

Jill A. Gallaher

Applied Research Scientist

Department of Mathematical Oncology

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EDUCATION

April 2010	Ph.D. Biomedical Physics <i>Thesis: Ion Traffic Across Cellular Membranes.</i>	East Carolina University Greenville, NC
May 2004	B.S. Physics <i>Concentration in biophysics, minor in Spanish.</i>	University of Missouri Columbia, MO

AWARDS

December 2017	\$10K Moffitt Physical Science-Oncology Centers Pilot Project grant: Investigating phenotypic and microenvironmental mechanisms for immunotherapy response.	
December 2013	\$50K winning team grant from Moffitt Cancer Center Integrated Mathematical Oncology workshop on Personalized Medicine: A real-time adaptive treatment platform to extend survival in lung cancers with epidermal-growth factor (EGFR) mutation.	
November 2012	\$50K winning team grant from Moffitt Cancer Center Integrated Mathematical Oncology workshop on Metastasis: Improving treatment strategies for patients with metastatic castrate resistant prostate cancer through personalized computational modeling.	

TRAVEL

April 2017	Women Advancing Mathematical Biology workshop - Columbus, OH Mathematical Biology Institute	
February 2017	Maths in the Integrated Cancer Biology Program & Physical Sciences in Oncology Network workshop - Scottsdale, AZ The Mayo Clinic	
September 2015	Cancer Evolution through Space and Time workshop - Plön, Germany Max Planck Institute for Evolutionary Biology	
July 2015	Many-cell System Modeling workshop - Knoxville, TN National Institute for Mathematical and Biological Synthesis	
February 2015	Tumor Heterogeneity and the Microenvironment workshop - Columbus, OH Mathematical Biosciences Institute	
September 2014	Ecology and Evolution of Cancer workshop - Columbus, OH Mathematical Biosciences Institute	
June 2013	Society for Mathematical Biology conference - Tempe, AZ \$500 grant from the IMA, MCMSC at ASU, MBI, and SoMSS at ASU	
July 2012	Society for Mathematical Biology conference - Knoxville, TN. \$500 Landahl grant	
June 2011	Joint meeting of the European Conference on Mathematical and Theoretical Biology and the Society for Mathematical Biology - Krakow, Poland. \$1000 National Science Foundation travel grant and \$500 Landahl grant	

March 2006 American Society for Laser Medicine and Surgery conference - Boston, MA.
\$1000 grant

REVIEWING

Acta Biotheoretica	Bulletin of Mathematical Biology
BMC Bioinformatics	British Lung Foundation
Cell Reports	J of Can Res & Clin Onc
Journal of Theoretical Biology	Journal of Translational Medicine
Mathematical Biosciences	Nature Communications
PLOS One	Scientific Reports

LANGUAGES & SOFTWARE

Java, MATLAB, Python, R, C++, FORTRAN, Mathematica, L^AT_EX, HTML, Processing, ImageJ.
Spoken: English, Spanish

RESEARCH EXPERIENCE

Dec 2013 - Present Hypoxia dynamics in lung cancer Moffitt Cancer Center
PI: Alexander R. A. Anderson Integrated Mathematical Oncology
A 2D-PDE model of lung tumor tissue based on the angiogenic cascade is used to define how key parameters affect tumor density profiles. These results are used to compare with imaging biomarkers and outcomes data from patients.

Jul 2012 - Present Heterogeneity in drug-induced steady states Moffitt Cancer Center
PI: Alexander R. A. Anderson Integrated Mathematical Oncology
We use a agent based model to investigate variation in drug response. By separating the effects of quiescence and apoptosis and comparing to data of a PC9 cell line to different drugs we find how each effect contributes to the resulting steady state during drug exposure.

Jan 2012 - Present Heterogeneity in Treatment Response in Glioblastoma Moffitt Cancer Center
PI: Alexander R. A. Anderson Integrated Mathematical Oncology
To investigate the heterogeneous response after treatment of glioblastoma, we build a cell based model that incorporates detailed migration and proliferation parameters gathered from single-cell experiments. We use a genetic algorithm to search a large parameter space and fit to large and small scale dynamics.

Dec 2012 - Present Exploiting evolution to treat heterogeneous tumors Moffitt Cancer Center
PI: Alexander R. A. Anderson Integrated Mathematical Oncology
Using an off-lattice cellular automata model and ODEs we test strategies to take advantage of how different fitness landscapes in different environments can be used to shape population metaphenotypes to either keep a tumor dormant longer or lead to eradication.

