. Megan Mabady**, summer 1993, summer 1994.
    Development of retroviral vectors expressing hammerhead ribozymes.

20. **Mr. Kevin Nguyen**, MPL 422, summer 1994.
    Screening for novel anti-HIV-1 compounds.

21. **Ms. Mansoora Ahmed**, MPL 422, Sept 1993 - May 1994; June 1994 - Aug 1995.
Construction of Tev expressing vectors and testing of PAP toxicity.

22. **Mr. Jonathan Chen**, MPL 422, June 1996 - Oct 1996.
Second generation retroviral vectors expressing packageable ribozymes.

23. **Ms. Nathalie Nina Martinek**, June 1996 - Sept 1996.
Retroviral vector development.

24. **Ms. Kawthra Salim**, MPL 422, Sept 1996 - May 1997.
Development of retroviral vectors expressing $tRNA_3^{Lys}$-ribozymes.

25. **Mr. Eric Ng** (High School student) Feb 1997 - May 1997.
Learned various laboratory techniques.

26. **Mr. Dareyl Vaz,** May 1997 - Aug 1997.
Mechanism underlying resistance conferred by the antisense RNA to HIV-1 Psi-Gag region.

27. **Mr. Mansour Haeryfar**, June 1997 - Aug 1997.
Assisted in plasmid DNA preparations and learned molecular biology techniques.

28. **Mr. Ashish Jain**, Sept 1996 – Dec 1997.
Second generation retroviral vectors expressing packageable ribozymes.
Mechanism underlying antisense RNA co-packaging.

29. **Mr. Manu Sharma** (MPL 422), Sept 1997 – April 1998.
Development of pentameric multi-targeted ribozyme against most common HIV subtypes.

30. **Mr. Eric Ho** (MGB 480), June 1997 – Sept 1998.
Development of multimeric ribozymes against HIV-1 co-receptor (CCR5) mRNA.

31. **Mr. Furqan Shaikh** (Life Sciences student), May 1998 – Aug 1998.
HIV gene therapy using anti-CCR5 ribozymes.

32. **Ms. Hafsa Shaikh** (TIN 404Y, TIN 405Y, TIN 406Y), Sept 1998 – May 1999.
Development of MGIN-based vectors expressing Gag-RNase T1.

33. **Ms. Kristine Forrest** (MPL 422), May 1999 – Aug 1999.
Cloning of MGI-GTRC and MGI-mtGTRC retroviral vectors.

34. **Mr. Kyung Han** (MGB 480), Sept 1999 – April 2000.
Cloning and characterization of MGI-GTRC and MGI-mtGTRC retroviral vectors.

35. **Mr. Reza Nazari** (MPL 422), Aug 1999 – Aug 2000.
Characterization of Gag-RNase T1 produced in mammalian cells.

36. **Mr. Prasanna Rajgopalan**, July 2001 – Aug 2001.
HIV gene therapy using multimeric hammerhead ribozymes.

37. **Ms. Nicole Kieser** (MPL 422), Sept 2001 – Aug 2002.
Vector development for HIV-1 gene therapy: construction of an HIV-2 based vector for expressing a fluorescent protein and an anti-HIV-1 gene.

38. **Mr. John Kraft** (MPL 422), Sept 2001 – Aug 2002.
Modifying a group II intron for use in anti-HIV-1 gene therapy.

39. **Ms. Christina Shek** (MPL 422), Sept 2003 – April 2004.
Anti-CCR5 ribozyme-mediated downregulation of surface CCR5 receptors.

40. **Ms. Niranjana Sathananthan** (MGY 480), Sept 2004 – April 2005.
Ribozyme-mediated gene therapy for HIV infection using MGIN and HIV-based vectors.

41. **Ms. Mitra Amoozgar**, Jan 2005 – April 2005.
Development of RNase protection assay.

42. **Mr. Suraj Sharma** (MGY 480), April 2004 – Sept 2005.
The development of a group II intron-based strategy for anti-HIV gene therapy.

43. **Ms. Alifiya Dawoodi**, Aug 2005 – Oct 2005.
Designing group II introns for inactivating HIV-1 provirus DNA.

44. **Mr. Eric Sy** (LMP299Y), Sept 2005 – May 2006.
Development and testing of a novel gene therapy strategy.

