

Dr. Sabina Jehan Haque

Postdoctoral Fellow in Systems Biology, Harvard Medical School

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Overview

I am an applied mathematician broadly compelled by explaining the cell with pure and applied math. I recently completed my PhD in [Systems Biology](#) at Harvard University advised by [Dr. Jeremy Gunawardena](#). My doctoral research involves using graph theory and stochastic processes to understand how cellular information processing tasks, such as those in eukaryotic gene regulation, depart from thermodynamic equilibrium. In September 2024, I will join the University of Michigan Ann-Arbor's Center for Applied and Interdisciplinary Mathematics and Center for the Study of Complex Systems as a Van Loo Postdoctoral Fellow.

Education

Harvard University

PhD in Systems Biology

Advisor: Jeremy Gunawardena

Dissertation title: Graph-theoretic approaches to biochemical reaction networks

Sep 2018 - Apr 2024

Middlebury College

B.A. in Mathematics (high honors),
Molecular Biology & Biochemistry

Sep 2014 - May 2018

Experience

University of Michigan Ann-Arbor

Van Loo Independent Postdoctoral Fellow

Sep 2024 - present

Harvard Medical School

Postdoctoral Research Fellow

May 2024 - Jun 2024

Research Interests

Geometry and topology

Algebraic graph theory

Spectra of Laplacian matrices

Chemical reaction network theory

Category theory & its applications

Cellular information processing

Non-equilibrium biophysics

3D structure of the genome

Low Reynolds number fluid dynamics

Continuous time Markov processes

Publications

1. **Haque, S. J.**, Satriano, M., Sorea, M. & Yu, P. Y. The Disguised Toric Locus and Affine Equivalence of Reaction Networks. *SIAM J. Appl. Dyn. Syst.* **22**, 1423–1444 (2023)
2. Chavez, A., Tuttle M, Pruitt B. W., Ewen-Campen B., Chari R., Ter-Ovanesyan D., **Haque S. J.** *et al.* Comparison of Cas9 activators in multiple species. *Nat. Methods* **13**, 563–567 (2016)

In Preparation

3. **Haque S. J.**, Cetiner U., Gunawardena J. Anomalous behaviour of the Steinberg signature for detecting departure from thermodynamic equilibrium. (In preparation).
4. **Haque S. J.**, Nam K.-M., Gunawardena J. A graph construction for analysing the parametric asymptotics of Markov processes (In preparation).

Fellowships and Awards

Lynch Foundation PhD Fellowship Department of Systems Biology, Harvard University	2023 - 2024
NSF-Simons QBio PhD Fellowship NSF-Simons Center for Mathematical & Statistical Analysis of Biology, Harvard University	2021 - 2022
Lynch Foundation PhD Fellowship Department of Systems Biology, Harvard University	2019 - 2021
Graduation with high honors Department of Mathematics, Middlebury College	2018
Outstanding Oral Presentation Graduate Program in Physical and Engineering Biology, Yale University	2017
College Scholar (Dean's List equivalent, earned each eligible semester) Middlebury College	2014 - 2018

Selected Talks

Following the energy: graph-theoretic models of broken detailed balance with biochemical applications. Barcelona Collaboratorium for Modelling and Predictive Biology, UPF, Barcelona Spain	Oct 17 2023
A graph-theoretic approach to Markov processes with applications in biochemical reaction networks. Mathematics Department Colloquium, Middlebury College, Middlebury VT	Oct 3 2023
Following the energy: graph-theoretic models of broken detailed balance with biochemical applications. NSF-Simons QBio Seminar, Harvard University, Cambridge MA	Apr 25 2023

