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Education

Ph.D. Mathematics, University of Missouri, 2009
Thesis Title: *Mathematical Problems from Cryobiology*,
Advisors: Carmen Chicone, Department of Mathematics and John Critser, Department of Veterinary Pathobiology
B.S., Mathematics, Purdue University, 2001

Research Interests

Mathematical Biology, Cryobiology, Optimization

Appointments

National Research Council/NIST Postdoctoral Associate, Mathematical and Computational Sciences Division, National Institute of Standards and Technology, 2009-present

Research Assistant, Departments of Mathematics and Veterinary Pathobiology, University of Missouri, 2002- 2009

Graduate Teaching Assistant, Department of Mathematics, University of Missouri, 2002-2009

Summer Research Student, Cryobiology Research Institute, Indiana University School of Medicine. Dr. John Critser, Advisor. Summers of 1994-1998, 1997 excluded.

Summer Research Assistant, *Washington University*. David Benson, Mentor. Research focused on collection of field samples from Ptarmigan in Glacier National Park, 1997

Awards and Honors

Peter L. Steponkus Crystal Award, awarded yearly for best student research and presentation at the annual Society for Cryobiology meeting, 2008

Featured as one of four outstanding graduate students in the graduate school advertising brochure, "Faces of Mizzou," 2008

Donald K. Anderson Graduate Research Award, University of Missouri campus wide award for the best graduate student research, 2007

Student Travel Award, 41st Annual Meeting of the Society for Cryobiology, 2004

Professional Affiliations and Service

Appointed to Editorial Board for *CryoLetters* Journal, 2008-present

Society for Cryobiology

Society for Industrial and Applied Mathematics

Publications

1. Analytic time optimal boundary control of the diffusion equation with applications in cryobiology. (with AJ Kearsley) *In preparation*.
2. Optimal control of a coupled heat and mass transfer model with applications in rapid freezing of tissues. (with AJ Kearsley) *In preparation*.
3. On the choice of cryoprotectant toxicity cost functionals for a state constrained cellular mass transport optimal control problem. (with AJ Kearsley) *In preparation*.
4. Identification and minimization of a toxicity cost function for the optimal addition and removal of cryoprotectants. (with AZ Higgins and AJ Kearsley) (*In review: Biotechnology and Bioengineering*).
5. Analytical optimal controls for the state constrained addition and removal of cryoprotective agents. (with CC Chicone and JK Critser) (*In review: Bulletin of Mathematical Biology*)
6. Mathematical model formulation and validation of water and cryoprotective agent transport in whole hamster pancreatic islets. (with CT Benson and JK Critser) (*In review: Journal of Biomechanical Engineering*)
7. A calorimetric method to measure water-cryoprotectant mutual diffusivity in biological tissues at both super- and sub-zero temperatures. (with X Han, Y Liu, JK Critser) (*In review: Int. J. Heat and Mass Transfer*).
8. Stability analysis of several non-dilute multiple solute transport equations. (*In press: Journal of Mathematical Chemistry*).
9. A general model for the dynamics of cell volume, global stability, and optimal control. (with CC Chicone and JK Critser) (*In press: Journal of Mathematical Biology*).

