Oleg A. Igoshin

Dates:

Professor of Bioengineering, of Chemistry and of Biosciences, Rice University

Research Interests:

- Systems-biology of bacterial cell differentiation
- Design principles of biochemical networks
- Self-organization mechanisms in multicellular systems
- Statistical mechanics of biochemical enzymes and reaction networks

Positions:

• Professor and Associate Chair, Department of Bioengineering, Rice University	07/19 -present
 Associate Professor, Department of Bioengineering, Rice University Assistant Professor, Department of Bioengineering, Rice University Joint Appointment in the Department of Biosciences 	07/13 - 06/19 01/07 - 06/13 09/12 -present
Joint Appointment in the Department of Chemistry	01/19 -present
 Postdoctoral Researcher, Department of Biomedical Engineering, UC Davis <u>Advisor:</u> Prof. Michael Savageau <u>Research Project:</u> Signaling Pathways in <i>Bacillus subtilis</i> 	10/04 -12/06
Education:	
• PhD in Physics, Department of Physics, UC Berkeley <u>Advisor:</u> Prof. George Oster, Dept. Molecular and Cell Biology <u>Thesis topic:</u> Modeling of pattern formation in Myxobacteria	08/00 -08/04
 MSc, Chemical Physics Department, Feinberg Graduate School, Weizmann Institute of Science, Israel, <u>Advisor:</u> Prof. A. I. Burshtein, <u>Thesis topic:</u> Diffusion-assisted electron and energy transfer 	10/98-07/00
• BSc Summa Cum Laude, Physics Department, Novosibirsk State University, Russia <u>Advisors:</u> Prof. A.B. Doktorov, Dr. A.A. Kipiyanov <u>Thesis topic:</u> Nonequilibrium statistical mechanics of chemical reactions	09/94-06/98
Honors and awards:	
 Outstanding Faculty Associate, Sid Richardson College, Rice University Distinguished Faculty Associate, Sid Richardson College, Rice University Premium Award in Systems Biology, Institute of Engineering and Technology (IET) 	2017 2012-16,2018 2011
 John C Dunn Foundation Collaborative Research Award NSF CAREER Award 	2009 02/2009

List of publications (papers):

<u>h-index</u>=28(<u>Google Scholar</u>)

- 1. Burshtein, A.I., <u>Igoshin, O.A.</u> *Photoconductivity and singlet oxygen generation in illuminated polymer in the air atmosphere*. Journal of Chemical Physics (1999) **111**: 2200-2209.
- 2. Krissinel, E.B., <u>Igoshin, O.A.</u>, Burshtein, A.I. *Integral, unified and Markovian theories of biexcitonic photoionization*. Chemical Physics (1999) **247**: 261-273.
- 3. <u>Igoshin, O.A.</u>, Kipriyanov, A.A., Doktorov, A.B. *Many-particle treatment of nonuniform reacting systems* $A+B \rightarrow C$ *and* $A+B \rightarrow C+D$ *in liquid solutions*. Chemical Physics (1999) **244**: 371-385.
- 4. Kipriyanov, A.A., Igoshin, O.A., Doktorov, A.B. *A new approach to the derivation of binary non-Markovian kinetic equations*. Physica A (1999) **268**: 567-606.
- 5. <u>Igoshin, O.A.</u>, Burshtein, A.I. *Quenching of fluorescence by irreversible energy transfer at arbitrary strong pumping light*. Journal of Luminescence (2000) **92**: 123-132.
- 6. Frantsuzov, P.A., <u>Igoshin, O.A.</u>, Krissinel, E.B. *Differential approach to the memory-function reaction kinetics*. Chemical Physics Letters (2000) **317**: 481-489.
- 7. Kipriyanov, A.A., Igoshin, O.A., Doktorov, A.B. *The effect of chemical displacement of B species in the reaction A* + *B* -> *B*. Physica A (2000) **275**: 99-133.
- 8. <u>Igoshin, O.A.</u>, Burshtein, A.I. *Impurity quenching of fluorescence in intense light. Violation of the Stern-Volmer law.* Journal of Chemical Physics (2000) **112**: 10930-10940.
- 9. <u>Igoshin, O.A.</u>, Mogilner, A., Welch, R.D., Kaiser, D., Oster, G. *Pattern formation and traveling waves in myxobacteria: theory and modeling*. Proc Natl Acad Sci U S A (2001) **98**: 14913-14918.
- 10. Lukzen, N.N., Krissinel, E.B., <u>Igoshin, O.A.</u>, Burshtein, A.I. *Instantaneous and permanent photoionization*. Journal of Physical Chemistry A (2001) **105**: 19-28.
- 11. Wolgemuth, C.W., Igoshin, O., Oster, G. The motility of mollicutes. Biophys J (2003) 85: 828-842.
- 12. Igoshin, O.A., Kaiser, D., Oster, G. *Breaking symmetry in myxobacteria*. Curr Biol (2004) 14: R459-462.
- 13. Igoshin, O.A., Oster, G. Rippling of myxobacteria. Math Biosci (2004) 188: 221-233.
- 14. <u>Igoshin, O.A.</u>, Welch, R., Kaiser, D., Oster, G. *Waves and aggregation patterns in myxobacteria*. Proc Natl Acad Sci U S A (2004) **101**: 4256-4261.
- 15. <u>Igoshin, O.A.</u>, Goldbeter, A., Kaiser, D., Oster, G. *A biochemical oscillator explains several aspects* of Myxococcus xanthus behavior during development. Proc Natl Acad Sci U S A (2004) **101**: 15760-15765.
- 16. <u>Igoshin, O.A.</u>, Neu, J., Oster, G. *Developmental waves in myxobacteria: A distinctive pattern formation mechanism.* Phys Rev E Stat Nonlin Soft Matter Phys (2004) **70**: 041911.
- 17. <u>Igoshin, O.A.</u>, Price, C.W., Savageau, M.A. *Signalling network with a bistable hysteretic switch controls developmental activation of the sigma transcription factor in Bacillus subtilis*. Mol Microbiol (2006) **61**: 165-184.
- Igoshin, O.A., Brody, M.S., Price, C.W., Savageau, M.A. Distinctive topologies of partnerswitching signaling networks correlate with their physiological roles. J Mol Biol (2007) 369: 1333-1352.
- Veening, J.W., <u>Igoshin, O.A.</u>, Eijlander, R.T., Nijland, R., Hamoen, L.W., Kuipers, O.P. *Transient heterogeneity in extracellular protease production by Bacillus subtilis*. Mol Syst Biol (2008) 4: 184.
- 20. Igoshin, O.A., Alves, R., Savageau, M.A. *Hysteretic and graded responses in bacterial two-component signal transduction*. Mol Microbiol (2008) **68**: 1196-1215.
- 21. Chaudhury, S., Igoshin, O.A. Dynamic Disorder-Driven Substrate Inhibition and Bistability in a Simple Enzymatic Reaction. Journal of Physical Chemistry B (2009) **113**: 13421-13428.
- 22. Tiwari, A., Balazsi, G., Gennaro, M.L., <u>Igoshin, O.A.</u> The interplay of multiple feedback loops with post-translational kinetics results in bistability of mycobacterial stress response. Phys Biol (2010) 7: 036005.
- 23. Eswaramoorthy, P., Dinh, J., Duan, D., <u>Igoshin, O.A.</u>, Fujita, M. *Single-cell measurement of the levels and distributions of the phosphorelay components in a population of sporulating Bacillus subtilis cells*. Microbiology (2010) **156**: 2294-2304.
- 24. Chaudhury, S., Igoshin, O.A. Dynamic Disorder in Quasi-Equilibrium Enzymatic Systems. PLoS One (2010) 5: e12364.