Dec 2010 - Present Phenotypic Inheritance in Heterogeneous Tumors Moffitt Cancer Center
PI: Alexander R. A. Anderson Integrated Mathematical Oncology
An off-lattice cellular automata model is built to investigate what role inheritance schemes may play in a growing heterogeneous tumor. By characterizing how distributions of phenotypes change over time and organize in space, insight is gained on the fitness of these metaphenotypes and how this can contribute to drug resistance and repopulation after treatment.

Dec 2010 - Dec 2011 Bridging population level and tissue level models Moffitt Cancer Center
PI: Alexander R. A. Anderson Integrated Mathematical Oncology
A PDE model of tumor tissue based on the angiogenic cascade is created to connect to results of a population statistical model of tumor growth and burden. We develop metrics to bridge the two scales and learn how we can separate the dependence of the primary tumor on the metastatic burden by introducing a circulating tumor cell population.

May 2009 - May 2010	Ion Traffic in Cell Membranes PI: Martin Bier <i>A model and numerical simulation was developed to give the transmembrane potential of muscle cells at low extracellular potassium conditions based on coupled nonlinear differential flux equations. Analytic solutions for the dimensions of the hysteresis loop in this region were also derived.</i> <i>Statistical and multiscale analysis of pore openings from pure lipid bilayers revealed power law distributions over several decades. A physical explanation and theoretical development of pore formation and stability was correlated to the solid-liquid phase transition of lipids.</i>	East Carolina University Department of Physics
Jun 2006 - Apr 2007	Turbulent Flow in Blood Vessels PI: David Pravica <i>To determine vessel geometry from infrasound created in the turbulent flow behind an aortic aneurysm, eigenvalues of monopolar and bipolar vortex frequencies were found from a combination of Schrödinger and Navier-Stokes equations.</i>	East Carolina University Department of Mathematics
Apr 2006 - Jun 2006	Linear Dichroism Response of Spider Silk Stretching PI: John Kenney <i>Calibrated a spectropolarimeter to characterize molecular orientation of spider silk proteins, by designing a uniform stretching device and measuring LD response of polyethylene with variation in stretch deformation and temperature.</i>	East Carolina University Department of Physics
May 2005 - Apr 2006	Photodynamic Therapy Dosimetry and Modeling PI: Claudio Sibata <i>Characterized fluorescence response of Photofrin® in regard to photodynamic therapy via measurements with optical phantoms and modeling using ASAP software.</i>	East Carolina University Department of Radiation Oncology
Jan 2004 - May 2004	Cell Aggregation and Self-Sorting PI: Gabor Forgacs <i>Created spherical aggregates and cell cultures for cell sorting experiments.</i>	University of Missouri - Columbia Department of Physics

TEACHING & MENTORING

Summer 2015-2017	Mentor - Integrated Math Oncology <i>Guided high school student's research project in High School Internship Program (HIPIMO)</i>	Moffitt Cancer Center Tampa, FL
Summer 2016	Mentor - Integrated Math Oncology <i>Guided undergraduate student's research project in the Future Leaders in Interdisciplinary Cancer Research (FLiCR) Program</i>	Moffitt Cancer Center Tampa, FL
Spring 2010	Technical Assistant - Math & Physics Department <i>Physics and astronomy lab design, development, and testing</i>	Pitt Community College Greenville, NC
Fall 2008 - 2009	Instructor - Math & Physics Department <i>Conceptual Physics: created lectures and taught labs for on campus courses and designed and taught online courses</i>	Pitt Community College Greenville, NC
Fall 2004 - 2009	Teaching Assistant - Physics Department <i>Taught labs for General Physics I & II, Astronomy, Modern Physics, Electronics, and Summer Ventures program for high school students</i>	East Carolina University Greenville, NC

Summer 2005, 2006	Freelance Editor - online textbook <i>Reviewed online physics problem sets, reported errors, and recommended solutions</i>	Prentice Hall & Web Assign
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ORGANIZED MINISYMPOSIA

“The cancer ecosystem: optimizing treatment based on evolution .” Co-organized with Alexander R. A. Anderson. *Society for Mathematical Biology*, July 2018, Sydney, Australia.

“Predicting therapeutic outcomes using mathematical models of cancer.” Co-organized with Jan Gevertz. *SIAM Life Sciences*, July 2016, Boston, MA.

“Zooming in and out: connecting individual and population behavior.” *European Society for Mathematical and Theoretical Biology*, June 2014, Gothenburg, Sweden.