10. Melting point equations for the ternary system water-sodium chloride-ethylene glycol revisited. (with A Bagchi, X Han, JK Critser, EJ Woods) (*In press: Cryobiology*).
11. MEMS-based Coulter counter for cell counting and sizing using multiple electrodes (with Y Wu, JK Critser, M Almasri.). *J. Micromech. Microeng.* **20**, 085035. 2010.
12. Note: Microelectromechanical systems Coulter counter for cell monitoring and counting (with Y Wu, JK Critser, M Almasri). *Review of Scientific Instruments.* **81**, 076103. 2010.
13. Measurement of the apparent diffusivity of ethylene glycol in mouse ovaries through rapid MRI and theoretical investigation of cryoprotectant perfusion procedures (with X Han, L Ma, A Brown, JK Critser). *Cryobiology.* **58** (3), 2009.
14. Osmotic Tolerance Limits and Membrane Permeability Characteristics of Stallion Spermatozoa Treated with Cholesterol (with AI Glazar, SF Mullen, J Liu, JK Critser, EL Squires, JK Graham). *Cryobiology.* **59** (2), 2009.
15. Osmotic characteristics and fertility of murine spermatozoa collected in different solutions (S Wei, H Men, JK Critser). *Reproduction,* **137**, 215-223, 2009.
16. *The History of Sperm Cryopreservation (with Walters E.M., Woods E., Critser J.K.). *In: A Practical Guide to Sperm Banking.* Ed: Allan Pacey and Matthew Tomlinson. 2009.
17. MEMS based Coulter counter for cell sizing (with M Korampally, Y Wu, JK Critser, M Almasri). *In: Proceedings of SPIE: Microfluidics, BioMEMS, and Medical Microsystems VI.* 22 January 2008, San Jose, CA, Vol. 6886, p 68860A
18. Development of a micro-scale differential scanning calorimeter for single cell measurements (with WG Zhao, GL Solbrekken, SF Mullen, X Han, JK Critser). *In: Proceedings of HT2007: 2007 ASME-JSME Thermal Engineering Summer Heat Transfer Conference.* July 8-12, 2007, Vancouver, British Columbia, Canada. Paper number HT2007-321555.
19. Improved cryopreservation methods for a mouse embryonic stem cell line. (with CM Kashuba Benson, JK Critser). *Cryobiology.* **56** (2) 2008.
20. Osmotic tolerance limits and effects of cryoprotectants on the motility, plasma membrane integrity and acrosomal integrity of rat sperm (with S Wei, H Men, JK Critser). *Cryobiology.* **53** (3), 336-348. 2006.
21. Mercury free operation of a Coulter Counter Multisizer II sampling stand (with MA Haidekker, CM Kashuba Benson, JK Critser). *Cryobiology.* **51** (3), 344-7. 2005.
22. Exact solutions of a two parameter flux model and cryobiological applications (with CC Chicone and JK Critser). *Cryobiology* **50** (3), 308— 316. 2005.
23. Fundamental cryobiology of reproductive cells and tissues (with EJ Woods, Y Agca, JK Critser). *Cryobiology.* Apr, **48** (2), 146-56. 2004.
24. *Fundamental Cryobiology (with JK Critser). *In: Proceedings of a Workshop on Transporting Gametes and Embryos.* (2004) Havermeier Monograph Series No. 12. Suffolk, UK.

25. Effects of Percoll separation, cryoprotective agents, and temperature on plasma membrane permeability characteristics of murine spermatozoa and their relevance to cryopreservation (with MJ Phelps, J Liu, CE Willoughby, JA Gilmore, JK Critser). *Biol Reprod.* **61** (4), 1031-41. 1999.
26. Hydraulic conductivity (L_p) and its activation energy (E_a), cryoprotectant agent permeability (P_s) and its E_a , and reflection coefficients (σ) for golden hamster individual pancreatic islet cell membranes (with CT Benson, C Liu, DY Gao, ES Critser, JK Critser). *Cryobiology.* **37** (4) 290-9. 1998.

*Not peer reviewed

Invited Presentations

- Basic principles of sperm cryopreservation. (2010) *ESHRE Sperm and testicular banking* course, Grenada, Spain.
- Mathematical problems from cryobiology. (2010) *George Mason University*. Applied and Computational Mathematics seminar series.

Conference Presentations and Abstracts

1. Exact and numerical boundary control of the diffusion equation in cryobiology (with AJ Kearsley). Presented at the *47th Annual Meeting of the Society for Cryobiology*. Bristol, United Kingdom, 2010. Abstract to be published in *Cryobiology*.
2. Stability analysis of several non-dilute multiple solute cellular mass transport equations (with AJ Kearsley). Presented at the *17th Annual NIST Sigma Xi Postdoctoral Poster Session*. Gaithersburg, MD. 2010.
3. Optimal control of cryoprotective agent addition and removal protocols (with CC Chicone, JK Critser). Presented at the *46th Annual Meeting of the Society for Cryobiology*. Sapporo, Japan, 2009. Abstract published in *Cryobiology*, **59**, (3) 2009.
4. Cholesterol-loaded methyl- β -cyclodextrin improves boar spermatozoa cryoprotectant addition and removal tolerance (with EM Walters (Presenter), A Reike, JK Graham, JK Critser). Presented at *45th Annual Conference of the IETS*. San Diego, CA. Abstract published in *Reproduction, Fertility and Development*. **21** (1), 140-141, 2008.
5. The cryobiological implications of fluid velocity and advection-diffusion (with CC Chicone, JK Critser). *45th Annual Meeting of the Society for Cryobiology*. Charlotte, NC, USA, 2008. Abstract published in *Cryobiology*, **57**, (3) 2008.
6. Measurement of apparent cryoprotectant diffusivity through rapid MRI and theoretical development of cryoprotectant perfusion procedures (X Han (Presenter), L Ma, A Brown,

