

Oleg A. IgoshinProfessor 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
- Pharmacokinetics and pharmacodynamics
- Statistical mechanics of biochemical enzymes and reaction networks

Positions:**Dates:**

- Professor and Associate Chair, Department of Bioengineering, Rice University 07/19 -present
- Associate Professor, Department of Bioengineering, Rice University 07/13 – 06/19
- Assistant Professor, Department of Bioengineering, Rice University 01/07 – 06/13
- Joint Appointment in the Department of Biosciences 09/12 -present
- Joint Appointment in the Department of Chemistry 01/19 -present
- Postdoctoral Researcher, Department of Biomedical Engineering, UC Davis
Advisor: Prof. Michael Savageau 10/04 -12/06
Research Project: Signaling Pathways in *Bacillus subtilis*

Education:

- PhD in Physics, Department of Physics, UC Berkeley 08/00 -08/04
Advisor: Prof. George Oster, Dept. Molecular and Cell Biology
Thesis topic: *Modeling of pattern formation in Myxobacteria*
- MSc, Chemical Physics Department, Feinberg Graduate School, Weizmann Institute of Science, Israel, 10/98-07/00
Advisor: Prof. A. I. Burshtein,
Thesis topic: *Diffusion-assisted electron and energy transfer*
- BSc *Summa Cum Laude*, Physics Department, Novosibirsk State University, Russia 09/94-06/98
Advisors: Prof. A.B. Doktorov, Dr. A.A. Kipiyanov
Thesis topic: *Nonequilibrium statistical mechanics of chemical reactions*

Honors and awards:

- Outstanding Faculty Associate, Sid Richardson College, Rice University 2017
- Distinguished Faculty Associate, Sid Richardson College, Rice University 2012-16,2018
- Premium Award in Systems Biology, Institute of Engineering and Technology (IET) 2011
- John C Dunn Foundation Collaborative Research Award 2009
- NSF CAREER Award 02/2009

List of publications (papers):

[† co-corresponding authors, * - equal contribution] **h-index** =37([Google Scholar](#))

1. Burshtein, A.I., Igoshin, O.A. *Photoconductivity and singlet oxygen generation in illuminated polymer in the air atmosphere*. Journal of Chemical Physics (1999) **111**: 2200-2209.
2. Krissinel, E.B., Igoshin, O.A., Burshtein, A.I. *Integral, unified and Markovian theories of biexcitonic photoionization*. Chemical Physics (1999) **247**: 261-273.
3. Igoshin, O.A., 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. Igoshin, O.A., 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., Igoshin, O.A., 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 $A + B \rightarrow B$* . Physica A (2000) **275**: 99-133.
8. Igoshin, O.A., Burshtein, A.I. *Impurity quenching of fluorescence in intense light. Violation of the Stern-Volmer law*. Journal of Chemical Physics (2000) **112**: 10930-10940.
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10. Lukzen, N.N., Krissinel, E.B., Igoshin, O.A., 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.
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13. Igoshin, O.A., Oster, G. *Rippling of myxobacteria*. Math Biosci (2004) **188**: 221-233.
14. Igoshin, O.A., Welch, R., Kaiser, D., Oster, G. *Waves and aggregation patterns in myxobacteria*. Proc Natl Acad Sci U S A (2004) **101**: 4256-4261.
15. Igoshin, O.A., 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. Igoshin, O.A., 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. Igoshin, O.A., 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.
18. Igoshin, O.A., Brody, M.S., Price, C.W., Savageau, M.A. *Distinctive topologies of partner-switching signaling networks correlate with their physiological roles*. J Mol Biol (2007) **369**: 1333-1352.
19. Veening, J.W., Igoshin, O.A., 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., Igoshin, O.A. *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., Igoshin, O.A., 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., [Igoshin, O.A.](#) *Adaptable functionality of transcriptional feedback in bacterial two-component systems*. PLoS Comput Biol (2010) **6**: e1000676.
26. Narula, J., Smith, A.M., Gottgens, B., [Igoshin, O.A.](#) *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., [Igoshin, O.A.](#) *Thermodynamic models of combinatorial gene regulation by distant enhancers*. IET Syst Biol (2010) **4**: 393-408.
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29. Tiwari, A., Ray, J.C., Narula, J., [Igoshin, O.A.](#) *Bistable responses in bacterial genetic networks: designs and dynamical consequences*. Math Biosci (2011) **231**: 76-89.
30. Ray, J.C.J., Tabor, J.J., [Igoshin, O.A.](#) *Non-transcriptional regulatory processes shape transcriptional network dynamics*. Nature Reviews Microbiology (2011) **9**: 817-828.
31. Zhang, H.Y., Angus, S., Tran, M., Xie, C.Y., [Igoshin†, O.A.](#), Welch†, R.D. *Quantifying Aggregation Dynamics during Myxococcus xanthus Development*. J Bacteriol (2011) **193**: 5164-5170.
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33. Tiwari, A., and [Igoshin, O.A.](#), *Coupling between feedback loops in autoregulatory networks affects bistability range, open-loop gain and switching times*, Physical Biology (2012) **9**: 055003.
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35. Narula, J., Devi, SN, J., Fujita†, M. and [Igoshin†, O.A.](#), *Ultrasensitivity of B. subtilis sporulation decision*, Proc Natl Acad Sci U S A (2012) **109**: 20196–20197 and E3513–E3522 [† co-corresponding authors.]
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41. Castillo-Hair, S.M., [Igoshin, O.A.](#) and Tabor, J.J. *How to train your microbe: methods for dynamically characterizing gene networks*, Current Opinion in Microbiology, (2015) **24**: 113–123
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43. Narula*, J., Kuchina*, A., Lee, D.-Y., Fujita, M., Süel†, G.M. and [Igoshin†, O.A.](#), *Chromosomal arrangement of phosphorelay genes couples sporulation and DNA replication*, Cell, (2015) **162**: 328–337

