Research Portfolio

Stellar Scientific Achievements:

- **Scientific discovery of the cow antibodies that are largest known to exist in a species that open doors of opportunity to develop novel drugs (against cancer, viruses and autoimmune disease), immunomodulators and vaccines.**

1. Saini, S. S., Allore, B., Jacobs, R. M. and Kaushik, A. 1999. Generation of an exceptionally long CDR3H, with multiple cysteine residues, provides a novel mechanism of antibody diversity. European Journal of Immunology. 29:2420-26.

2. Kaushik, A. 2001. Evaluation of IL-2 (Leuvectin) gene therapy. Current Opinion in Investigational Drugs. 2:976-81.

3. Ramsland, P. A., Kaushik, A., Marchalonis, J. J. and Edmunson, A. B. 2001. Incorporation of long CDR3 into V domains: Implications for the structural evolution of the antibody-combining site. Exp. Clin. Immunogenetics. 18:176-98.

4. Saini, S.S. and Kaushik, A. 2002. Extensive CDR3H length heterogeneity exists in bovine foetal VDJ rearrangements. Scandinavian Journal of Immunology. 55:140-48.

5. Kaushik, A., Shojaei, F. and Saini, S. S. 2002. Novel insight into antibody diversification from cattle. Veterinary Immunology & Immunopatholgy 87:347-350.

6. Saini, S. S., Kaushik, A., Basrur, P. and Yamashiro, S. 2003. Ultrastructural and immunological characteristics of xenogeneic hybridomas originating from bovine leukemia virus infected cattle. Veterinary Pathology. 40:460-64.

7. Shojaei, F., Saini S. S., Kaushik A. K. 2003. Unusually long germline genes contribute to the generation of exceptionally long CDR3H in bovine antibodies. Molecular Immunology 40:61-67.

8. Saini, S.S., Farrugia W., Muthusamy N., Ramsland, P. A. & Kaushik, A.K. 2007. Structural evidence for a new IgG1 antibody sequence allele of cattle. Scandinavian Journal of Immunology. 65:32-38 (Journal Cover Picture Citation).

9. Koti, M., Kataeva, G. and Kaushik, A. K. 2008. Organization of DH-gene locus is distinct in cattle. Dev. Biol. (Basel) 132:307-13.

10. Kaushik, A. K., Kehrlis Jr., M. E., Ng, S., Kurtz, A., Koti, M., Shojaei, F. Saini, S. 2009. Somatic mutations and isotype restricted exceptionally long CDR3H

contribute to antibody diversification in cattle. Vet. Immunol. Immunopathol. 127:106-13.

12. Koti, M. and Kaushik, A. K0. Novel Atypical Nucleotide Insertions specifically at Junction Generate Exceptionally Long CDR3H in Cattle Antibodies. Molecular Immunology. 47: 2119-28.

13. Koti, M., Nagy, E. and Kaushik, A. K. 2011. A single point mutation in framework region 3 of heavy chain affects viral neutralization dynamics of single-chain Fv against bovine herpes virus type-1. Vaccine. 29: 7905-12 (DOI: 10.1016/j.vaccine.2011.08.077).

14. Pasman, Y., Nagy, E., and Kaushik, A. K. 2012. Enhanced bovine herpes virus type-1 neutralization by multimerized scFvs regardless of differential glycosylation. Clinical and Vaccine Immunology. 19(8): 1150-57 (DOI: 10.1128/CVI.00130-12).

15. Pasman, Y., Bhogal, R. and Kaushik, A. K. 2013. Novel Perspective on Antibody Diversification from Bovine Immunoglobulin Genetics. Chapter 1, In: Cattle: Domestication, Diseases and Environment. (George Liu Editor), p.1-23. Nova Science Publisher Inc., New York 11788-3619, USA.

16. Koti, M., Saini, S.S., Sachan, A. and Kaushik, A. K. 2014. Engineered Bovine Antibodies in Development of New Therapeutics, Immunomodulators and Vaccines. Antibodies 3: 205-214.