Following the energy: graph-theoretic models of broken detailed balance with biochemical applications.	Mar 26 2023
Systems Biology Department Seminar, Harvard University, Cambridge MA	
Graph-theoretic models of detecting broken detailed balance in molecular information processing.	Jul 11 2022
2022 SIAM Annual Meeting MS 26: Trends and New Results in Deterministic Models of Biochemical Interaction Networks, Pittsburgh PA	
Graph-theoretic models of non-equilibrium conditions in molecular information processing.	May 17 2022
Systems Biology PhD Program retreat, Harvard University, Cambridge MA	
Investigating mathematical properties of non-equilibrium signatures in biological information processing systems.	Mar 16 2022
Poster at 2022 American Physical Society Annual March Meeting, Chicago IL	
Graph-theoretic models of non-equilibrium conditions in molecular information processing.	Nov 10 2021
NSF-Simons QBio Seminar, Harvard University, Cambridge MA	
Using the linear framework to analyze non-equilibrium behavior in biological systems.	Dec 03 2019
Systems, Synthetic, and Quantitative Biology G2 Symposium, Harvard University, Cambridge MA	
Stochasticity and magnetoreception in models of magneto-aerotaxis: an idea in-progress.	May 15 2019
Poster at NSF-Simons Quantitative Biology Initiative Symposium, Harvard University, Cambridge MA	
Dynamics and perturbations in laminar flows: an analytical approach.	May 09 2018
Mathematics Department senior thesis talk, Middlebury College, Middlebury VT	
Analysis of endocytic protein dynamics by stochastic modeling of fluorescent signal lifetimes.	Sep 09 2017
Mathematics Department seminar, Middlebury College, Middlebury VT	
Analysis of endocytic protein dynamics by stochastic modeling of fluorescent signal lifetimes.	July 18 2017
Physical and Engineering Biology (PEB) REU Symposium, Yale University, New Haven CT	
Modeling neurodegenerative diseases in <i>S. cerevisiae</i> of fluorescent signal lifetimes.	Aug 01 2016
Church lab meeting, Harvard University, Cambridge MA	

Harvard University

AM 50: Introduction to Applied Mathematics

Spring 2020

Middlebury College (STEM Peer Tutor)

MATH 0223: Multivariable Calculus

Spring 2018

CHEM 0322: Biochemistry of Macromolecules

Spring 2018

MATH 0122: Calculus II

Fall 2017

MATH 0121: Calculus I

Fall 2017

MATH 0200: Linear Algebra

Spring 2017

Precalculus (private tutoring)

Spring 2016

Middlebury College (Peer Writing Tutor for First Year Writing Seminars)

Head First Year Seminar Mentor

2017 - 2018

FYSE 1259: Science and Science Fiction

Fall 2017

FYSE 1483: The Magic of Numbers

Fall 2016

FYSE 1167: Shakespeare's Characters

Fall 2015

Conferences and workshops attended

Simons-NSF MathBioSys Annual Meeting 2023

Apr 2023

Simons Foundation, New York NY

2022 SIAM Annual Meeting

Jul 2022

David L. Lawrence Convention Center, Pittsburgh PA

APS Annual March Meeting 2022

Mar 2022

McCormick Place - West Building, Chicago IL

Quantitative Approaches in Biology (virtual)

Nov 2020

Northwestern University NSF-Simons Center

Mathematical Models in Biology: From Information Theory to Thermodynamics (virtual)

Jul 2020

Banff International Research Station (BIRS)

Workshop on Dynamics, Randomness, and Control in Molecular and Cellular Networks

Nov 2019

Center for Mathematical Sciences and Applications, Harvard University, Cambridge MA

Quantitative Biology Initiative Symposium

May 2019

Harvard University, Cambridge MA

Outreach

Guest speaker for summer class on Physics of Biological Function

Jun 2023

Wentworth Institute of Technology, Boston MA

Cambridge Science Festival volunteer Cambridge, MA	Oct 2022
Graduate research assistant in Quantitative Biology grant preparation NSF-Simons Center for Quantitative Biology, Harvard University, Cambridge MA	May-Jul 2022
Diversity, equity, and inclusion contributor, recruiter, and mentor Systems Biology Department/PhD Program, Harvard University, Cambridge MA	2020-present
“What is Systems Biology?” outreach event creator/coordinator Cambridge Science Festival, Cambridge MA	Apr 2019
Guest speaker at Teen Cafe in Biotechnology MIT Museum, Cambridge MA	Apr 2019

Writing

Cellular mathematics: how does math enhance our understanding of life at the molecular level? https://sabinahaque.substack.com/	2022-present
Graph Theory 101 Science in the News Special Edition: Networks, Harvard University, Cambridge MA https://sitn.hms.harvard.edu/flash/2021/graph-theory-101/	Jun-Aug 2021
Challenging an epidemic of systemic racism in America https://medium.com/@sjhaque14/challenging-an-epidemic-of-systemic-racism-in-america-26c419744fb9	Jun 2020

References

References made available upon request.