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47. Castillo-Hair, S., Sexton, J., Landry, B., Olson, E., Igoshin, O.A., 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
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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
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61. Mallory, J.D., Kolomeisky†, A.B., Igoshin†, O.A. *Trade-Offs between Error, Speed, Noise and Energy Dissipation in Biological Processes with Proofreading*, Journal of Physical Chemistry B (2019) **123**: 4718-4725 <https://doi.org/10.1021/acs.jpccb.9b03757>
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68. Zhang,Z., Cotter,C., Lyu,Z., Shimkets L.J., Igoshin, O. A., *Data-driven models reveal mutant cell behaviors important for myxobacterial aggregation*, mSystems(2020) **5**(4) e00518-20, <https://doi.org/10.1128/mSystems.00518-20>
69. Zhang*, H., Lyu*, Z, Y. Fan*, C. R. Evans*, K. W. Barber, K. Banerjee, O. A. Igoshin, J. Rinehart, J. Ling, *Metabolic Stress Promotes Stop Codon Readthrough and Phenotypic Heterogeneity*, PNAS (2020) **117**(36) 22167-22172 <https://doi.org/10.1073/pnas.2013543117>
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79. Chen, Z., Srivastava, P., Zarazúa-Osorio, B., Marathe, A., Fujita†, M. and Igoshin†, O.A., *Bacillus subtilis histidine kinase KinC activates biofilm formation by controlling heterogeneity of single-cell response*, mBio (2022) **13** (1): e01694-21
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81. Yu, Q., Kolomeisky, A.B., Igoshin, O.A., *The energy cost and optimal design of networks for biological discrimination*, Royal Society Interface (2022) **19**: 20210883
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91. Perepelitsa†, M., Timofeyev, I., Murphy, P., Igoshin†, O.A., *On the existence of weak solutions for the kinetic models of the motion of myxobacteria with alignment and reversals*, Kinetic and Related Models (2025) <https://doi.org/10.3934/krm.2025001>
92. Igoshin*†, O.A., Kolomeisky*†, A.B., Makarov†*, D.E., *Uncovering dissipation from coarse observables: a case study of a random walk with unobserved internal states*. Journal of Chemical Physics (2025) **162**: 034111 <https://doi.org/10.1063/5.0247331> [Editor's Pick]
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95. Nash, A.M., DeBonis, J., Murungi, D., Castillo, B., Kim, B., Hu, F., Chambers, C., Nguyen, A. Hernandez, A., Wang, Z., Rios, P.D., Ghandi S., Joshi I., Isa D., Zheng, N., Peng, W., Igoshin, O.A., Oberholzer, J., Hodges, H.C., Reticker-Flynn, N., and Veiseh, O., *IL-12-producing cytokine factories induce precursor exhausted T cells and elimination of primary and metastatic tumors. cytokine factories induce precursor exhausted T cells and elimination of primary and metastatic tumors*, Journal for the Immunotherapy of Cancer (2025) 0:e010685. <https://doi.org/10.1136/jitc-2024-010685>
96. Khan, T., Murphy, P., Zhang, J., Igoshin†, O.A., Welch R.D., *Genetic and Environmental Determinants of Streaming and Aggregation in Myxococcus xanthus*, submitted preprint <https://doi.org/10.1101/2024.11.06.622364>
97. Hecht, A.D., Igoshin†, O.A., *Kinetic mechanism for fidelity of CRISPR-Cas9 variants*, submitted, preprint <https://doi.org/10.1101/2025.01.27.634389>
98. Zhang, Y., Palma, C. S.D., Chen, Z., Zarazúa-Osorio, B., Fujita, M. and Igoshin†, O.A., *Biophysical modeling reveals the transcriptional regulatory mechanism of Spo0A, the master regulator in starving Bacillus subtilis*, submitted, preprint <https://doi.org/10.1101/2025.01.21.634141>
99. Palma, C.S.D., Haller, D.J., Tabor, J.J., Igoshin†, O.A., Spo0A~P pulsing period is the primary cause for biofilm matrix deactivation, submitted, preprint <https://doi.org/10.1101/2025.02.13.638117>
100. Li, S., Zhang, J., Ajo-Franklin†, C.M., Igoshin†, O.A., *The growth benefits and toxicity of quinone synthesis are balanced by a dual regulatory mechanism and substrate limitations*, submitted, preprint <https://doi.org/10.1101/2025.02.15.638467>
101. Midha, T., Kolomeisky†, A.B., Igoshin†, O.A., *Kinetic mechanisms for the sequence dependence of transcriptional errors*, submitted, preprint <https://doi.org/10.1101/2025.03.04.641307>