17. Pasman, Y. and Kaushik, A. K. 2014. Bovine immunoglobulin genetics - a phylogenetic pers-pective. In: Comparative Immunoglobulin Genetics (A. K. Kaushik, and Y. Pasman, Editors). Apple Academic Press, Toronto, Canada. p.,187-221.

18. Aida, Y., Takeshima, S.-N., Baldwin, C. L. and Kaushik, A. K. 2015. Bovine Immunogene- tics. In: The Genetics of Cattle (Dorrian J. Garrick, and Anatoly Ruvinsky, Editors) 2nd Edition CAB International. P., 153-191.

19. Pasman, Y. and Kaushik, A. K. 2016. VH and VL domains of polyspecific IgM and monospecific IgG antibodies contribute differentially to antigen recognition and virus neutralization functions. Scandinavian Journal of Immunology. 84: 28-38.

20. Pasman, Y. and Kaushik, A. K. 2016. Exceptionally long CDR3H of bovine scFv antigenized with BoHV-1 B-epitope generates specific immune response against the targeted epitope. Molecular Immunology. 77, 113-125.

21. Pasman, Y., Daniele Merico and Kaushik, A. K. 2017. Preferential expression of IGHV and IGHD encoding antibodies with exceptionally long CDR3H and a rapid global shift in transcriptome characterizes development of bovine neonatal immunity. Developmental and Comparative Immunology. 67, 495-507.

22. Damani-Yokota P, Gillespie A, Pasman Y, Merico D, Connelley TK, Kaushik A, Baldwin C. L. 2018. Bovine T cell receptors and γδ WC1 co-receptor transcriptome analysis during the first month of life. Dev Comp Immunol. 88:190-199. (doi: 10.1016/j.dci.2018.07.023)

❖ **Discovery of Cow Mega-bodies for Next Generation Therapeutics:**

- Research Highlight and Interview, 'Mega-antibodies: next-generation therapeutics' in in the journal 'International Innovation', 2014,161:94-95 (www.internationalinnovation.com); Youtube: https://youtu.be/m6VBJJF2BjU (CTV Kitchener news).
- Development of anti-viral antibody based drugs that prevent bovine respiratory disease in cattle

1. Koti, M., Farrugia, W., Nagy, E., Ramsland, P.A., Kaushik, A.K. 2010. Construction of single- chain Fv with two possible CDR3H conformations but similar inter-molecular forces that neutralize bovine herpes virus I. Mol. Immunol. 47: 953-960.

2. Koti, M., Nagy, E. and Kaushik, A. K. 2011. A single point mutation in framework region 3 of heavy chain affects viral neutralization dynamics of single-chain Fv against bovine herpes virus type 1. Vaccine. 29: 7905-12.

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Research Discoveries

- Development of novel cow antibody based vaccines and drugs
- Discovery of unique antibodies with an exceptionally long CDR3H in cattle antibodies.
- Novel genetic elements encoding antibodies
- Novel mechanisms of antibody diversification
- Origin of autoantibodies in natural autoimmunity and systemic autoimmune disease Research Applications
- Development of scFv capable of virus neutralization
- Development of new vaccines via antigenization of scFvs