- JK Critser). *45th Annual Meeting of the Society for Cryobiology*. Charlotte, NC, USA, 2008. Abstract published in *Cryobiology*, **57**, (3) 2008.
7. Melting point equations for the ternary system water-sodium chloride-ethylene glycol revisited (with EJ Woods (Presenter), A Bagchi, X Han, JK Critser). *45th Annual Meeting of the Society for Cryobiology*. Charlotte, NC, USA, 2008. Abstract Published in *Cryobiology*, **57**, (3) 2008
 8. An improved cryopreservation method for the R1 embryonic stem cell line (with CMK Benson (Presenter) and JK Critser). *44th Annual Meeting of the Society for Cryobiology*. Banff, Canada, 2007. Abstract published in *Cryobiology*, **55**, (3) 2007
 9. Coulter Counter data reduction and parameter estimation (with JM Gallia, CC Chicone, JK Critser). *43rd Annual Meeting of the Society for Cryobiology*. Hamburg, Germany, 2006. Abstract Published in *Cryobiology*, **53** (3) 2006.
 10. Improved cryopreservation methods for mouse embryonic stem cell lines (with CMK Benson (Presenter), JK Critser). *43rd Annual Meeting of the Society for Cryobiology*. Hamburg, Germany, 2006. Abstract Published in *Cryobiology*, **53** (3) 2006.
 11. Comparison of membrane permeability characteristics of multiple mouse embryonic stem cell lines (with CK Benson (Presenter), JK Critser). *42nd Annual Meeting of the Society for Cryobiology*. Minneapolis, MN, 2005. Abstract Published in *Cryobiology*, **51** (3) 2005.
 12. Theoretical Optimization of CPA addition and removal strategies (with CC Chicone, JK Critser). *42nd Annual Meeting of the Society for Cryobiology*. Minneapolis, MN, 2005. Abstract Published in *Cryobiology*, **51** (3) 2005.
 13. Implicit and Exact solutions of a two parameter solute solvent flux model (with CC Chicone, JK Critser). *41st Annual Meeting of the Society for Cryobiology*. Beijing, China, 2004. Abstract Published in *Cryobiology*, **49** (3) 2004.
 14. Comparison of membrane permeability characteristics for mouse embryonic stem cell lines (with CK Benson, Y Agca, JK Critser). *41st Annual Meeting of the Society for Cryobiology*. Beijing, China, 2004. Abstract Published in *Cryobiology*, **49** (3) 2004.
 15. Water and solute permeability of human cord blood endothelial progenitor cells (with E.J Woods, L. Mead, D. Ingram, M. Yoder, J.K. Critser). *41st Annual Meeting of the Society for Cryobiology*. Beijing, China, 2004. Abstract Published in *Cryobiology*, **49** (3) 2004.
 16. "Solvent and solute chemical potential and theoretical constraints on the osmotic virial equation" (with C. Chicone, J. A. W. Elliott and J. K. Critser), *First Annual Meeting Extreme Cryobiology*, Edmonton, AB, January 30-31, 2004 abstract published in *Cell Preservation Technology* 2(3), 236 (2004).
 17. Murine Spermatozoa Cryopreservation: Development of a Defined Cryoprotectant Medium. (with Woods EJ (Presenter), Liu J, Agca Y, Gilmore J, Critser JK). *36th Annual Meeting of the Society for Cryobiology*. Marseille, France, 1999. Abstract Published in *Cryobiology*, **39** (6), 284-285, 1999.