List of publications (book chapters):

1. Balazsi, G., Igoshin, O.A. 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**
2. Harvey, C.W., Igoshin, O.A., 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):

1. 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 pattern formation and emergent collective behaviors in myxobacteria*, HHMI – Janelia Farms, Ashburn, VA 4/4/2024
2. *Understanding Trade-offs in Biological Error Correction*, Physics Colloquium, Univ of Arizona 12/01/2023
3. *Understanding Trade-offs in Biological Information Processing*, Dept of Physics Seminar, Postech, Pohang, Republic of Korea 05/17/2023
4. *Uncovering the mechanisms of pattern formation and emergent collective behaviors in myxobacteria*, Computational Sciences Colloquium, KIAS, Seoul, Republic of Korea 05/08/2023
5. *Uncovering the mechanisms of pattern formation and emergent collective behaviors in myxobacteria*, Mathematical Sciences Colloquium, KAIST, Daejeon, Republic of Korea 05/04/2023
6. *Understanding Trade-offs in Biological Information Processing*, Biomedical Mathematics Seminar, Institute of Basic Sciences, Daejeon, Republic of Korea 05/01/2023
7. *Uncovering the mechanisms of pattern formation and emergent collective behaviors in myxobacteria*, Institute of Mathematics Colloquium, UFRJ, Rio de Janeiro, Brazil 03/22/2023
8. *Uncovering the mechanisms of pattern formation and emergent collective behaviors in myxobacteria*, Dept of Physics Colloquium, UNICAMP, Campinas, Brazil 03/20/2023
9. *Uncovering the mechanisms of pattern formation and emergent collective behaviors in myxobacteria*, Colloquium Instituto de Física Teórica - IFT - Unesp - São Paulo, Brazil 03/17/2023
10. *Understanding Trade-offs in Biological Information Processing*, Invited talk, Mathematical Models in Biology: From Information Theory to Thermodynamics (22w5155), Banff International Research Station, Banff, AB 08/08/2022
11. *Uncovering the mechanisms of self-organization behaviors in Myxococcus xanthus biofilm*, , Invited talk at Aspen Physics Center Winter Conference, Aspen, CO 04/01/2022
12. *Understanding Trade-offs in Biological Error Correction*, Invited seminar, Center for Neuroscience and Cell Biology, University of Coimbra, Portugal (Virtual) 03/04/2022
13. *Understanding Trade-offs in Biological Error Correction*, Biophysics Virtual Seminar Series, Univ of Michigan 12/04/2020
14. *Uncovering the mechanisms of self-organization behaviors in Myxobacteria biofilms*, Invited talk at The Physics of Collective Cell Migration, Princeton Center for Theoretical Science, Princeton, NJ 01/16/2020
15. *Slowdown of growth controls cellular differentiation*, Invited talk at Aspen Physics Center Winter Conference, Aspen, CO 01/09/2020
16. *Making cell-fate-decisions: Lessons from Sporulating Bacteria*, Invited seminar, Duke Center for Genomic and Computational Biology, Durham, NC 12/09/2019