Research Profile

I have an internationally recognized established research program focused on fundamental aspects of humoral immunity in health and disease consistently supported by NSERC Discovery, equipment and OMAFRA research grants since 1992. Specifically, my research is focused on understanding autoimmunity and systemic autoimmune disease and dissecting immunoglobulin genetics aimed at developing next generation of antibody-based immunotherapeutics and vaccines. My research contributions in the field include: 2 Books, 88 Peer-reviewed Research articles and book chapters, 4 patents (plus 1 applied) and 106 invited or research presentations at conferences. Some of my published research is cited in the immunology textbooks. My early research led to identification of genetic elements encoding autoantibody that for the first time demonstrated that the same genetic elements that defended host against harmful agents encoded pathogenic autoantibodies involved in systemic autoimmune disease, for example, Lupus. This school of thinking that influenced the field of autoimmunity, from 'horror autotoxicus' to physiological autoreactivity, and is outlined in the book Molecular Immunobiology of Self-Reactivity published in 1992 by Marcel Dekker Inc., New York, USA. This led my research to focus on understanding the construction of primary antibody repertoire in health and disease. Apart from identifying new genetic elements, my studies of variable kappa genes in mice broke the prevailing dogma of accessibility-related variable gene expression. I showed enormous plasticity in the construction of primary antibody repertoire because of stochastic heavy and light chain pairing, though exceptions exist. Further, my laboratory demonstrated that a higher expression of kappa light chains in mice resulted, in part, from counter selection of lambda light chains to limit self- reactivity in the primary antibody repertoire. At terminal autoimmune disease state, my laboratory showed that pathogenic IgM autoantibodies had unique structural features in mice, consistent with clonal selection but without somatic mutations. My laboratory further demonstrated that the threshold of B-cell selection during ontogeny influenced the generation of pathogenic IgM autoantibodies involved in the pathogenesis of systemic autoimmune disease. My seminal contributions on the origin of pathogenic IgG and IgM autoantibodies in systemic autoimmune disease have had profound implications on developing therapeutic approaches and disease management strategies targeting B-lymphocytes.

I extended the studies on construction of humoral immune system to cattle that led us to identify and classify the genetic elements encoding bovine antibody. My laboratory has the world lead in bovine immunoglobulin genetics where I am recognized internationally as an expert in the field, for example, IMGT Expert (International Immunogenetics Information System, France; http://www.imgt.org/IMGTindex/ IMGTexperts.php), Curator, Comparative Immunoglobulin Workshop (http://www.healthcare.uiowa.edu/ cigw/animals/cow.htm Univ. of Iowa, USA). My laboratory discovered that some bovine antibodies are the largest known to exist in any species because of an exceptionally long CDR3H, called Megabodies, generated by recombination of unique genetic elements (longest DH gene) involving novel antibody diversification mechanisms. The exceptionally long CDR3H of these antibodies generates a unique antigen-binding site with structural features resulting in atypical conformational diversity. This seminal discovery has gained attention throughout the world and has spurred research for developing new therapeutics using the unique structural features of the antigen-combining site generated by large sized CDR3H. These

advances in knowledge are outlined in my book, Comparative Immunoglobulin Genetics published in 2014 by Apple Academic Press, CRC Press, New Jersey USA. This discovery was highlighted as Mega-antibodies: next-generation therapeutics in the journal 'International Innovation' in 2014. I have now developed for the first-time transcriptome reference signatures of immunocompetence in the bovine newborn, which is relevant to developing neonatal vaccination strategies. I also show that antibodies with exceptionally long CDR3H play an important role in the acquisition of neonatal humoral immunity in cattle.

I extended the knowledge gained from bovine immunoglobulin genetics to its application in developing next generation of antibody-based immunotherapeutics and vaccines. My laboratory developed the first bovine antibody fragment, called scFv (single chain fragment variable), capable of neutralizing bovine herpes virus type-1 (BoHV-1) and enhanced its viral neutralizing potency by multimerizing it. This provides first antibody fragment based anti-viral drug against an important cattle pathogen. My laboratory recently showed 'proof of concept' of developing antibody fragment-based next generation of vaccines by exploiting the exceptionally long CDR3H of bovine antibody.

To conclude, research contributions of my laboratory have led to the following research advances and applications:

• Origin of autoantibodies in natural autoimmunity and systemic autoimmune disease• Skewed development of primary antibody repertoire in systemic autoimmune disease

• Discovery of unique antibodies with an exceptionally long CDR3H in cattle.