- 25. Ray, J.C., <u>Igoshin, O.A.</u> Adaptable functionality of transcriptional feedback in bacterial twocomponent systems. PLoS Comput Biol (2010) **6**: e1000676.
- 26. Narula, J., Smith, A.M., Gottgens, B., <u>Igoshin, O.A.</u> *Modeling reveals bistability and low-pass filtering in the network module determining blood stem cell fate*. PLoS Comput Biol (2010) **6**: e1000771.
- 27. Narula, J., <u>Igoshin, O.A.</u> Thermodynamic models of combinatorial gene regulation by distant enhancers. IET Syst Biol (2010) **4**: 393-408.
- Xie, C.Y., Zhang, H., Shimkets, L.J., <u>Igoshin, O.A.</u> Statistical image analysis reveals features affecting fates of Myxococcus xanthus developmental aggregates. Proc Natl Acad Sci U S A (2011) 108: 5915-5920.
- 29. Tiwari, A., Ray, J.C., Narula, J., <u>Igoshin, O.A.</u> Bistable responses in bacterial genetic networks: designs and dynamical consequences. Math Biosci (2011) **231**: 76-89.
- 30. Ray, J.C.J., Tabor, J.J., <u>Igoshin, O.A.</u> Non-transcriptional regulatory processes shape transcriptional network dynamics. Nature Reviews Microbiology (2011) **9**: 817-828.
- Zhang, H.Y., Angus, S., Tran, M., Xie, C.Y., <u>Igoshin[†], O.A.</u>, Welch[†], R.D. *Quantifying* Aggregation Dynamics during Myxococcus xanthus Development. J Bacteriol (2011) **193**: 5164-5170. [[†] co-corresponding authors.]
- 32. Ray, J.C.J. and <u>Igoshin, O.A.</u>, *Interplay of Noisy Gene Expression and Ultrasensitive Dynamics Influences Bacterial Operon Organization*, PLoS Comp Bio (2012), **8**:e1002672.
- 33. Tiwari, A., and <u>Igoshin, O.A.</u>, *Coupling between feedback loops in autoregulatory networks affects bistability range, open-loop gain and switching times*, Physical Biology (2012) **9**: 055003.
- Zhang, H., Vaksman, Z., Litwin D., Shi P., Kaplan H., <u>Igoshin, O.A</u> The Mechanistic Basis of Myxococcus xanthus Rippling Behavior and Its Physiological Role during Predation, PLoS Comp Biology (2012), 8: e1002715. [Featured-image(cover) story]
- Narula, J., Devi, SN, J., Fujita[†], M. and <u>Igoshin[†], O.A.</u>, Ultrasensitivity of B. subtilis sporulation decision, Proc Natl Acad Sci U S A (2012) **109**: 20196–20197 and E3513–E3522 [[†] cocorresponding authors.]
- 36. Narula*, J., Williams*, CJ, Tiwari*, A., Marks-Bluth, J., Pimanda, J.E. and <u>Igoshin, O.A.</u>, *Mathematical model of a gene regulatory network reconciles effects of genetic perturbations on hematopoietic stem cell emergence*, Developmental Biology (2013) **379**: 258–269 [* - equal contribution]
- Vishnoi* M, Narula* J, Devi SN, Dao HA, <u>Igoshin†, O.A</u>, Fujita† M., *Triggering sporulation in Bacillus subtilis with artificial two-component systems reveals the importance of proper Spo0A activation dynamics*, Mol Microbiol (2013) **90:** 181–194 [† co-corresponding authors, * equal contribution]
- 38. Balagam, R., Litwin, D.B., Czerwinski, F., Sun, M., Kaplan, H.B., Shaevitz, J.W., <u>Igoshin, O.A.</u>, *Myxococcus xanthus gliding motors are coupled elastically coupled to the substrate as predicted by the focal adhesion model of gliding motility*, PLoS Comp Biol, (2014) **10:** e1003619
- Lee*, J., Tiwari*, A., Shum, V., Mills, G.B., Mancini, M.A., <u>Igoshin[†], O.A.</u>, Balazsi[†], G., Unraveling the regulatory connections between two controllers of breast cancer cell fate, Nucleic Acid Research, (2014) 42: 6839-6849 [[†] co-corresponding authors, * - equal contribution]
- 40. Judd, J., Ho, M.L., Tiwari, A., Gomez, E.J., Dempsey, C., Van Vliet. K., <u>Igoshin, O.A.</u>, Silberg, J.J., Agbandje-McKenna, M., Suh, J., *Tunable Protease-Activatable Virus nanonodes* programmed to compute proteolytic signatures, ACS Nano (2014) **8:** 4740-4746
- 41. Castillo-Hair, S.M., <u>Igoshin, O.A.</u> and Tabor, J.J. How to train your microbe: methods for dynamically characterizing gene networks, Current Opinion in Microbiology, (2015) **24:** 113–123
- Datta, P., Ravi, J., Guerrini, V., Chauhan, R., Neiditch, M.B. Shell, S.S., Fortune, S.M., Hancioglu, B., <u>Igoshin, O.A.</u> and Gennaro, M.L., *The Psp system of Mycobacterium tuberculosis integrates* envelope stress sensing and envelope preserving functions, Molecular Microbiology, (2015) 97: 408
- Narula*, J., Kuchina*, A., Lee, D.-Y., Fujita, M., Süel<u>†</u>, G.M. and. <u>Igoshin†, O.A.</u>, *Chromosomal arrangement of phosphorelay genes couples sporulation and DNA replication*, Cell, (2015) 162: 328–337 [† co-corresponding authors, * equal contribution]