17. *Understanding trade-offs of biological error correction*, Invited talk, Workshop on Protein-DNA Interactions: from Biophysics to Cancer Biology, Rice University 12/05/2019
18. *Understanding trade-offs of biological error correction*, Keynote talk, 16th International Conference on Molecular Systems Biology, De La Salle University, Manila 10/29/2019
19. *Uncovering the mechanisms of self-organization behaviors of Myxococcus xanthus bacteria*, Invited seminar, Chinese University of Hong Kong 06/17/2019
20. *Pattern formation and multicellular self-organization behaviors in myxobacterial biofilms*, Quantitative Biology Seminar, UCSD 05/20/2019
21. *Uncovering the mechanisms of self-organization behaviors of Myxococcus xanthus bacteria*, Invited colloquium, Department of Physics, Emory University, Atlanta, GA 12/03/2018
22. *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
23. *Making cell-fate-decisions: Lessons from Sporulating Bacteria*, Biophysics group seminar, UC Berkeley, CA 07/27/2018
24. *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
25. *Uncovering the mechanisms of self-organization behaviors in Myxococcus xanthus bacteria*, Systems Biology Seminar, Boston University 04/19/2018
26. *Uncovering the mechanisms of self-organization behaviors in Myxococcus xanthus bacteria*, Department of Mathematics Colloquium, Georgia State University 01/19/2018
27. *Uncovering the mechanisms of self-organization behaviors in Myxococcus xanthus bacteria*, Bacterial Interest Group (BIG), Texas Medical Center, Houston, TX 12/13/2017
28. *Uncovering the mechanisms of self-organization behaviors of Myxococcus xanthus bacteria*, Invited talk at 11th annual q-bio Conference, Rutgers, NJ 08/02/2017
29. *Making cell-fate-decisions: Lessons from Sporulating Bacteria*, Center for “Quantitative Analysis of Molecular and Cellular Biosystems” Heidelberg University 06/23/2017
30. *Making cell-fate-decisions: Lessons from Sporulating Bacteria*, National Institute of Health Biophysics group 01/25/2017
31. *Uncovering design principles of bacterial cell-fate decision network*, Department of Microbiology, UC Davis, CA 12/14/2016
32. *Making cell-fate-decisions: Lessons from Sporulating Bacteria*, Biophysics seminar, UCSF, San Francisco, CA 12/12/2016
33. *Making cell-fate-decisions: Lessons from Sporulating Bacteria*, Department of Bacteriology Distinguished Lectures in Microbiology, UW Madison, WI 12/08/2016
34. *Making cell-fate-decisions: lessons from sporulating bacteria*, Basic Sciences Division Seminar, Fred Hutchinson Cancer Research Center, Seattle, WA 04/12/2016
35. *Uncovering design principles of bacterial cell-fate decision network*, Joint CMU-Pitt Ph.D. Program in Computational Biology Seminar, University of Pittsburgh, PA 04/08/2016
36. *Gene dosage imbalance during DNA replication controls bacterial cell-fate decision*, Invited Focus Session talk, APS March Meeting 03/17/2016
37. *Uncovering design principles of bacterial cell-fate-decision network*, Applied Math Seminar, UC Irvine 02/29/2016
38. *Systems Biology of Cell-fate-decisions: Lessons from Sporulating Bacteria*, Keck Seminar, Gulf Coast Consortia, Houston, TX 02/19/2016
39. *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