45. **Ms. Nandini Mehta** (LMP299Y), Sept 2005 – May 2006.
Development and testing of a novel gene therapy strategy.

46. **Ms. Divya Garg** (Summer student), May 2006 – July 2006.
HIV-1 gene strategy.

47. **Mr. Ricky Tsai** (LMP299Y; Life sciences student), Sept 2005 – Aug 2006.
Development and testing of a novel gene therapy strategy.

48. **Mr. Nikhil Shah** (LMP 299Y), May 2006 – Aug 2006.
Development and testing of a novel gene therapy strategy.

49. **Mr. Yutong Zhao** (Undergraduate student), Feb 2007 – June 2007.
HIV-1 gene therapy using multimeric hammerhead ribozymes.

50, **Gayanan Jaynathan,** March 2008 – July 2008.
HIV-1 gene therapy using multimeric hammerhead ribozymes.

51. **Mrs. Kamna Singh,** March 2008 – July 2008.
Development of a novel gene therapy strategy to prevent HIV-1 replication in uninfected individuals.

52. **Mr. Alexander Waechter**, Mar 2009 – August 2009.
HIV gene therapy for prevention and treatment.

53. **Mr. Raman Srivastava,** May 2009 – Aug 2009.
Development of lentiviral vectors for HIV gene therapy.

54. **Ms. Anuradha Singh,** May 2009 – Aug 2009.
Development of lentiviral vectors for HIV gene therapy.

55. **Mr. Umair Iqbal**, Sept 2008 – Dec 2009.
Design of a fusion proteins to inhibit HIV infection.

56. **Mr. William Yuan** (HMB 397), Oct – Nov 2009.
Vector construction elements for use in gene therapy treatments of HIV.

57. **Mr. Jin Meng,** May 2009 – April 2010.
Characterization and activity of fusion proteins designed to inhibit HIV infection.

58. **Ms. Katherine Mazur** (MGY 480), Sept 2009 – May 2010.
Characterization and activity of fusion proteins designed to inhibit HIV infection.

59. **Mr. Mark Ruberry,** Sept 2009 – April 2010.
Development and testing of lentiviral vectors expressing multimeric hammerhead ribozymes.

60. **Ms. May,** Feb – Mar 2010.
Characterization and activity of fusion proteins designed to inhibit HIV infection.

61. **Ms. Payal,** Feb – Mar 2010.
Characterization and activity of fusion proteins designed to inhibit HIV infection.

62. **Ms. Avantika Mathur** (3rd year CO-OP student, Univ of Waterloo), May 2010 – Aug 2010.
Characterization and activity of fusion proteins designed to inhibit HIV infection.

63. **Mr. Masoud Ameli,** Nov 2000 – present.
HIV gene therapy using multimeric ribozymes to prevent viral entry and replication.

64. **Mr. Jimmy Chen,** May 2009 - Sept 2010; May 2011- Sept 2011.
Development and testing of lentiviral vectors expressing fusion proteins and multimeric hammerhead ribozymes.

65. **Mr. Yuda Yu**, Jan 2012 – Sept 2012.
Characterization and activity of fusion proteins designed to inhibit HIV infection.

66. **Mr. Parth Shah**, June 2011 – Aug 2011; May 2012 – Sept 2012.
HIV gene therapy using secreted antiviral proteins.

67. **Mr. Juan Umana**, May 2012 – Sept 2012.
HIV Gene therapy.

68. **Mr. Waktar Ahmed**, April 2013 – August 2013.
Secreted bifunctional antiviral proteins for HIV prevention and treatment.

69. **Mr. Faris Sulaiman**, June 2014 – Sept 2015.
Secreted bifunctional antiviral proteins for HIV prevention and treatment.

3. **Research training for Graduate students**

Direct Supervision for M.Sc./Ph.D. students

1. **Mr. Migara Weerasinghe**, **M.Sc.**, Sept 1989 - Sept 1991.
Project title: The development and testing of retroviral vectors expressing HIV-1 specific ribozymes and their testing in mammalian cells.
Fellowships:
- University of Toronto special entrance, 2 terms (Sept 1989).
- University of Toronto open fellowship, 1 term (Sept 1990).
Current position: Dentist.