- 44. Balagam, R. and Igoshin, O.A., *Mechanism for collective cell alignment in Myxococcus xanthus bacteria*, PLoS Comp Biol, (2015) **11**(8): e1004474
- 45. Ascensao*, J., Datta*, P., Hancioglu*, B., Sontag*, E., Gennaro ML and Igoshin, O.A., Nonmonotonic response to monotonic stimulus: regulation of glyoxylate shunt gene-expression dynamics in Mycobacterium tuberculosis, PLoS Comp Biol, (2016) **12**(2): e1004741
- 46. Narula*, J., Kuchina*, A., Fang, Z., Fujita, M., Süel, G.M. and. <u>Igoshin, O.A.</u>, *Slowdown of growth controls cellular differentiation*, Mol Sys Bio, (2016) **12**(4):871 [* equal contribution]
- 47. Castillo-Hair, S., Sexton, J., Landry, B., Olson, E., <u>Igoshin, O.A.</u>, Tabor, J.J., *FlowCal: A user-friendly, open source software tool for automatically converting flow cytometry data from arbitrary to absolute units*, ACS Synthetic Bio (2016) **5** (7): 774
- Parta, P., Kissoon, K., Cornejo, I., Kaplan, H.B. and. <u>Igoshin, O.A.</u>, *Colony Expansion of Socially* Motile Myxococcus xanthus Cells Is Driven by Growth, Motility, and Exopolysaccharide Production, PLoS Comp Biol, (2016) **12**(6): e1005010
- 49. Narula, J., Fujita, M., and. <u>Igoshin, O.A.</u>, *Functional Requirements of Cellular Differentiation:* Lessons from Bacillus, Current Oppinion in Microbiology, (2016) **34**: 38.
- 50. Narula*, J., Tiwari*, A., and <u>Igoshin, O.A.</u>, *Role of autoregulation and relative synthesis of operon partners in alternative sigma factor networks*, PLoS Comp Biol, (2016) e1005267 doi:10.1371/journal.pcbi.1005267 [* equal contribution]
- 51. Banerjee, K., Kolomeisky[†], A.B., and <u>Igoshin[†],O. A.</u>, *Accuracy of substrate selection by enzymes is controlled by kinetic discrimination*, J. Phys. Chem. Lett., (2017) **8**: 1552–1556
- 52. Banerjee, K., Kolomeisky*†, A.B., and <u>Igoshin*†,O. A.</u>, *Elucidating interplay of speed and accuracy in biological error correction*, Proc Natl Acad Sci U S A (2017) **114:** 5183-5188 [† co-corresponding authors, * equal contribution]
- 53. Cotter, C.R, Schüttler, H.-B., <u>Igoshin⁺,O. A.</u>, and Shimkets⁺, L.J, *Data-driven modeling reveals cell behaviors controlling self-organization during Myxococcus xanthus development*, Proc Natl Acad Sci U S A (2017) **114:** E4592-E4601 [⁺ co-corresponding authors]
- 54. Winkle, J.J., <u>Igoshin, O.A.</u>, Bennett, M.R., Josić K., and Ott W., *Modeling mechanical interactions in growing populations of rod-shaped bacteria*, Physical Biology, (2017) **14**: 055001
- 55. Fan*, Y., Evans*, C.R., Barber*, K.W., Banerjee, K, Weiss, K.J., Margolin, W., Igoshin, O.A., Rinehart, J., Ling, J., *Heterogeneity of Stop Codon Readthrough in Single Bacterial Cells and Implications for Population Fitness*, Molecular Cell, (2017), 67: 1–11,e1–e5[* - equal contribution]
- 56. Li*, X., Balagam*, R., He, T.-F.,Lee P.P., <u>Igoshin</u>[†], <u>O.A</u>.,and Levine[†] H., On the mechanism of long-range alignment order of fibroblasts, Proc Natl Acad Sci U S A (2017) **114**(34): 8974-8979 [[†] co-corresponding authors, * equal contribution]
- 57. Parta, P., Vallalo, C.N., Wall, D. and. Igoshin[†], O<u>.A.</u>, *Mechanism of kin-discriminatory demarcation line formation between growing colonies of swarming bacteria*, Biophys J, (2017) **113**: 2477–2486
- 58. Shis, D.L., Bennett, M.R., and <u>Igoshin⁺, O.A.</u>, *Dynamics of Bacterial Gene Regulatory Networks*, Annu Rev Biophys, (2018) **47**: 447-467
- Zhang, Z., Cotter, C.R, Shimkets, L.J., <u>Igoshin⁺,O. A.</u>, Agent-Based Modeling Reveals Possible Mechanisms for Observed Aggregation Cell Behaviors in Myxococcus xanthus, Biophys J, (2018), 115: 2499-2511 doi: <u>https://doi.org/10.1016/j.bpj.2018.11.005</u>
- Saha, S. Parta, P., <u>Igoshin O.A</u>., Kroos, L. Systematic analysis of the Myxococcus xanthus developmental gene regulatory network supports posttranslational regulation of FruA by Csignaling, Molecular Microbiology Molecular Microbiology, (2019) 111:1732–1752 doi:10.1111/mmi.14249