40. *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
41. *Uncovering design principles of bacterial cell-fate decision network*, Computational and Integrative Biomedical Research Center Seminar, Baylor College of Medicine, Houston, TX 10/07/2015
42. *Uncovering evolutionary design principles of bacterial differentiation decisions* Northwestern University, Molecular Biophysics Colloquium, Evanston, IL 09/11/2014
43. *Slowdown of cell growth acts as the signal triggering cellular differentiation*, 9th Invited talk, International Conference on Bioinformatics of Genome Regulation and structure\Systems Biology, Novosibirsk, Russia 06/26/2014
44. *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
45. *Stochasticity & Ultrasensitivity In Bacterial Networks*, Departmental Colloquium, Department of Computational and Applied Mathematics and Statistics, Notre Dame University, South Bend, IN 09/09/2013
46. *Stochasticity & Ultrasensitivity In Bacterial Networks*, Center of Quantitative Biology colloquium, Peking University, Beijing, China 08/06/2013
47. *Design principles of Bacillus subtilis sporulation decision network*, NSF/RU Cell Decision Making Workshop, Arlington, VA 06/11/2013
48. *Stochasticity & Ultrasensitivity In Bacterial Networks*, Departmental Colloquium, Department of Microbiology, University of Georgia, Athens, GA 04/11/2013
49. *Uncovering design principles of Bacillus subtilis sporulation network*, Computational and Integrative Biomedical Research Center Seminar, Baylor College of Medicine, Houston, TX 04/03/2013
50. *Uncovering the mechanisms behind Bacillus subtilis sporulation decisions*, Invited talk, Frontiers in Systems and Synthetic Biology '13 (FSSB'13), Atlanta, GA 03/22/2013
51. *Stochasticity & Ultrasensitivity In Bacterial Networks*, Science at the Edge Seminar, Michigan State University, East Lansing, MI 03/15/2013
52. *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
53. *Self-organization mechanisms in Myxococcus xanthus swarms*, Experimental Biophysics Laboratory Seminar, Princeton University, NJ 12/11/2012
54. *Stochasticity & Ultrasensitivity In Bacterial Networks*, Public Health Research Institute Center, UMDNJ - New Jersey Medical School, Newark, NJ 12/10/2012
55. *Stochasticity & Ultrasensitivity In Bacterial Networks*, Systems Biology Seminar, University of Washington, Seattle, WA 12/04/2012
56. *Self-organization mechanisms in Myxococcus xanthus swarms*, Biomedical sciences Colloquium, University of Coimbra, Coimbra, Portugal 09/21/2012
57. *Ultrasensitivity and stochasticity of the Bacillus subtilis sporulation decision*, International Conference on Stochastic Processes in Systems Biology, Genetics & Evolution, Houston, TX 08/23/2012
58. *Interrogating Bacillus subtilis Sporulation Network*, Suel Lab, UT Southwestern, Green Center for Systems Biology, Dallas, TX 07/20/2012
59. *Interrogating Bacillus subtilis Sporulation Network*, Losick Lab, Harvard, Boston, MA 04/24/2012
60. *Stochasticity & Ultrasensitivity In Bacterial Networks*, Department of Physics/Bioinformatics Group, Boston University, Boston, MA 04/23/2012
61. *Stochasticity & Ultrasensitivity In Bacterial Networks*, Systems Biology Theory Lunch, Department of Systems Biology, Harvard Medical School, Boston, MA 04/20/2012

62. *Stochasticity & Ultrasensitivity In Bacterial Networks*, Integrative BioSystems Institute, GeorgiaTech, Atlanta, GA 04/04/2012
63. *Reverse-engineering mechanisms of multicellular self-organization with mathematical modeling and statistical image processing*, MD Andersen, Systems Biology Department, Houston, TX 03/22/2012
64. *Mechanisms of Self-Organization in Myxococcus xanthus Biofilms: Aggregation and Rippling*, Bacterial Interest Group (BIG), Texas Medical Center, Houston, TX 03/08/2012
65. *Stochasticity & Ultrasensitivity In Bacterial Networks*, Department of Bioengineering, University of Texas at Dallas, Dallas, TX 02/28/2012
66. *Stochasticity & Ultrasensitivity In Bacterial Networks*, , Mathematical Biology Seminar, UC Davis, Davis, CA 02/06/2012
67. *Stochasticity and ultrasensitivity in bacterial network*, Department of Bioengineering, Johns Hopkins University, Baltimore, MD 12/14/2011
68. *Stochasticity and ultrasensitivity in bacterial network*, Department of Biomedical sciences Colloquium, University of Coimbra, Coimbra, Portugal 11/18/2011
69. *Dynamical Properties of gene regulatory networks: bistability, feedback and Stochasticity*, Molecular systems Biology Module for PDBEB, University of Coimbra, Coimbra, Portugal 11/18/2011
70. *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
71. *Engineering Approaches to Computational Systems Biology: Research Overview*, Department of Systems Biology Retreat, MD Anderson 10/12/2011
72. *Structure-function relationships in bacterial gene regulatory networks*, 2011 Computational Cell Biology Summer School, Cold Spring Harbor, NY 06/17/2011
73. *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
74. *Interplay of Noisy Gene Expression and Dynamics Explains Patterns of Bacterial Operon Organization*, APS March Meeting 2011, Dallas, TX 03/22/2011
75. *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
76. *Evolutionary Design Principles of Genetic Networks: from E. coli to Stem Cells*, Special Seminar at Center for Computational Biology & Bioinformatics, Columbia University, New York, NY 11/04/2010
77. *Reverse-engineering of self-organization mechanisms in Myxococcus xanthus swarms*, BIOMAPS and Department of Mathematics Seminar, Rutgers University, NJ 11/03/2010
78. *Bistability and low-pass filtering in the network module determining blood stem cell fate*, 7th International Conference on Bioinformatics of Genome Regulation and structure\Systems Biology, Novosibirsk, Russia 06/23/2010
79. *Design Principles of bacterial stress-response circuits*, Bacterial Interest Group (BIG), Texas Medical Center, Houston, TX 06/02/2010
80. *Reverse engineering self-organization of bacterial biofilms*, K2I institute member luncheon seminar, Rice University 04/09/2010
81. *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
82. *Mathematical Modeling in Systems Biology: Introduction and Examples*, Invited guest lecture, University of Houston-Downtown, Houston, TX 03/22/2010