• Identification of new and unique genetic elements encoding bovine antibodies

• Novel mechanisms of antibody diversification• Development of bovine antibody fragment capable of virus neutralization

• Development of new bovine antibody fragment based vaccines via antigenization

Patents:

- "Novel bovine VDJ cassette, BF1H1, suitable for antigenization", U.S. Patent, No. 6,740,747, Granted 2004.
- "Bovine D-genes and their application", US patent No. 7,196,185, Granted 2007.• "Development of neutralizing ScFvs against Bovine Herpes Virus type-1 for prevention, therapy and diagnosis of Infectious Bovine Rhino-tracheitis"o PCT International Patent Application filed July, 2008o US Patent No. 8,383,115 B2 Granted February 26, 2013o Canadian Patent No. CA 2693137, Granted October 29, 2013
- Pasman Y, Kaushik AK. 2015. Antigenized single chain variable fragments and methods and uses thereof. Application: US Patent Office under serial number: 62/252937.

Books, Publications, Abstracts and Presentations:

Books:

1. Bona, C. and A. K. Kaushik (1992). Molecular Immuobiology of Self-Reactivity. Marcel Dekker, Inc.: New York, USA; Basel, Switzerland. (Reviewed by: H. Schroeder. Immunology Today, 1992. 13:423- 24).

2. Kaushik, A. and Pasman, Y. 2014. Comparative Immunoglobulin Genetics. Apple Academic Press, Toronto, Canada.

Book Chapters:

1. Pandey, R. and Kaushik, A. 1980. Buffalopox an emerging pox zoonoses. Proc. Intl. Congr. Dis. Cattle. 2:1526-28.

2. Mayer, R., Zaghouni, H., Kaushik, A., Kasturi, K., Fidanza, V. and Bona, C. 1990. The expression of Ly-1 and Ig-V gene families in hybridomas producing autoantibodies of various specificities. In: Molecular Aspects of Autoimmunity (Farid, N. and Bona, C., Editors) Academic Press, San Diego, p.1-27.

3. Goidl, Edmond A., McEvoy, Susan J. Martin, Bonilla, Francisco, Kaushik, A. and Bona, Constantin A. 1990. Regulation of the Expressed Idiotypic Repertoire in the Normal Immune Response of the Aged. In: Biomedical Advances in Aging (Allan L. Goldstein, Editor). Plenum Press, New York, USA. p. 413 - 24.

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6. Kaushik, A. and Bona, C. 2002. Genetic origin of murine autoantibodies. In: Molecular Pathology of Autoimmune Disease (Theofilopoulos, A. N. and Bona, C. A. Editors) 2nd edition, Taylor and Francis Publishers, New York, USA, p. 53-67.

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8. Pasman, Y. and Kaushik, A. K. 2014. Bovine immunoglobulin genetics - a phylogenetic perspective. In: Comparative Immunoglobulin Genetics (A. K. Kaushik, and Y. Pasman, Editors). Apple Academic Press, Toronto, Canada. p.,187-221.

9. Aida, Y., Takeshima, S.-N., Baldwin, C. L. and Kaushik, A. K. 2015. Bovine

Immunogenetics. In: The Genetics of Cattle (Dorrian J. Garrick, and Anatoly Ruvinsky, Editors). 2nd Edn. CAB International. p.,153-191.

Peer Reviewed Journal Articles:

10. Kaushik, A. and Pandey, R. 1980. Cellular and humoral immune responses to buffalopox virus in experimentally infected mice and rabbits. Immunology 41:153-158.

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Other Articles:

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2. Srivastva, R., Kaushik, A. and Prasad, S. Micro-ELISA for detection of Marek's disease virus antibodies in vaccinated flocks. 8th Annual Meeting of Indian Immunology Society, Bombay, November 21-23, 1981.
3. Srivastva, R., Kaushik, A. and Prasad, S. Prevalence of rotavirus antibody among cattle in India. 9th. Annual Meeting of Indian Immunology Society, New Delhi, October 30-31, 1982.
4. Kaushik, A., Grover, Y. and Pandey, R. Immunity to buffalopox virus. 6th Intl. Congr. Virol. Sendai, Japan, September 1-7, 1984.
5. Kaushik, A., Poncet, P. and Bussard, A. Anti-bromlainized mouse erythrocyte autoantibody idiotype: strain distribution. 7th European Immunology Meeting, Jerusalem, Israel, September 8-13, 1985.