“Agent-based simulations in oncology: applications to therapeutics.” Co-organized with MunJu Kim. *Society for Mathematical Biology*, June 2013, Tempe, AZ.

PUBLICATIONS

Gallaher, J., Hawkins-Daarud, A., Massey, S., Swanson, K.R.S., Canoll, P., and Anderson, A.R.A. “Bridging Scales of heterogeneity in PDGF-driven glioblastoma.” In Preparation.

Gallaher, J. and Anderson, A.R.A. “Heterogeneity in drug-induced steady states.” In Preparation.

Nichol, D., Gallaher, J., Grove, O., Knutsdottir, H., Scurll, J., Hazlehurst, L., Creelan, B., Anderson, A. R. A., Jeavons, P., and Gerlee, P. “Minimising the risk of recurrence using model predictive control and concurrent optimization: the case of EGFR-positive lung cancer.” In Preparation.

Gallaher, J., Enriquez-Navas, P. M., Luddy, K. A., Gatenby, R. A., and Anderson, A. R. A. “Spatial Heterogeneity and Evolutionary Dynamics Modulate Time to Recurrence in Continuous and Adaptive Cancer Therapies.” *Cancer Research*- In Press 2018.

Gallaher, J., Brown, J., and Anderson, A.R.A. “The dynamic tumor ecosystem: how cell turnover and trade-offs affect cancer evolution.” Submitted to the Proceedings of the Royal Society B - March 2018.

Juliano, J., Gil, O., Hawkins-Daarud, A., Noticewala, S. Rockne, R.C., Gallaher, J., Massey, S., Sims, P. A., Anderson, A.R.A., Swanson, K.R.S., and Canoll, P. “Comparative dynamics of microglial and glioma cell motility at the infiltrative margin of brain tumors.” *JR Soc Interface*. 15 (2018): 2017058.

Massey, S. C., Rockne, R. C., Hawkins-Daarud, A., Gallaher, J., Anderson, A. R. A., Canoll, P., Swanson, K. R. “Simulating PDGF-Driven Glioma Growth and Invasion in an Anatomically Accurate Brain Domain.” *Bull Math Biol*. (2017): 1-18.

Gallaher, J. A., Hawkins-Daarud, A., Massey, S. C., Swanson, K. R., and Anderson, A. R. A. “Hybrid approach for parameter estimation in agent-based models.” *BioRxiv*. (2017): 1-3.

Saeed-Vafa, D., Bravo, R., Dean, J. A., El-Kenawi, A., Mon Pere, N., Strobl, M., Daniels, C., Stringfield, O., Damaghi, M., Tunali, I., Brown, L. V., Curtin, L., Nichol, D., Peck, H., Gillies, R. J., and Gallaher, J. A. “Combining radiomics and mathematical modeling to elucidate mechanisms of resistance to immune checkpoint blockade in non-small cell lung cancer.” *BioRxiv*. (2017): 1-5.

Gatenbee, C., Folguera-Blasco, N., Daniels, C., Gallaher, J., Rockne, R., Nicholson, M., Maniati, E., Kennedy, J., Luddy, K., Locke, F. L., Robertson-Tessi, M. “Exploiting Homeostatic Repopulation to Increase DC Vaccine Efficacy in Multiple Myeloma.” *BioRxiv*. (2016): 1-3.

Gallaher, J. and Anderson, A.R.A. “The role of contact inhibition in intratumoral heterogeneity: An off-lattice individual based model.” *bioRxiv*, 036467 (2016): 1-3.

Gallaher, J., Cook, L. M., Gupta, S. Araujo, A., Dillon, J. Park, J. Y., Scott, J. G., Pow-Sang, J., Basanta, D., and Lynch C. C. “Improving treatment strategies for patients with metastatic castrate resistant prostate cancer through personalized computational modeling.” *Clinical & Experimental Metastasis*. 31 (2014): 991-999.

Gallaher, J., Babu, A., Plevritis, S., Anderson, A. R. A. . “Bridging population and tissue scale tumor dynamics: A new paradigm for understanding differences in tumor growth and metastatic disease.” *Cancer Research*. 74 (2014): 426-435.

Gallaher, J., Anderson, A. R. A. . “Evolution of intratumoral phenotypic heterogeneity: the role of trait inheritance.” *Interface Focus*. 3 (2013): 20130016.