83. *Uncovering the physiological implications of transcriptional feedback in bacterial genetic circuit*, Interdisciplinary cluster on Networks, University of Houston, Houston, TX 02/26/2010
84. *Uncovering its physiological implications of transcriptional feedback with mathematical modeling*, Seminar at Computational Science and Mathematics Division, Pacific Northwest National Lab, Richland, WA 11/12/2009
85. *Transcriptional feedback in bacterial signaling and mammalian development: uncovering its physiological implications with mathematical modeling*, Colloquium at University of Connecticut Health Center, Farmington, CT 09/17/2009
86. *Uncovering design principles of bacterial biochemical networks and biofilm self-organization*, Colloquium at Cambridge Computational Biology Institute, Cambridge, UK 09/18/2008
87. *Uncovering design principles of bacterial biochemical networks*, Colloquium at symposium “Modeling and Analysis of Biological networks”, University of Houston 05/16/2008
88. *Uncovering design principles of biochemical networks*, Department Colloquium, Notre Dame University, Biocomplexity Seminar Series 02/11/2008
89. *Uncovering design principles of biochemical networks*, Department Colloquium, Syracuse University, Department of Biology 02/15/2008
90. *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
91. *Uncovering design principles of bacterial gene regulation*, Department Colloquium, Rice University, Biochemistry and Cell Biology Department 10/12/2007
92. *Patterns and signaling in Myxobacteria development*, Plenary invited talk at International conference on Systems Biology, Long Beach, CA 10/04/2007
93. *Uncovering design principles of bacterial gene regulation with mathematical modeling*, Biology Department Colloquium, University of Houston, TX 09/19/2007
94. *Design principles of graded and bistable switches in signaling networks*, Department Colloquium, MD Andersen, Systems Biology Department 09/05/2007
95. *Graded and bistable switches in bacterial signaling networks*, Stochastic Gene Transcription & Signaling Workshop Rice University 06/22/2007
96. *Bacterial development: Insights from Mathematical Modeling*, CAAM Colloquium, Rice University 04/23/2007
97. *Design principles of graded and bistable responses in bacterial signaling switches*, Biophysics Seminar, Rice University 04/19/2007

Recent conference presentations (self*):

*in addition over 70 presentations by trainees over the last 10 years

1. *Uncovering the mechanisms of motility coordination in myxobacteria*, International Workshop: Chemotaxis - from Basic Physics to Biology, Max Planck Institute for the Physics of Complex Systems 05/13/2024
2. *Making cell-fate decisions: Lessons from B. subtilis sporulation and biofilm formation*, Major ideas in quantitative microbial physiology: Past, Present and Future The Carlsberg Academy, Copenhagen, Denmark[talk] 06/14/2022
3. *Cellular behaviors underlying Myxococcus xanthus aggregate coarsening*, 47th International Conference on the Biology of Myxobacteria, Murcia, Spain[talk] 06/01/2022
4. *Modeling Reveals Possible Mechanisms for Observed Aggregation Cell Behaviors*, 45th International Conference on the Biology of Myxobacteria, Sheffield, UK [talk] 06/04/2018
5. *Uncovering the mechanisms of self-organization behaviors of Myxococcus xanthus bacteria*, 2017 Physics of Living Systems (iPoLS) meeting, Paris, France[talk] 07/26/2017
6. *Mathematical modeling of M. xanthus vegetative spreading*, 44th International Conference on the Biology of Myxobacteria, Arlington, VA[talk] 06/18/2017