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50. Koti, M., Nagy, E. and Kaushik, A. K. Single point mutation in FR3 of engineered scFv affects viral neutralization without loss of epitope specificity. 21st Annual Meeting of the Canadian Society for Immunology. Mont-Tremblant, Quebec, April, 2008.
51. Koti, M., Kataeva, G. and Kaushik, A. K. 2008. Organization of DH-gene locus is distinct in cattle. Animal genomics for Animal Health Paris, France. (M. H. Pinard, C. Gay, P.P. Pastoret and B. Dodet; Dev. Biol. (Basel) 132:307-13).
52. Pasman, Yfke, Saini, Surrinder, Smith, Elspeth and Kaushik, Azad. 2010. Organization of bovine lambda light chain locus. 23rd Canadian Society for Immunology Meeting, Niagra Falls, Ontario (April 23- 26, 2010).
53. Pasman, Yfke, Nagy, Eva and Kaushik, Azad. 2010. Monomeric and multimerized scFv neutralize bovine herpes virus-1. 23rd Canadian Society for Immunology Meeting, Niagra Falls, Ontario (April 23- 26, 2010).
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58. Pasman, Yfke, Saini, Surrinder, Smith, Elspeth and Kaushik, Azad. 2010. Restricted Vλ1-Jλ3-Cλ3 recombinations encode the most λ-light chain repertoire in cattle. 9th International Veterinary Immunology Symposium, Tokyo, Japan (August 16-20, 2010).
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60. Pasman, Yfke, and Kaushik, Azad. 2011. Functional scFvs against bovine herpesvirus-1 show differential cleavage and glycosylation patterns. 98th AAI Meeting, San Francisco, USA (May 13-17, 2011)
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pastoris. 24th Canadian Society for Immunology Meeting, Chateau lake Louise (April 8-11, 2011).

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64. Kaushik, A. K. 2012. Functional aspects of single chain Fv and its multimers against Bovine Herpes Virus-1. Antibody Design and Discovery Conference, June 7-8, 2012, San Diego, USA (Distinguished Speaker).
65. Pasman Yfke, Nagy, Eva and Azad Kaushik. 2013. Recognition and neutralization of bovine herpesvirus-1 by bovine antibody variable heavy- and light-chain domains. American Association for Immunologists, Annual meeting Honolulu Hawaii U.S.A (May 2-7, 2013); J Immunol 2013 190:48.1.
66. Pasman Yfke and Azad Kaushik. 2013. Elucidating the role of bovine heavy- and light-chain variable domains in polyspecific antigen-binding. American Association for Immunologists, Annual meeting Honolulu Hawaii U.S.A (May 2-7, 2013); J Immunol 2013 190:141.15.
67. Yfke Pasman and Azad K. Kaushik. 2013. Antigenization of bovine immunoglobulin variable regions for development of novel vaccines. 15th International Congress of Immunology Milan Italy (August 22- 27, 2013);http://www.frontiersin.org/MyFrontiers/Events/AbstractDetails.aspx?ABS_DOI=10.3389/conf.fim mu.2013.02.01176 (Invited presentation).
68. Yfke Pasman and Azad K. Kaushik. 2013. Polyspecific antigen binding by bovine immunoglobulin heavy- and light-chain variable domains. 15th International Congress of Immunology Milan Italy (August 22-27, 2013);http://www.frontiersin.org/MyFrontiers/Events/AbstractDetails.aspx?ABS_DOI=10.3389 /conf.fimmu.2013.02.01177
69. Yfke Pasman and Azad K. Kaushik. 2013. Polyspecific antigen binding by individual bovine immunoglobulin heavy- and light chain variable domains. 10th International Veterinary Immunology Symposium, Milan Italy. (August 28 – September 1, 2013).
70. Yfke Pasman and Azad K. Kaushik. 2013. Bovine Herpesvirus-1 epitope grafting onto bovine immunoglobulin CDR3H to induce protective immunity. 10th International Veterinary Immunology Symposium, Milan Italy. (August 28 – September 1, 2013).
71. Azad K. Kaushik. 2014. Engineering bovine antibodies to develop novel therapeutics and vaccines. 6th Annual International Congress of Antibodies 2014. Dalian, China. (April 25 - 28, 2014).
72. Pasman Yfke and Azad Kaushik. 2014. Differential contribution of variable heavy and variable light chain domains in viral epitope recognition and neutralization function. Immunology 2014. American Association for Immunologists, Annual meeting