Bier, M., Gallaher, J. “Ion Traffic Through a Cell Membrane - and How its 1/f Noise Connects to Gambler’s Ruin, Catalan Numbers and Zipf’s Law.” *Fluctuation and Noise Letters*. 10 (2011): 419-430.

Gallaher, J., Wodzińska, K., Heimbürg, T., and Bier, M. “Ion-channel-like Behavior in Lipid Bilayer Membranes at the Melting Transition.” *Physical Review E* 81 (2010): 061925.

Gallaher, J., Bier, M., and Siegenbeek van Heukelom, J. “First Order Phase Transition and Hysteresis in a Cells Maintenance of the Membrane Potential - An Essential Role for the Inward Potassium Rectifiers.” *Biosystems* 101 (2010): 149-155.

Barakat, I., Gallaher, J., Chen, H., and Lee, R. C. “In Vivo Electroporation: An Important Injury Mechanism in Electrical Shock Trauma.” In *Advanced Electroporation Techniques in Biology and Medicine*, edited by A. Pakhomov, D. Miklavcic, and M. Markov. Boca Raton, FL: CRC Press, 2010.

Gallaher, J., Bier, M., and Siegenbeek van Heukelom, J. “The Role of Chloride Transport in the Control of the Membrane Potential in Skeletal Muscle - Theory and Experiment.” *Biophysical Chemistry* 143 (2009): 18-25.

INVITED TALKS “Adaptive vs continuous cancer therapy: Exploiting space and trade-offs in drug scheduling”. *International Society for Evolution, Ecology, and Cancer*, December 2017, Tempe, AZ.

“Adaptive therapy for heterogeneous tumors: exploiting trade-offs and space in drug scheduling”. *Modeling Biological Evolution*, April 2017, Leicester, England.

“Growth-factor driven glioblastoma across scales: from the bulk to single cells in growth and treatment”. *Maths of the PSON & ICBP Meeting*, February 2017, Scottsdale, AZ.

“How a tumor’s phenotypic distribution can guide treatment strategy”. *Society for Industrial and Applied Mathematics*, July 2016, Boston, MA.

“Targeting the phenotype: treatment strategies for heterogeneous tumors”. *American Institute of Mathematical Sciences*, July 2016, Orlando, FL.

“How a tumor’s phenotypic distribution can guide treatment strategy”. *Invited by Rick Durrett to the Duke University Mathematics department meeting*, May 2016, Durham, NC.

“Steering phenotypic evolution in heterogeneous tumors”. *Cancer Evolution through Space and Time at the Max Planck Institute for Evolutionary Biology*, September 2015, Plön, Germany.

“Steering tumor heterogeneity: phenotypic selection vs clonal targeting ”. *Ecology and Evolution of Cancer workshop at the Mathematical Biosciences Institute*, September

ber 2014, Columbus, OH.

“Understanding the relative role of intrinsic and extrinsic heterogeneity in glioblastoma”, in the minisymposium: Spatial Models in Cancer. *European Conference on Mathematical and Theoretical Biology*, June 2014, Gothenburg, Sweden.

“Hurry up and wait!: an agent-based model of glioblastoma with saltatory migration of single cells”, in the minisymposium: Brain Oncology Network of Knowledge. *Society for Mathematical Biology*, June 2013, Tempe, AZ.

“Innate Sensitivity or acquired acclimation.” *Integrated Cancer Biology Program Math Meeting*, March 2012, Tampa, FL.

“Competition breeds insight: elucidating trait inheritance through environmental stress.” *Integrated Cancer Biology Program Jr Investigators Meeting*, October 2011, Cambridge, MA.

“From populations to cells and back again: linking primary growth rates to metastatic burden.” *Integrated Cancer Biology Program PI Meeting*, September 2011, New York, NY.

“Phenotypic Inheritance in a growing tumor.” *CWI Life Sciences seminar*, July 2011, Amsterdam, The Netherlands. Invited by Roeland Merks of the Biomodeling and Biosystems Analysis Group.

CONTRIBUTED TALKS

“Traversing Scales: combining population statistics with tissue dynamics to link primary and metastatic disease.” *Society for Mathematical Biology Annual Meeting*, July 2012, Knoxville, TN.

“Phenotypic Inheritance Transforms heterogeneity in tumor growth.” *European Conference on Mathematical and Theoretical Biology & Society for Mathematical Biology Joint Meeting*, June 2011, Krakow, Poland.

“An analytic study of the bistable transmembrane voltage with hypokalemia.” *East Carolina University Research and Creative Achievement Week*, March 2009, Greenville, NC.