2. **Ms. Sian-Eng Liem**, **M.Sc.**, Jan 1990 - Jan 1993. ***Degree obtained in Jan 1993.***
Project title: The development and testing of retroviral vectors expressing *trans*-dominant mutants of HIV-1 proteins to confer resistance against HIV-1.
Fellowships:
- NHRDP fellowship, Feb 1991 - Jan 1992.
Current position: Optometrist.

3. **Mr. Robert W Banglmaier**, **M.Sc.** student, Sept 1990 - Jan 1993. ***Degree obtained in Jan 1993.***
Project Title: Development of HIV-1-like retroviral vectors for $CD4^+$ cell gene therapy.
Fellowships:
- University of Toronto special entrance (Sept 1990 - Aug 1991).
Current position: Optometrist.

4. **Mr. Rocco Lombardi**, **M.Sc.** student, Sept 1993 - June 1996. ***Degree obtained in June 1996.***
Project Title: Development and testing of retroviral vectors co-expressing *trans*-dominant mutants of HIV-1 *gag* and *env* genes.
Fellowships:
- University of Toronto open (1 term) Sept 1993.
- NHRDP M.Sc. AIDS fellowship (Sept 1994 - Aug 1995).
Current position: Family Physician in Ontario, Canada.

5. **Mr. Jeffery Noronha**, **M.Sc.** student, Sept 1993 – Aug 1996.
Project Title: Further anti-HIV-1 gene therapy testing using retroviral vectors expressing HIV-1 packaging signal.
Fellowships
- University of Toronto Open (1 term) Sept 1994.
Current position: Computer analyst/programmer.

6. **Mr. Ali Ramezani**, **Ph.D.** student, Sept 1993 – April 1999. ***Degree obtained in April 2002.***
Project Title: Development and testing of mono- and multimeric hammerhead ribozymes for HIV-1 gene therapy.
Fellowships:
- University of Toronto open (1 term) Sept 93.
- NHRDP fellowship (Sept 93 - Aug 1995).
- Connaught fellowship (Sept 1995 - Aug 1996).
- Connaught fellowship (Sept 1996 - Aug 1997) - declined.
- OGS fellowship (Sept 1996 - Aug 1997) - declined.
- NHRDP fellowship (June 1996 - June 1998).
Awards:
Microbiology Res Day Best Presentation Award, 1996
McPhearson Award, 1998.
Current position: Associate Professor at George Washington University, USA.

7. **Ms. Maria Fe Medina**, **Ph.D.** student, Sept 1993 – Jan 2000. ***Degree obtained in Jan 2000.***
Project Title: Development of improved tRNA ribozymes for use in anti-HIV-1 gene therapy.
Fellowships:
- University of Toronto open (1 term) Sept 1994.
- University of Toronto open (2 terms) Sept 1996.
- University of Toronto open (2 terms) Sept 1997.
Current position: Assistant Professor at the McMaster University, Ontario, Canada.

8. **Mr. Azim Ladha**, **M.Sc.** student, Jan 1994 - May 1996.
Project Title: Suicide gene therapy and development of an indicator suicide cell system for anti-Tat drug screening.
Fellowships:
- NHRDP M.Sc. AIDS fellowship (Sept 1994 - Feb 1996).
- University of Toronto open (1 term) Sept 1994 - declined.
Current position: Sales representative.

9. **Mr. Sanjeev Singwi**, **M.Sc.** student, Sept 1996 – Aug 1999. ***Degree obtained in Aug 1999.***
Project Title: Development of packageable RNases for use in anti-HIV-1 gene therapy.
Fellowships:
- University of Toronto open (1 term) Sept 1996.

- University of Toronto open (1 term) Sept 1997.
Current position: Anaesthetist in New Market, Ontario, Canada.

10. **Ms. Ayella Shams**, **M.Sc.** student, Sept 2005 – Nov 2005; took a leave of absence and quit the graduate program.
Project Title: HIV gene therapy to protect the healthy cells and rescue the infected cells.