2/21/2020

- Mallory, J.D., Kolomeisky[†], A.B., <u>Igoshin[†], O.A.</u> Trade-Offs between Error, Speed, Noise and Energy Dissipation in Biological Processes with Proofreading, Journal of Physical Chemistry B (2019) **123**: 4718-4725 (doi:10.1021/acs.jpcb.9b03757)
- 62. Castillo-Hair, S. M., .E. A. Baerman, M. Fujita., <u>O. A. Igoshin</u>, J. J. Tabor. *Optogenetic control of Bacillus subtilis gene expression*, Nat Commun (2019) **10** (1) 3099.
- S. M. Castillo-Hair, M. Fujita., <u>Igoshin, O. A.</u>, Tabor, J.J.. An engineered Bacillus subtilis inducible promoter system with 20,000-fold dynamic range. ACS Synth Biol, (2019) 8(7)1673-1678 (doi: 10.1021/acssynbio.8b00469)
- Igoshin[†], O.A., Chen, J., Xing, J., Liu, J. Elston, T.C., Grabe, M., Kim, K.S., Nirody, J., Rangamani, P., Sun, S.X., Wolgemuth, C., Biophysics at the coffee shop: lessons learned working with George Oster, Molecular Biology of Cell, (2019) 30(16): 1882-1889, (doi:10.1091/mbc.E19-02-0107)
- Molinari, S., Shis, D.L., Bhakta, S.P., Chappell, J. <u>Igoshin, O.A.</u>, Bennett, M.R., *A synthetic system for asymmetric cell division in Escherichia coli*, Nature Chem Bio, (2019) 15:917–924 https://doi.org/10.1038/s41589-019-0339-x
- 66. Mallory, J.D., Kolomeisky[†], A.B., <u>Igoshin[†], O.A.</u> Kinetic control of stationary flux ratios for a wide range of biochemical processes, PNAS (2019) submitted https://www.biorxiv.org/content/10.1101/858126v1.abstract
- 67. Zhang,Z., Cotter,C., Lyu,Z., Shimkets L.J., <u>Igoshin, O. A.</u>, *Data-driven models reveal mutant cell behaviors* important for myxobacterial aggregation, eLife (submitted), <u>https://www.biorxiv.org/content/10.1101/2020.02.08.939462v1</u>

List of publications (book chapters):

- Balazsi, G., <u>Igoshin, O.A.</u> and Gennaro, M.L., *The transcriptional regulatory network of Mycobacterium tuberculosis*, in *Bacterial Gene Regulation and Transcriptional Networks*, ed. M.M. Babu, Caister Academic Press, 2013; **ISBN: 978-1-908230-14-0**
- Harvey, C.W., <u>Igoshin, O.A.</u>, Welch R.D., Alber M. and Shimkets L.J., *Computational Biology:* From Observation to Statistical Image Analysis to Modeling and Back to Biology, in Myxobacteria: Genomics, Cellular and Molecular Biology, eds. Z. Yang and P.I. Higgs, Caister Academic Press, 2014 ISBN: 978-1-908230-34-8

List of publications (books):

Manila

 Igoshin, O.A, Integral Encounter Theory of Photochemical Transfer Reactions: Formalism and Applications, LAP Lambert Academic Publishing AG&Co, Koln, Germany, 2009, ISBN: 978-3-8383-0101-3

Recent invited talks and seminars:

1. Uncovering the mechanisms of self-organization behaviors in Myxobacteria 01/16/2020 biofilms, Invited talk at The Physics of Collective Cell Migration, Princeton Center for Theoretical Science, Princeton, NJ 2. Slowdown of growth controls cellular differentiation, , Invited talk at Aspen Physics 01/09/2020 Center Winter Conference, Aspen, CO 3. Making cell-fate-decisions: Lessons from Sporulating Bacteria, Invited seminar, 12/09/2019 Duke Center for Genomic and Computational Biology, Durham, NC 4. Understanding trade-offs of biological error correction, Invited talk, Workshop on 12/05/2019 Protein-DNA Interactions: from Biophysics to Cancer Biology, Rice University 5. Understanding trade-offs of biological error correction, Keynote talk, 16th 10/29/2019 International Conference on Molecular Systems Biology, De La Salle University,

	CV: Oleg Igoshin	2/21/2020
6.	Uncovering the mechanisms of self-organization behaviors of Myxococcus xanthus bacteria. Invited seminar, Chinese University of Hong Kong	06/17/2019
7.	Pattern formation and multicellular self-organization behaviors in myxobacterial biofilms. Quantitative Biology Seminar, UCSD	05/20/2019
8.	Uncovering the mechanisms of self-organization behaviors of Myxococcus xanthus bacteria, Invited colloquium, Department of Physics, Emory University, Atlanta,	12/03/2018
9.	Mechanisms of emergent self-organization behaviors in Myxococcus xanthus biofilms, Centre for Genomic Regulation (CRG) and the Barcelona Biomedical Research Park Seminar	09/03/2018
10.	Making cell-fate-decisions: Lessons from Sporulating Bacteria, Biophysics group seminar, UC Berkeley, CA	07/27/2018
11.	Uncovering the mechanisms of self-organization behaviors of Myxococcus xanthus bacteria, Invited talk at Mathematical Approaches to Cell-Cell Communication and Collective Behaviours Workshop, Banff International Research Station, Banff, AB, Canada	07/08/2018
12.	Uncovering the mechanisms of self-organization behaviors in Myxococcus xanthus bacteria. Systems Biology Seminar. Boston University	04/19/2018
13.	Uncovering the mechanisms of self-organization behaviors in Myxococcus xanthus bacteria Department of Mathematics Colloquium, Georgia State University	01/19/2018
14.	Uncovering the mechanisms of self-organization behaviors in Myxococcus xanthus bacteria Bacterial Interest Group (BIG) Texas Medical Center, Houston, TX	12/13/2017
15.	Uncovering the mechanisms of self-organization behaviors of Myxococcus xanthus bacteria Invited talk at 11 th annual a-bio Conference Rutgers NI	08/02/2017
16.	Making cell-fate-decisions: Lessons from Sporulating Bacteria, Center for "Quantitative Analysis of Molecular and Cellular Biosystems" Heidelberg University	06/23/2017
17.	Making cell-fate-decisions: Lessons from Sporulating Bacteria, National Institute of Health Biophysics group	01/25/2017
18.	Uncovering design principles of bacterial cell-fate decision network, Department of Microbiology, UC Davis, CA	12/14/2016
19.	Making cell-fate-decisions: Lessons from Sporulating Bacteria, Biophysics seminar, UCSF, San Francisco, CA	12/12/2016
20.	Making cell-fate-decisions: Lessons from Sporulating Bacteria, Department of Bacteriology Distinguished Lectures in Microbiology, UW Madison, WI	12/08/2016
21.	Making cell-fate-decisions: lessons from sporulating bacteria, Basic Sciences Division Seminar, Fred Hutchinson Cancer Research Center, Seattle, WA	04/12/2016
22.	<i>Uncovering design principles of bacterial cell-fate decision network,</i> Joint CMU-Pitt Ph.D. Program in Computational Biology Seminar, University of Pittsburgh, PA	04/08/2016
23.	Gene dosage imbalance during DNA replication controls bacterial cell-fate decision. Invited Focus Session talk, APS March Meeting	03/17/2016
24.	Uncovering design principles of bacterial cell-fate-decision network, Applied Math Seminar, UC Irvine	02/29/2016
25.	Systems Biology of Cell-fate-decisions: Lessons from Sporulating Bacteria, Keck Seminar, Gulf Coast Consortia, Houston, TX	02/19/2016
26.	Uncovering the mechanisms and physiological roles of non-monotonic response dynamics in bacterial stress response and differentiation, IMA Workshop Biological Systems and Networks, Minneapolis, MN	11/19/2015
27.	Dynamic modeling of gene regulatory network controlling HSC emergence reconciles effects of genetic perturbations of Runx1, Batsheva de Rathchild Seminar on RUNX transcription factors in development and disease, Weizmann Institute of Science, Israel	10/18/2015