POSTERS

Gallaher, J., Enriquez-Navas, P. M, Luddy, K. A. Gatenby, R. A. and Anderson, A. R. A. “Adaptive Therapy for Heterogeneous Cancer: exploiting space and trade-offs in drug scheduling.” *Moffitt Scientific Symposium*, May 2017, Tampa, FL.

Gallaher, J., Stringfield O., and Anderson, A. R. A. “Integrating patient-specific quantitative imaging with a dynamic mathematical tissue model to infer lung adenocarcinoma growth and outcome.” *3rd Annual Moffitt Anatomic Pathology Symposium*, January 2017, Sarasota, FL.

Gallaher, J., Hawkins-Daarud, A., Massey, S., Swanson, K. R., Canoll, P., and Anderson, A.R.A. “How heterogeneity influences post-treatment dynamics in PDGF-driven glioblastoma.” *Moffitt Scientific Symposium*, May 2016, Tampa, FL.

Gallaher, J., Massey, S., Hawkins-Daarud, A., Swanson, K. R., Canoll, P., and Anderson, A.R.A. “Fitting models with single cell data in growth factor driven glioblastoma.” *Many-cell system modeling workshop at the National Institute for Mathematical and Biological Synthesis*, July 2015, Knoxville, TN.

Gallaher, J., Tyson, D., Quaranta, V., and Anderson, A.R.A. “Heterogeneous responses to anticancer drugs.” *Joint Maths meeting of the PSOC and ICBP*, February 2015, Tampa, FL.

Gallaher, J. and Anderson, A.R.A. “The velocity of phenotypic evolution.” *Tumor Heterogeneity and the Microenvironment workshop at the Mathematical Biosciences Institute*, February 2015, Columbus, OH.

Gallaher, J. and Anderson, A.R.A. "Treating Intratumor heterogeneity: evolution and drug resistance." *Moffitt Scientific Symposium*, May 2014, Tampa, FL.

Gallaher, J. and Anderson, A.R.A. "Exploiting evolution to develop better personalized therapeutic strategies." *American Association for Cancer Research session on Cellular Heterogeneity in the Tumor Microenvironment*, February 2014, San Diego, CA.

Gallaher, J. and Anderson, A.R.A. "Treatment of Heterogeneous Tumors: shaping the phenotype space." *Integrated Cancer Biology Program Principle Investigators Meeting*, May 2013, Rockville, MD.

Gallaher, J., Canoll, P., Swanson, K. R., Anderson, A.R.A. "Does preexisting heterogeneity in glioblastoma inform post-treatment dynamics?" *Society for Neuro-Oncology*, November 2012, Washington D.C.

Gallaher, J., Babu, A., Plevritis, S., Anderson, A.R.A. "Traversing Scales: combining population statistics with tissue dynamics to link primary and metastatic disease." *Moffitt Scientific Symposium*, April 2012, Tampa, FL.

Gallaher, J., Tyson, D., Quaranta, V., Anderson, A.R.A. "Trait selection in a serum-deficient environment." *Integrated Cancer Biology Program Principle Investigator's Meeting*, September 2011, New York, NY.

Gallaher, J., Anderson, A.R.A. "*In silico* investigation of the role of phenotypic inheritance in a heterogeneous tumor population." *Moffitt Scientific Symposium*, April 2011, Tampa, FL.

Gallaher, J., Bier, M., and Siegenbeek van Heukelom, J. "Uncovering an Analytical Description of the Transmembrane Voltage Bistability at Low Extracellular Potassium Concentrations." *Biophysical Society Annual Meeting*, February 2009, Boston, MA.

Gallaher, J., Bier, M., and Siegenbeek van Heukelom, J. "Control of the Membrane Potential by Chloride Transport in Skeletal Muscle - Theory and Experiment." *Biophysical Society Annual Meeting*, February 2008, Long Beach, CA.

Gallaher, J., Bier, M., and Siegenbeek van Heukelom, J. "Isoprenaline Eliminates Cellular Transmembrane Voltage Bistability - Theory and Experiment." *East Carolina University Research and Creative Achievement Week*, March 2007, Greenville, NC.

Gallaher, J. A., Bonnerup, C. A., Allison, R. R., and Sibata, C. H. "Fluorescence Response Quantification of Photofrin® Concentration in Optical Phantoms." In *American Society for Laser Medicine and Surgery Annual Meeting*, March 2006, Boston, MA.