Pittsburgh, U.S.A (May 2-6, 2014); J Immunol 2014 192:140.11.

73. Pasman Yfke, Daniele Merico and Azad Kaushik. 2015. Differentially expressed immune related genes in bovine neonatal development. American Association for Immunologists, Annual meeting New Orleans, U.S.A (May 2-6, 2014); J Immunol 2015 194:146.2.
74. Pasman Yfke, Daniel Merico and Azad Kaushik. 2015. Differentially expressed immune related genes in bovine neonatal development. American Association for Immunologists, Annual meeting New Orleans, U.S.A (May 2-6, 2015); J Immunol 2014 194:146.2 (Invited Block presentation).
75. Azad Kaushik and Pasman Yfke. 2016. Functional differences exist in contribution of V_H and V_L from polyspecific IgM and monospecific IgG antibodies in antigen recognition and virus neutralization functions. American Association for Immunologists, Annual meeting, Seattle, USA (May 13-17, 2016) [J Immunol 2016 196:216.2].
76. Azad Kaushik, Pasman Yfke and Daniele Merico. 2016. IGHV and IGHD encoding antibodies with exceptionally long CDR3H are predominant in the bovine neonatal B cells. American Association for Immunologists, Annual meeting, Seattle, USA (May 13-17, 2016). [Journal of Immunology 2016. 196: (1 Supplement) 77.2].
77. Pasman Yfke and Azad Kaushik. 2016. VH and VL from polyspecific IgM and monospecific IgG antibodies contribute differentially to antigen recognition and virus neutralization function. 16th International Congress of Immunology (August 21-26, 2016), Melbourne. Australia (Eur. J. Immunol. 2016. 46(Suppl.1): 801).
78. Pasman Yfke and Azad Kaushik. 2016. Exceptionally long CDR3H of bovine scFv antigenized with BoHV-1 B-epitope generates specific immune response against the targeted epitope. 16th International Congress of Immunology (August 21-26, 2016), Melbourne. Australia (Eur. J. Immunol. 2016. 46(Suppl.1): 1100).
79. Pasman Yfke, Daniele Merico and Azad Kaushik. 2016. IGHV and IGHD encoding antibodies with exceptionally long CDR3H are most expressed at birth in the bovine neonate. 16th International Congress of Immunology (August 21-26, 2016), Melbourne. Australia (Eur. J. Immunol. 2016. 46(Suppl.1): 871).
80. Yfke Pasman, Daniele Merico and Azad K. Kaushik. 2016. Exceptionally long CDR3H of bovine scFv provides a suitable scaffold for antigenization with conformational B-epitope capable of inducing specific immune response. 11th International Veterinary Immunology Symposium (August 16- 19, 2016), Gold Coast, Australia.
81. Yfke Pasman and Azad K. Kaushik. 2016. Development of bovine humoral neonatal immunity is characterized by predominant expression of IGHV and IGHD encoding antibodies with exceptionally long CDR3H. 11th International Veterinary Immunology Symposium, Milan Italy (August 16-19, 2016). Gold Coast, Australia.
82. Kaushik, A. K. 2016. 'Exceptionally long CDR3H of bovine scFv antigenized with BoHV-1 B-epitope generates specific immune response against the targeted epitope (Session speaker), 2nd International Conference on Antibodies and Therapeutics (July 11-12, 2016), Philadelphia, USA.
83. Damani-Yakota, P., A. Kaushik, J.C. Tefler and C.L. Baldwin. 2016. Variegated gene expression of WC1, a hybrid PRR/Co-receptor on single-cell memory γδ T cell clones.