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28.	Uncovering design principles of bacterial cell-fate decision network, Computational and Integrative Biomedical Research Center Seminar, Baylor College of Medicine,	10/07/2015
29.	Houston, 1X Uncovering evolutionary design principles of bacterial differentiation decisions Northwestern University, Molecular Biophysics Colloquium, Evanston, IL	09/11/2014
30.	Slowdown of cell growth acts as the signal triggering cellular differentiation, 9 th Invited talk, International Conference on Bioinformatics of Genome Regulation and structure\Systems Biology, Novosibirsk, Russia	06/26/2014
31.	Ph.D. Program in Systems, Synthetic and Physical Biology (SSPB) at Rice University: Challenges, solutions and perspectives, UK/US Synthetic Biology Workshop, Chicago, IL	02/13/2014
32.	<i>Stochasticity & Ultrasensitivity In Bacterial Networks,</i> Departmental Colloquium, Department of Computational and Applied Mathematics and Statistics, Notre Dame University, South Bend, IN	09/09/2013
33.	Stochasticity & Ultrasensitivity In Bacterial Networks, Center of Quantitative Biology colloquium, Peking University, Beijing, China	08/06/2013
34.	Design principles of Bacillus subtilis sporulation decision network, NSF/RU Cell Decision Making Workshop, Arlington, VA	06/11/2013
35.	Stochasticity & Ultrasensitivity In Bacterial Networks, Departmental Colloquium, Department of Microbiology, University of Georgia, Athens, GA	04/11/2013
36.	Uncovering design principles of Bacillus subtilis sporulation network, Computational and Integrative Biomedical Research Center Seminar, Baylor College of Medicine, Houston, TX	04/03/2013
37.	Uncovering the mechanisms behind Bacillus subtilis sporulation decisions, Invited talk, Frontiers in Systems and Synthetic Biology '13 (FSSB'13), Atlanta, GA	03/22/2013
38.	Stochasticity & Ultrasensitivity In Bacterial Networks, Science at the Edge Seminar, Michigan State University, East Lansing, MI	03/15/2013
39.	Design principles of information processing in the Bacillus subtilis sporulation network, Investigative Workshop on Systems and Synthetic Microbiology, NIMBioS at the University of Tennessee, Knoxville, TN	03/12/2013
40.	Self-organization mechanisms in Myxococcus xanthus swarms, Experimental Biophysics Laboratory Seminar, Princeton University, NJ	12/11/2012
41.	Stochasticity & Ultrasensitivity In Bacterial Networks, Public Health Research Institute Center, UMDNJ - New Jersey Medical School, Newark, NJ	12/10/2012
42.	Stochasticity & Ultrasensitivity In Bacterial Networks, Systems Biology Seminar, University of Washington, Seattle, WA	12/04/2012
43.	Self-organization mechanisms in Myxococcus xanthus swarms, Biomedical sciences Colloquium, University of Coimbra, Coimbra, Portugal	09/21/2012
44.	Ultrasensitivity and stochasticity of the Bacillus subtilis sporulation decision, International Conference on Stochastic Processes in Systems Biology, Genetics & Evolution, Houston, TX	08/23/2012
45.	Interrogating Bacillus subtilis Sporulation Network, Suel Lab, UT Southwestern, Green Center for Systems Biology, Dallas, TX	07/20/2012
46.	Interrogating Bacillus subtilis Sporulation Network, Losick Lab, Harvard, Boston, MA	04/24/2012
47.	Stochasticity & Ultrasensitivity In Bacterial Networks, Department of Physics/Bioinformatics Group, Boston University, Boston, MA	04/23/2012
48.	Stochasticity & Ultrasensitivity In Bacterial Networks, Systems Biology Theory Lunch, Department of Systems Biology, Harvard Medical School, Boston, MA	04/20/2012
49.	Stochasticity & Ultrasensitivity In Bacterial Networks, Integrative BioSystems Institute, GeorgiaTech, Atlanta, GA	04/04/2012