11. **Mr. Reza Nazari**, **Ph.D.** student, Sept 2000 – June 2008.
Project Title: RNA and DNA inactivation strategies to prevent / inhibit HIV-1 replication via gene therapy.
Fellowships:
- OHTN Fellowship Sept 2002 – Aug 2004.
- University of Toronto open (4 terms).
Awards:
Best **M.Sc. poster presentation award** during *Lab Medicine & Pathobio* Res Day, Mar 2002.
Best **Ph.D. poster presentation award** during *Lab Medicine & Pathobio* Res Day, Feb 2004.
Current position: Assistant Professor at Tehran University, Iran.

12. **Mr. Alexander Falkenhagen, M.Sc.** student, Sept 2009; **Ph.D.** Student, Sept 2011 – Dec. 2016.
Project title: A novel gene therapy approach based on secreted antiviral proteins for the control of HIV replication.
Fellowships:
- University of Toronto open (2 terms).
Awards:
Best **Ph.D. poster presentation award**, *15th Lab Med & Pathobio* Grad Stud Res Day, Mar 2012.

Direct Supervision for rotation students

1. **Mr. Felipe Cisternas**, Sept 1997 - Dec 1997.
Assisted in the development of retroviral vectors expressing *trans*-dominant mutants of HIV-1 *gag* and *env*.

2. **Ms. Emma Fung**, Sept 1997 - Dec 1997.
Assisted in the development of retroviral vectors expressing tRNA-ribozymes.

3. **Ms. Daniella Ionescu**, May 1998 – June 1998.
Development of packageable multimeric hammerhead ribozymes against HIV RNA.

4. **Mr. Alan Poon**, Sept 1998 – Oct 1998.
Development of MGIN-based vectors expressing packageable ribozymes.

5. **Mr. Rikki Ranesh Bharadwaj**. Oct 1999 - Dec 1999.
Gene therapy using antisense and sense RNA based packageable ribozymes.

6. **Mr. Jeffery M Chen.** Nov 2000 - Dec 2000.
Anti-HIV gene therapy using anti-CCR5 ribozymes.

7. **Ms. Angela Moffett**. Sept - Oct 2003.
Development and testing of HIV-2 based vectors.

8. **Ms. Ayella Shams**. Aug 2005 – Sept 2005; leave of absence – is not returning.
Development of retroviral vectors expressing group II introns targeted against HIV-1 provirus DNA.

9. **Ms. Sally Tisayakorn.** Oct 2005 - Dec 2005.
Development and testing of HIV-1- and HIV-2-based vectors.

10. **Mr. Donald Bocchinfuso**. Sept 2010 - Oct 2010.
Genetic therapies using secreted proteins.

11. **Nandini Raghuram**. Sept 2011 – Oct 2011.
Development and testing of lentiviral vectors expressing secreted interfering proteins.

Indirect Supervision

1. **Mr. Hai Shiene Chen**
M.Sc., Sept 1988 - Oct 1993 (Supervisor, Dr. VL Chan).
Title: *In vitro* mutagenesis of HIV-1 RT gene.

2. **Mr. Wah-Kiam Chia**
Ph.D., Sept 1988 - Feb 1995 (Supervisor, Dr. SE Read).
Title: Cytotoxic T Lymphocyte response in AIDS patients.

3. **Mr. Hrvoje Steve Beg**
M.Sc., Sept 1989 - Oct 1993 (Supervisor, Dr. E Fish).
Title: Cytokine regulation of Cell proliferation.

4. **Ms. Esther Soto**
M.Sc., Sept 1989 - Oct 1992 (Supervisor, Dr. E Fish).
Title: T cell cytokine levels in Rheumatoid Arthritis.

5. **Ms. Susan Holi**
M.Sc., Sept 1989 - Aug 1992 (Supervisor, Dr. MG AbouHaidar).
Title: Infectious cDNA clones of plant viruses.

6. **Mr. Edward Arko**
Ph.D. student, Sept 1989 - Aug 1990 (Supervisor, Dr. VL Chan).
Title: An inexpensive rapid drug screening strategy for new anti RT compounds.

7. **Ms. Xiaoyi Li**
M.Sc., Sept 1989 - Jan 1993 (Supervisor, Dr. SE Read).
Title: Antibody dependent cellular cytotoxic response in AIDS patients.

8. **Ms. Mi-Kyung Sung**
Ph.D., Sept 1989 - Nov 1994 (Supervisor, Dr. AV Rao)
Title: The biological activity of soybean saponins and its implications in colon carcinogenesis.