7. *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
8. *Stoichiometric sequestration and feedback regulation in alternative σ -factor networks: implications for response dynamics*, Microbial Stress Response Gordon Conference, Mount Holyoke College, South Hadley, MA [poster] 07/21/2016
9. *Bacillus subtilis sporulation decision is controlled by DNA replication dynamics and slowdown of Cell Growth*, 5th ASM Conference on Prokaryotic Cell Biology and Development, Washington D.C. [talk] 06/14/2015
10. *Slowdown of cell growth acts as the signal triggering cellular differentiation*, The 8th Annual q-bio Conference on Cellular Information Processing, Santa Fe, NM [talk] 08/16/2014
11. *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
12. *Mechanism of cell alignment in M. xanthus groups*, 41st International Conference on the Biology of Myxobacteria, Frejus, France [talk] 05/27/2014
13. *Biophysical analysis of mechanical intercellular interactions discriminates between alternative models of A-motility*, 40th Annual International Conference on the Biology of the Myxobacteria, Beijing, China [talk] 08/08/2013
14. *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
15. *Self-organization mechanisms in Myxococcus xanthus swarms*, John Dunn Multicellular Self-Organization Meeting, Rice University, Houston, TX, [talk] 11/09/2012
16. *Interplay of Gene Expression Noise and Ultrasensitive Dynamics Influences Bacterial Operon Organization*, 8th International Conference on Bioinformatics of Genome Regulation and structure\Systems Biology, Novosibirsk, Russia [talk] 06/29/2012
17. *Ultrasensitivity of B. subtilis sporulation decision*, 4th ASM Conference on Prokaryotic Cell Biology and Development, Montreal, QE, Canada [poster] 05/02/2012
18. *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
19. *Pattern Formation in Myxococcus xanthus, Growth and patterns: pattern formation in Biology*, Aspen Center for Physics, Aspen, CO [poster] 01/03/2012
20. *Ultrasensitivity of B. subtilis sporulation decision*, 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
21. *Reverse-engineering of self-organization mechanisms in Myxococcus xanthus swarms*, The 5th Annual q-bio Conference on Cellular Information Processing, Santa Fe, NM [talk] 08/12/2011
22. *Statistical image analysis reveals features affecting the fates of Myxococcus xanthus developmental aggregates*, 38th Annual International Conference on the Biology of the Myxobacteria, Mt Kisco, NY [talk] 07/19/2011
23. *Patterns of bacterial operon organization reduce network noise, Stochastic Physics in Biology*, Gordon Research Conference, Ventura, CA [poster] 01/24/2011
24. *Bacterial Operon Patterns Reduce Biochemical Noise*, Workshop and Symposium “From Networks to Pattern Formation – Evolution of Biological Function, Houston, TX, [talk] 12/04/2010
25. *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

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| 26. <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 |
| 27. <i>Multiple positive feedbacks lead to bistability and low-pass filtering in gene regulatory network module controlling hematopoiesis</i> , Workshop 2: Signal transduction and gene regulatory networks, Ohio Mathematical Biosciences Institute, Columbus, OH [talk] | 11/03/2009 |
| 28. <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 |
| 29. <i>Understanding Feedback Architectures in Two-Component Systems Signaling</i> , 3rd ASM Conference on Prokaryotic Development, Cambridge, MA [poster] | 07/02/2009 |
| 30. <i>Feedback regulation and bistability in bacterial two-component systems</i> , ICAM workshop “Evolutionary Design Principles of Biological Networks” 4 th Computational and Theoretical Biology Symposium, [talk] | 12/06/2008 |
| 31. <i>Feedback regulation and bistability in bacterial two-component systems</i> , Microbial Stress Response Gordon Conference, Mount Holyoke College, South Hadley, MA [poster] | 07/08/2008 |
| 32. <i>Graded and Bistable Switches in Bacterial Development and Stress Responses</i> , 3 rd Computational and Theoretical Biology Symposium, Rice University, [talk] | 12/07/2007 |

Service:Departmental:

- Associate Chair, 2019-present
- Faculty mentoring committee, co-chair 2022-present
- Faculty Award committee, c-chair 2024-25
- MBE Committee, Chair 2016-2019
- Admission committee, 2007, 2011-15, 2017-18 – member, 2008 – co-chair
- Awards committee, 2009-11
- Faculty Search committee, 2013- 2022
- Undergraduate advising committee, 2016-present

University:

- Rice Institute of Synthetic Biology Steering Committee, 2023-present
- Systems, Synthetic and Physical Biology (SSPB) Ph.D. Program steering committee: 2012-present
- SSPB admission committee: 2012-2017; chair 2015-2017
- Benefits Committee, 2013-2023
- High-performance computing subcommittee, 2008-2020
- Divisional Advisor for Engineering, Sid Richardson College (2008 –2013)

Professional:

- **Journal Editorial Boards:** Associate Editor, PLOS Computational Biology; Associate Editor, msystems
- **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. **Discussion Leader**, 2023 Collective Behavior Conference GRC, Newry, ME, USA, 08/19