U.K.

Distinguished Invited Lectures:

84. Peritoneal B cell and autoimmunity' Round Table Conference on Autoimmunity, Pasteur Institute, Paris, June 1987.
85. Vh11: a new murine gene family. University of Texas Medical Branch, Galveston, Texas 77550, April 1988.
86. Idiotype and structure of autoantibodies reactive with bromelain treated red blood cells. Mount Sinai School of Medicine, New York, May, 1988.
87. 'Molecular analysis of natural autoantibodies'. National Institute of Immunology, New Delhi, September 1988.
88. Phenomenon of autoimmunity, University of Missouri, Columbia, February 1990.
89. Construction of immunoglobulin repertoire, University of Geneva Medical School, Geneva, September 1990.
90. Idiotype: Concepts and Applications. University of Guelph, Guelph, 1991.
91. Construction of antibody repertoire. University of Guelph, Guelph, 1992.
92. B lymphocyte, Immunodeficiency and Autoimmunity, Mount Sinai School of Medicine, New York, December 1994.
93. Molecular immunobiology of self reactive autoantibodies, Molecular biology 1995 Conference, San Diego, 1995.
94. CDR3H length in health and disease, Oklahoma Medical Research Foundation, Oklahoma City, 1997.
95. Current perspectives on B-1 lymphocytes and immune response, International Centre of Genetic Engineering and Biotechnology, New Delhi, 1998.
96. 'Novel insight through bovine immunoglobulin genes', Department of Molecular Biology, University of Guelph, 1999.
97. Of mice, cattle and antibodies, Ohio State University Children's Hospital, February 2001.
98. Novel insight into antibody diversification from cattle. International Veterinary Immunology, Symposium, Uppsala, Sweden, July 2001.
99. Bovine Antibody gene Technology in Health and Disease, Angenics, University of Guelph, Guelph, November, 2001.
100. Bovine Antibody Transgenesis, Albert Einstein College of Medicine, New York, USA, 2004.
101. The dogma of cattle antibody', Institute for Molecular Biology and Biotechnology, Vrije Universiteit Burssel, Burssel, Belgium, October, 2005.
102. Immunoglobulin genetics, Round Table Meeting, INSERM Unit, L'Eclole the Medicine, Paris, France, February, 2006.
103. Antibodies: Structure, Function and Application. South Dakota State University, Brookings, USA, November 2, 2007.
104. Translational aspects of bovine antibodies in animal health. Ontario Ministry of Agriculture and Food, Guelph, Ontario, Canada, November 28, 2007.
105. Bovine antibody genetics in health and disease, IMGT, CNRS, Universite Montpellier 2, Montpellier, France, February 2010.

106. Functional aspects of single chain Fv and its multimers against Bovine Herpes Virus-1, Antibody Design and Discovery Conference, June 7-8, 2012, San Diego, USA (Distinguished Speaker).
107. Novel structural and functional aspects of bovine antibody suitable for engineering new anti- viral drugs and vaccines. Faculty of Veterinary Medicine, Lala Lajpat Rai University of veterinary and Animal Science, Hisar, India, May, 2014.
108. Cow Megabodies for Better Human Health, National Academy of Agricultural Sciences, New Delhi, India, January, 2015.
109. Exceptionally long CDR3H of bovine scFv antigenized with BoHV-1 B-epitope generates specific immune response against the targeted epitope (Session speaker), 2nd International Conference on Antibodies and Therapeutics (July 11-12, 2016), Philadelphia, USA.

Research Citations in Text Books:

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