9. **Mr. Hong Zheng**
M.Sc., Sept 1990 - Jan 1994 (Supervisor, Dr. B McNeil).
Title: Glycolytic gene expression in yeast.

10. **Mr. John (Jianhua) Xu**
Ph.D., Sept 1992 - Sept 1997 (Supervisor, Dr. MG AbouHaidar).
Title: Use of PAP Protein for HIV-1 gene therapy.

11. **Mr. Richard Ikegami**
M.Sc., Sept 1994 - Aug 1995 (Supervisor, Dr. MG AbouHaidar).
Title: Papaya Mosaic Potex Virus as an expression vector for foreign peptides.

12. **Ms. Alice Meng**
M.Sc., Sept 1994 - Sept 1996 (Supervisor, Dr. MG AbouHaidar).
Title: Determination of antiviral and ribosome inactivating activities of pokeweed antiviral protein.

13. Mr. Duncan Gellatly
Ph.D., Sept 1994 - 1997 (Supervisor, Dr. MG AbouHaidar).
Title: Structure-function analysis of the viroid-like satellite RNA of lucerne transient streak virus.

14. Ms. Ashkan Golshani
M.Sc., Sept 1994 – Aug 1999 (Supervisor, Dr. MG AbouHaidar).
Title: Alternative initiation of translation in *E. coli.*

15. Ms. Debbie Gurfinkel
Ph.D., Sept 1997- Dec 2003 (Supervisor, Dr. AV Rao).
Title: Dietary saponins, the relationship between chemical structure and carcinogenic activity.

16. Mr. Jodi Pongoski
Ph.D., Jan 1998 - 2002 (Supervisor, Dr. A Cochrane).
Title: *Trans*-dominant mutants of the HIV-1 Rev protein.

4. Research Training for Post-doctoral/MD research fellows

1. Dr. Hari HP Cohli, Ph.D., Feb 1991 - March 1992.
Project title: Development and testing of retroviral vectors expressing antisense RNAs to HIV-1 packaging signal and rev responsive element.

2. Dr. Chengsheng Zhang, M.D., May 1993 - April 1994.
Project title: Gene therapy using human bone marrow stem cells in "humanized" mice.

3. Dr. Mario Ostrowski, M.D., Jan 1994 - Dec 1994.
Project title: Anti-HIV-1 RT drug screening.

4. Dr. Yuri Melekhovets, Ph.D., Sept 1994 - Aug 1996.
Project title: *In vitro* evolution of anti-HIV genes.

5. Dr. Shi-Fa Ding, M.D., Ph.D., March 1995 – Aug 1998.
Project title: Further testing of retroviral vectors expressing anti-HIV genes.

6. Dr. Xue Zhong Ma, M.D., Aug 1997 – Aug 1998.
Project title: Development of MGIN-based retroviral vectors expressing packageable multimeric ribozymes targeted against HIV-1 RNA and against the CCR5 mRNA.

7. Dr. Lianna Kiriakopoulou, Ph.D., Aug 1998 – June 1999.
Project title: Development and testing of a targeted RNase.

8. Dr. Betty Lamothe, Ph.D., Sept 1999 – Dec 1999.
Project title: Development and testing of a packageable RNase.

9. Dr. Alka Arora, Ph.D., Oct 2000 – April 2004.
Project title: Further testing of MGIN- and HIV-based retroviral vectors expressing anti-HIV genes.
Fellowship: OHTN fellowship from Sept 2001 – Apr. 2004.

10. Dr. K.K. Rao, Ph.D., Feb 2004 – Dec. 2004.
Project title: Further testing of HIV-based vectors expressing anti-HIV genes.

11. Dr. Puneet Arora, Aug 2009 – Dec 2009.
Project title: Development and testing of lentiviral vectors expressing multimeric ribozymes.

12. Dr. Risha Khatri, June 2015 – Sept 2015.
Project title: Secreted bifunctional antiviral proteins for HIV gene therapy.

13. **Dr. Alexander Falkenhagen**, Jan 2017 – Dec 2017.
Project title: Secreted bifunctional antiviral proteins for HIV treatment and proteins.