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50.	<i>Reverse-engineering mechanisms of multicellular self-organization with mathematical modeling and statistical image processing,</i> MD Andersen, Systems Biology Department, Houston, TX	03/22/2012
51.	Mechanisms of Self-Organization in Myxococcus xanthus Biofilms: Aggregation and Rippling, Bacterial Interest Group (BIG), Texas Medical Center, Houston, TX	03/08/2012
52.	Stochasticity & Ultrasensitivity In Bacterial Networks, Department of Bioengineering, University of Texas at Dallas, Dallas, TX	02/28/2012
53.	Stochasticity & Ultrasensitivity In Bacterial Networks, , Mathematical Biology Seminar, UC Davis, Davis, CA	02/06/2012
54.	Stochasticity and ultrasensitivity in bacterial network, Department of Bioengineering, Johns Hopkins University, Baltimore, MD	12/14/2011
55.	<i>Stochasticity and ultrasensitivity in bacterial network,</i> Department of Biomedical sciences Colloquium, University of Coimbra, Coimbra, Portugal	11/18/2011
56.	Dynamical Properties of gene regulatory networks: bistability, feedback and Stochasticity, Molecular systems Biology Module for PDBEB, University of Coimbra, Coimbra, Portugal	11/18/2011
57.	Contact-based Signaling Explains the Emergent Properties and Physiological Role of Traveling Waves Formed during Myxococcus xanthus Predation, 4th ASM Conference on Cell-Cell Communication in Bacteria, Miami, FL	11/09/2011
58.	Engineering Approaches to Computational Systems Biology: Research Overview, Department of Systems Biology Retreat, MD Anderson	10/12/2011
59.	<i>Structure-function relationships in bacterial gene regulatory networks,</i> 2011 Computational Cell Biology Summer School, Cold Spring Harbor, NY	06/17/2011
60.	The Interplay of Noisy Gene Expression and Biochemical Dynamics Explains Patterns of Bacterial Operon Organization, XII International Congress on Molecular Systems Biology, Universitat de Lleida (Spain),	05/10/2011
61.	Interplay of Noisy Gene Expression and Dynamics Explains Patterns of Bacterial Operon Organization, APS March Meeting 2011, Dallas, TX	03/22/2011
62.	Uncovering self-organization mechanisms in Myxococcus xanthus swarms with modeling and image processing, Mathematical Biology Seminar, Center for Computational Biology & Bioinformatics, Columbia University, BC, Canada	03/03/2011
63.	<i>Evolutionary Design Principles of Genetic Networks: from E. coli to Stem Cells,</i> Special Seminar at Center for Computational Biology & Bioinformatics, Columbia University, New York, NY	11/04/2010
64.	Reverse-engineering of self-organization mechanisms in Myxococcus xanthus swarms, BIOMAPS and Department of Mathematics Seminar, Rutgers University, NJ	11/03/2010
65.	<i>Bistability and low-pass filtering in the network module determining blood stem cell fate,</i> 7 th International Conference on Bioinformatics of Genome Regulation and structure\Systems Biology, Novosibirsk, Russia	06/23/2010
66.	Design Principles of bacterial stress-response circuits, Bacterial Interest Group (BIG), Texas Medical Center, Houston, TX	06/02/2010
67.	<i>Reverse engineering self-organization of bacterial biofilms</i> , K2I institute member luncheon seminar, Rice University	04/09/2010
68.	Interplay of Multiple Feedbacks with Post-Translational Kinetics in Mycobacterial Stress-Response Network, Invited Guest lecture, World Tuberculosis Day Symposium, Public Health Research Institute New Jersey Medical School, Newark, NJ	03/23/2010
69.	Mathematical Modeling in Systems Biology: Introduction and Examples, Invited guest lecture, University of Houston-Downtown, Houston, TX	03/22/2010
70.	<i>Uncovering the physiological implications of transcriptional feedback in bacterial genetic circuit,</i> Interdisciplinary cluster on Networks, University of Houston, Houston, TX	02/26/2010

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71.	Uncovering its physiological implications of transcriptional feedback with mathematical modeling, Seminar at Computational Science and Mathematics	11/12/2009
72.	<i>Transcriptional feedback in bacterial signaling and mammalian development:</i> <i>uncovering its physiological implications with mathematical modeling</i> , Colloquium at University of Connecticut Health Center, Farmington, CT	09/17/2009
73.	Uncovering design principles of bacterial biochemical networks and biofilm self- organization, Colloquium at Cambridge Computational Biology Institute, Cambridge LIK	09/18/2008
74.	<i>Uncovering design principles of bacterial biochemical networks</i> , Colloquium at symposium "Modeling and Analysis of Biological networks", University of Houston	05/16/2008
75.	<i>Uncovering design principles of biochemical networks</i> , Department Colloquium, Notre Dame University, Biocomplexity Seminar Series	02/11/2008
76.	<i>Uncovering design principles of biochemical networks</i> , Department Colloquium, Syracuse University, Department of Biology	02/15/2008
77.	Graded and Bistable Switches in Bacterial Development and Stress Responses, Department Colloquium, UT Health Science Center at Houston Medical School, Department of Microbiology & Molecular Genetics	11/01/2007
78.	Uncovering design principles of bacterial gene regulation, Department Colloquium, Rice University, Biochemistry and Cell Biology Department	10/12/2007
79.	Patterns and signaling in Myxobacteria development, Plenary invited talk at International conference on Systems Biology, Long Beach, CA	10/04/2007
80.	Uncovering design principles of bacterial gene regulation with mathematical modeling Biology Department Colloquium, University of Houston, TX	09/19/2007
81.	<i>Design principles of graded and bistable switches in signaling networks</i> , Department Colloquium, MD Andersen, Systems Biology Department	09/05/2007
82.	<i>Graded and bistable switches in bacterial signaling networks,</i> Stochastic Gene Transcription & Signaling Workshop Rice University	06/22/2007
83.	<i>Bacterial development: Insights from Mathematical Modeling</i> , CAAM Colloquium, Rice University	04/23/2007
84.	Design principles of graded and bistable responses in bacterial signaling switches, Biophysics Seminar, Rice University	04/19/2007
Reco	ent conference presentations (self*): *in addition over 70 presentations by trainees over the last 10 years	
1.	Modeling Reveals Possible Mechanisms for Observed Aggregation Cell Behaviors, 45th International Conference on the Biology of Myxobacteria, Sheffield, UK	06/04/2018
2.	Uncovering the mechanisms of self-organization behaviors of Myxococcus xanthus bacteria, 2017 Physics of Living Systems (iPoLS) meeting, Paris, France	07/26/2017
3.	Mathematical modeling of M. xanthus vegetative spreading, 44th International Conference on the Biology of Myxobacteria, Arlington, VA	06/18/2017
4.	Detecting Starvation Stress without Specific Metabolite Sensing: Control of the Sporulation Decision in Bacillus subtilis, Microbial Stress Response Gordon Conference, Mount Holyoke College, South Hadley, MA [talk]	07/19/2016
5.	Stoichiometric sequestration and feedback regulation in alternative σ -factor networks: implications for response dynamics, Microbial Stress Response Gordon	07/21/2016

- Conference, Mount Holyoke College, South Hadley, MA [poster]
 Bacillus subtilis sporulation decision is controlled by DNA replication dynamics and 06/14/2015 slowdown of Cell Growth, 5th ASM Conference on Prokaryotic Cell Biology and Development, Washington D.C. [talk]
- 7. Slowdown of cell growth acts as the signal triggering cellular differentiation, The 8th 08/16/2014 Annual q-bio Conference on Cellular Information Processing, Santa Fe, NM [talk]