18. Water Permeability (L_p) and its activation energy (E_a), cryoprotectant permeability (P_s) and its E_a , and reflection coefficients (σ) for golden hamster individual pancreatic islet cell membranes (with Benson CT (Presenter), Liu C, Gao DY, Critser ES, Critser JK). *33rd Annual Meeting of the Society for Cryobiology*. Indianapolis, IN, 1996. Abstract Published in *Cryobiology*, **33** (6) 1996.
19. Effects of Percoll Preparation on the Hydraulic Conductivity of Murine Spermatozoa (Willoughby CE, Mazur P, Critser JK). *33rd Annual Meeting of the Society for Cryobiology*. Indianapolis, IN, 1996. Abstract Published in *Cryobiology*, **33** (6) 1996.

Local Presentations, Lectures, and Panels

1. Modeling and optimization in cryobiology. *Applied and Computational Mathematics Division Seminar Series*. NIST, 2010.
2. Cryobiology: The how and why of freezing cells. *NIST Take our Daughters and Sons to Work Day*. 4-half hour lectures to elementary school children. NIST, 2010.
3. Mathematical Problems in Cryobiology. *Department of Mathematics Graduate Student Seminar*. University of Missouri, 2008.
4. Mathematics and Cryobiology. *MU Graduate School Adventures in Education*, University of Missouri, 2008. (An event exposing children to graduate research).
5. Cryobiology is a convergence of fields in the university setting. *Keynote-MU Graduate Professional Council Missouri Legislator Awards Event*. University of Missouri, 2008.
6. What we can freeze from the body and why: a historical, physical and mathematical introduction. *MU Body Project 2008* (Interdisciplinary conference for MU Graduate students). University of Missouri, 2008.
7. *Panel Member for "Tips on Surviving (and Succeeding in) Graduate School,"* University of Missouri-Columbia, 2007.
8. *Panel Member for "Surviving Graduate School: The Graduate Student Perspective,"* University of Missouri-Columbia, 2007.
9. Mathematics and Cryobiology. *MU Graduate School Adventures in Education*, University of Missouri, 2007. (An event exposing children to graduate research).
10. Mathematical Optimization of CPA Addition and Removal Strategies. *Department of Mathematics Graduate Student Seminar*. University of Missouri-Columbia, 2005.
11. FUN-damentals of Cryobiology. *Lecture for Veterinary Pathobiology Reproductive Biology Seminar Series*. University of Missouri-Columbia, 2004.

Classroom Teaching

Multivariate Calculus Instructor

Finite Mathematics Independent Study Instructor

Finite Mathematics Instructor, 2 semesters.

Introductory Algebra Instructor, 5 semesters.

Mentoring

Directly mentored four students participating in an eight-week long Biosystems Research Experience for Undergraduates in Engineering.

Claire Schulkey—Was convinced by the experience to pursue a graduate degree in mathematics at Washington University at St. Louis. 2007

Sarah Rodda—Worked on numerical optimization of CPA addition and removal schemes. 2007

Jason Gallia— Was convinced by the experience to pursue a graduate degree in computer science at Binghamton University. 2006

Professional Development and Leadership:

Co-chair "*Biophysics of Cryobiology*" session. *47th Annual Meeting of the Society for Cryobiology*. Bristol, United Kingdom, 2010.

Organizer of Departmental Graduate Student Seminar. Fall 2008.

Entering Mentoring 8-Week Workshop on mentoring in undergraduate research, Office of Undergraduate Research, University of Missouri-Columbia, 2007

Committee Member, Society for Cryobiology Annual meeting Peter J. Steponkus Crystal Award committee, 2007.

Mathematical aspects of computational biology (Two Week Workshop), Mathematical Sciences Research Institute, Berkeley, CA 2006

National Science Foundation Grant Writing Workshop, Cryobiology Conference 2005, University of Minnesota.

University of Missouri Animal Care and Use Committee Laboratory Mouse Handling Workshop, 2003.

University of Missouri Animal Care and Use Committee Laboratory Rat Handling Workshop, 2003.

Teaching Workshop, 2-Week workshop on teaching mathematics to undergraduates, Department of Mathematics, University of Missouri-Columbia, 2002

Mentoring Development Course: Semester long course on mentoring. Purdue University, 2001.

References

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Additional References Available Upon Request