2. **Co-Organizer:** Emergent Collective Behaviors: Integrating Simulation and Experiment, Banff International Research Station (BIRS), Canada, May 2022
3. **Organizer:** 46th International Conference on the Biology of Myxobacteria, Rice University, Houston, 06/2019
4. **Local organizing committee chair:** 12th Annual q-bio Conference | Quantitative and Systems Biology, Rice University, Houston, 06/2018
5. **Co-chair and organizer,** Focus Session, APS March Meeting, 2016, Baltimore, MD
6. **Co-organizer:** Annual Computational & Theoretical Biology Symposium, Rice University, Houston, TX, 2007-2013
7. **Session co-chair:** Biomedical Engineering Society Annual Meeting, Atlanta, GA, 10/2012
8. **Co-organizer:** ICAM workshop “*Multiscale Theory of Networked Biological Systems: from Molecular Complexes to Cellular Networks and Multicellular Self-organization*”, Rice University, 12/2011
9. **Session co-chair:** Biomedical Engineering Society Annual Meeting, Hartford, CT, 10/2011
10. **Organizing committee:** XII International Congress on Molecular Systems Biology (ICMSB2011), Universitat de Lleida (Spain), 05/2011
11. **Co-organizer:** Workshop and Symposium: “*From Networks to Pattern Formation – Evolution of Biological Function*”, Houston, TX, 12/2010
12. **Co-organizer:** *From Motors to Morphogenesis: George Oster-Inspired Research*, Berkeley, CA, 05/2009
13. **Invited Discussion Leader:** *I2CAM Workshop on "Soft Active Matter: from Granular Rods to Flocks, Cells and Tissues"*, 05/2009
14. **Session chair:** *Bioinformatics Workshop, 26th Annual Houston Conference on Biomedical Engineering Research*, 03/2009
15. **Co-organizer:** ICAM workshop “*Evolutionary Design Principles of Biological Networks*”, Rice University, 12/2008

External Research Support:

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 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 <i>Bacillus subtilis</i> (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(PIs: M. Gennaro, R. Pine, E. Sontag and G. Balazsi)	\$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)
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
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 <i>Myxococcus xanthus</i>	\$ 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
Sep 2020- Aug 2026	Senior Investigator	National Science Foundation	PHY-2019745, Center for Theoretical Biological Physics	~\$15mil
Sep 2021- Aug 2025	Co-PI	NIH	Dynamics and pattern formation in differentiating cellular populations	\$1,200,000

May 2022- April 2026	Co-PI	NSF	Optogenetic interrogation of <i>B. subtilis</i> stress-response network dynamics	\$1,311,080
June 2022- May 2025	Principal Investigator	Welch Foundation	C-1995-20220331 Non-equilibrium mechanisms controlling the selectivity of biochemical information processing	\$300,000 (direct)
October 2023- Feb 2029	Investigator, PK-modeling Lead	ARPA-H	THOR: Targeted Hybrid Oncotherapeutic Regulation	\$45,021,264

Teaching:

- BIOE Undergraduate Core Class: Numerical Methods for Bioengineering
- BIOE Undergrad Lab: Computational Biology
- 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

Ph.D. Student mentoring:**Current Students**

Jiangguo Zhang (BIOE), Andrew Hecht (BIOE), Zheng Diao (SSPB, co-advised with Caleb Bashor), Yujia Zhang (BIOE), Yiduo Wang (BIOE, co-advised with Caleb Bashor), Jon DeBonis (BIOE)

Alumni

Name	Degree	Position
Zhang, Haiyang	Ph.D. in BIOE, 2012	Principal Researcher, Amazon
Tiwari, Abhinav	Ph.D. in BIOE, 2013	Pfizer 2013-2018, Deceased 2018
Narula, Jatin	Ph.D. in BIOE, 2015	Pfizer
Balagam, Rajesh	Ph.D. in BIOE, 2017	Software Engineer - Machine Learning Apps at MathWorks
Castillo-Hair, Sebastian	Ph.D. in BIOE, 2019 (co-supervised with Jeff Tabor)	Research Assistant Professor, UW
Sara Molinari	Ph.D. in SSPB, 2019 (co-advised with Matt Bennett)	Assistant Professor of Bioengineering, University of Maryland College Park
Rao, Satyajit	Ph.D. in BIOE, 2020	Translational modeler, Novartis Biomedical Research
Zhang, Zhaoyang	Ph.D. in PHYS, 2020	Senior Scientist @ PROS
Coleman, Seth	Ph.D. in APPLPHYS, 2021	Engineering Scientist at Applied Research Laboratories, The University of Texas at Austin

Chen, Zhuo	Ph.D. in SSPB, 2022	Scientist at Shenzhen BGI Genomics Co., Ltd.
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Other educational activities:

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