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8.	Slow-down of cell growth acts as stress signal triggering sporulation in Bacillus subtilis, Microbial Stress-response GRC, Mount Holyoke, MA [poster]	07/31/2014
9.	Mechanismof cell alignment in M. xanthus groups, 41st International Conference on the Biology of Myxobacteria, Frejus, France [talk]	05/27/2014
10.	<i>Biophysical analysis of mechanical intercellular interactions discriminates between alternative models of A-motility</i> , 40 ^h Annual International Conference on the Biology of the Myxobacteria, Beijing, China [talk]	08/08/2013
11.	Uncovering cell fate decision mechanisms during Bacillus subtilis sporulation, 9th Annual Computational & Theoretical Biology Symposium Biophysical Approaches to Systems and Synthetic Biology, Rice University, Houston, TX, [talk]	12/01/2012
12.	Self-organization mechanisms in Myxococcus xanthus swarms, John Dunn Multicellular Self-Organization Meeting, Rice University, Houston, TX, [talk]	11/09/2012
13.	Interplay of Gene Expression Noise and Ultrasensitive Dynamics Influences Bacterial Operon Organization, 8 th International Conference on Bioinformatics of Genome Regulation and structure\Systems Biology, Novosibirsk, Russia [talk]	06/29/2012
14.	<i>Ultrasensitivity of B. subtilis sporulation decision</i> , 4th ASM Conference on Prokaryotic Cell Biology and Development, Montreal, QE, Canada [poster]	05/02/2012
15.	Mechanisms of Self-Organization in Myxococcus Xanthus Biofilms: Aggregation and Rippling, 4th ASM Conference on Prokaryotic Cell Biology and Development, Montreal, QE, Canada [poster]	05/02/2012
16.	Pattern Formation in Myxococcus xanthus, Growth and patterns: pattern formation in Biology, Aspen Center for Physics, Aspen, CO [poster]	01/03/2012
17.	<i>Ultrasensitivity of B. subtilis sporulation decision</i> , ICAM workshop "Multiscale Theory of Networked Biological Systems: from Molecular Complexes to Cellular Networks and Multicellular Self-organization", Computational and Theoretical Biology Symposium, Rice University, Houston, TX, [talk]	12/09/2011
18.	<i>Reverse-engineering of self-organization mechanisms in Myxococcus xanthus swarms</i> , The 5 th Annual q-bio Conference on Cellular Information Processing, Santa Fe, NM [talk]	08/12/2011
19.	Statistical image analysis reveals features affecting the fates of Myxococcus xanthus developmental aggregates, 38 th Annual International Conference on the Biology of the Myxobacteria, Mt Kisco, NY [talk]	07/19/2011
20.	Patterns of bacterial operon organization reduce network noise, Stochastic Physics in Biology, Gordon Research Conference, Ventura, CA[poster]	01/24/2011
21.	Bacterial Operon Patterns Reduce Biochemical Noise, Workshop and Symposium "From Networks to Pattern Formation – Evolution of Biological Function, Houston, TX,[talk]	12/04/2010
22.	Uncovering its physiological implications of transcriptional feedback in bacterial stress-response circuits, Microbial Stress Response Gordon Conference, Mount Holyoke College, South Hadley, MA [poster]	07/19/2010
23.	<i>Bistability and low-pass filtering in gene regulatory network module controlling hematopoiesis,</i> 5 th Computational and Theoretical Biology Symposium, Rice University, [talk]	12/05/2009
24.	Multiple positive feedbacks lead to bistability and low-pass filtering in gene regulatory network module controlling hematopoiesis, Workshop 2: Signal transduction and gene regulatory networks, Ohio Mathematical Biosciences Institute, Columbus, OH [talk]	11/03/2009
25.	<i>Quantifying, modeling and analyzing self-organization patterns in M. xanthus swarms</i> , 36 th Annual International Conference on the Biology of the Myxobacteria, Boston, MA [talk]	07/08/2009
26.	<i>Understanding Feedback Architectures in Two-Component Systems Signaling,</i> 3rd ASM Conference on Prokaryotic Development, Cambridge, MA [poster]	07/02/2009

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27.	Feedback regulation and bistability in bacterial two-component systems, ICAM	12/06/2008
	workshop "Evolutionary Design Principles of Biological Networks" 4th	
	Computational and Theoretical Biology Symposium, [talk]	
28.	Feedback regulation and bistability in bacterial two-component systems, Microbial	07/08/2008
	Stress Response Gordon Conference, Mount Holyoke College, South Hadley, MA	
	[poster]	
29.	<i>Graded and Bistable Switches in Bacterial Development and Stress Responses</i> , 3 rd	12/07/2007
	Computational and Theoretical Biology Symposium, Rice University, [talk]	

Service:

Departmental:

- MBE Committee, Chair 2016-present
- Admission committee, 2007, 2011-15,2017-18 member, 2008 co-chair
- Awards committee, 2009-11
- Faculty Search committee, 2013- present
- Undergraduate advising committee, 2016-present

University:

- Systems, Synthetic and Physical Biology (SSPB) Ph.D. Program steering committee: 2012-present
- SSPB admission committee: 2012-2017; chair 2015-2017
- Benefits Committee, 2013-present
- High-performance computing subcommittee, 2008-present
- Divisional Advisor for Engineering, Sid Richardson College (2008 2013)

Professional:

- Journal Editorial Boards: Associate Editor, PLOS Computational Biology
- Journal Reviewer: Science, eLife, Science Signaling, Nature Methods, Nature Microbiology, PNAS, PLoS Biology, PLoS Computational Biology, PLoS Genetics, J bacteriology, Molecular Microbiology, Archives of Microbiology, Biophysical Journal, Bulletin of Mathematical Biology, Physical Biology, Journal of Theoretical Biology, Mathematical Biosciences
- **Grant Reviewer:** NIH, NSF, National Science Center(Poland), U.S. Army Corps of Engineers' Engineer Research and Development Center, American Institute of Biological Sciences SPARS

Affiliations: Biomedical Engineering Society, American Physical Society - Division of Biological Physics, American Society of Microbiology

Conference/Workshop Organization:

- 1. Local organizing committee chair: 12th Annual q-bio Conference | Quantitative and Systems Biology, Rice University, Houston, 06/2018
- 2. Co-chair and organizer, Focus Session, APS March Meeting, 2016, Baltimore, MD
- 3. **Co-organizer:** Annual Computational & Theoretical Biology Symposium, Rice University, Houston, TX, 2007-2013
- 4. Session co-chair: Biomedical Engineering Society Annual Meeting, Atlanta, GA, 10/2012
- Co-organizer: ICAM workshop "Multiscale Theory of Networked Biological Systems: from Molecular Complexes to Cellular Networks and Multicellular Self-organization", Rice University, 12/2011
- 6. Session co-chair: Biomedical Engineering Society Annual Meeting, Hartford, CT, 10/2011
- 7. **Organizing committee:** XII International Congress on Molecular Systems Biology (ICMSB2011), Universitat de Lleida (Spain), 05/2011
- 8. **Co-organizer:** Workshop and Symposium: *"From Networks to Pattern Formation Evolution of Biological Function"*, Houston, TX, 12/2010
- 9. **Co-organizer:** From Motors to Morphogenesis: George Oster-Inspired Research, Berkeley, CA, 05/2009
- 10. Invited Discussion Leader: I2CAM Workshop on "Soft Active Matter: from Granular Rods to Flocks, Cells and Tissues", 05/2009

- 11. Session chair: Bioinformatics Workshop, 26th Annual Houston Conference on Biomedical Engineering Research, 03/2009
- 12. Co-organizer: ICAM workshop "Evolutionary Design Principles of Biological Networks", Rice University, 12/2008

Award Period	Role	Agency	Title	Amount Awarded
Mar 2009 - Feb 2014	Principal Investigator	National Science Foundation	CAREER: Self-Organization Mechanisms in <i>Myxococcus xanthus</i> Swarms	\$640,000
May 2009- Feb 2014	Principal Investigator	National Science Foundation	REU Supplements CAREER: Self- Organization Mechanisms in <i>Myxococcus</i> <i>xanthus</i> Swarms	\$31,000
July 2009 June 2012	Co-Principal Investigator	National Science Foundation	Systems Analysis of the Sporulation Initiation Network in the Bacterium Bacillus subtilis (PI: M. Fujita, UH)	\$252,199 (subcontract for Rice)
Oct 2009- Dec 2012	Principal Investigator	John C Dunn Foundation	Synthetic tuning of a breast cancer- controlling network	\$97,400
May 2010- April 2013	Co-Principal Investigator	National Science Foundation	MRI-R2: Acquisition of Data Analysis and Visualization Cyber-Infrastructure for Computational Science and Engineering Applications(DAVinCI)"	\$2,928,889
Aug 2010- July 2015	Principal Investigator	National Institutes of Health, NIGMS	R01 GM096189 Feedback regulation and transcriptional coupling in bacterial stress-response (co-PIs: M. Gennaro and G. Balazsi)	\$1,347,801(total including subcontracts)
Sept 2010-Aug 2014	Subcontract/ Co-Principal Investigator	National Institutes of Health, NHLBI	Mapping and modeling host-pathogen interactions in TB latency and reactivation(<i>PIs: M. Gennaro, R. Pine, E.</i> <i>Sontag and G. Balazsi</i>)	\$441,996 (subcontract for Rice)
Sept 2011-Aug 2015	Co-Principal Investigator	National Science Foundation	EFRI-MKS: Harnessing Intercellular Signaling to Engineer Pattern Formation (PI: J. Tabor)	\$1,999,997 (total including subcontracts)
Jan 2013- Dec 2015	Co-Principal Investigator	NHMRC Project Grant, Australia	Reconstructing Transcriptional Networks in Leukaemic Cells	\$60,000(2014- 15, direct cost subcontract)
Feb 2013- Jan 2016	Principal Investigator	National Science Foundation	MCB-1244135, Collaborative research: Information processing by gene regulatory network controlling bacterial sporulation	\$261,481.00
July 2014- June 2017	Principal Investigator	National Science Foundation	Collaborative Research: Decoding the self-organization mechanism in <i>Myxococcus xanthus</i> multicellular development with quantitative experiments and mathematical modeling	\$340,000 (tot over 3 years)

External Research Support:

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July 2014- June 2017	Co-Principal Investigator	National Science Foundation	Network Governing <i>Myxococcus</i> Development	\$94,000(sub over 2 years)
Aug 2014- Aug 2019	Senior Investigator	National Science Foundation	Center for Theoretical Biological Physics - Houston	\$9,400,000.00 (total for 10 investigators)
June 2015- May 2017	Co-Principal Investigator	National Institutes of Health, NIAID	Interrogation of <i>B. subtilis</i> sporulation network with light-switchable promoter	\$275,000 (full amount)
May 2016- April 2020	Principal Investigator	National Science Foundation	MCB- 1616755 Collaborative research: Information integration by gene regulatory networks controlling bacterial cell fate decisions	\$905,847 (including UCSD sub)
Nov 2016 – October 2018	Co-Principal Investigator	DARPA	HR0011-17-2-0012 Engineered control systems for asymmetric cell division in synthetic bacteria	\$900,000 (full amount)
June 2019-May 2022	Principal Investigator	Welch Foundation	C-1995-20190330 Speed-Accuracy- Dissipation Trade-Offs in Non- Equilibrium Biochemical Information Processing	\$165,000 (direct)
July 2019- June 2022	Principal Investigator	National Science Foundation	DMS- 1903275 Collaborative Research: Mechanisms of Multicellular Self- Organization in Myxococcus xanthus	\$ 309,089 (Rice part)
July 2019- June 2023	Principal Investigator	National Science Foundation	Collaborative Research: RoL: Deep- learning framework to quantify emergent multicellular phenotypes for functional gene annotation	\$ 709,844

Total as PI (including some subcontracts): ~\$4,800k

Total as co-PI (including some subcontracts and equipment grants):~\$4,650k

Teaching:

- BIOE Undergraduate Core Class: Numerical Methods for Bioengineering
- BIOE Graduate Core Class: Introduction to Computational biology
- BIOE Grad Elective/SSPB Core Grad Class: Introduction to Systems Biology: Modeling and Design Principles of Biochemical Networks
- Seminars: Advances in Bioengineering, SSPB Graduate Seminar
- •

Other educational activities:

- Co-advisor, Rice iGem Team, 2007-2009
- Guest lecturer in several Summer schools