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OFER KIMCHI

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CURRENT

Branco Weiss Fellow October 2024 – 2029
Lewis-Sigler Theory Scholar, Princeton University *Princeton, NJ*
Fellow, Center for the Physics of Biological Function, City University of New York *New York, NY*
September 2021 – present

EDUCATION

Harvard University *Cambridge, MA*
Ph.D., Biophysics May 2021
National Defense Science and Engineering Graduate (NDSEG) Fellowship

Princeton University *Princeton, NJ*
A.B., Physics; Graduated with Highest Honors May 2016
Certificates: Quantitative & Computational Biology; Applied & Computational Mathematics

SELECTED FELLOWSHIPS, HONORS AND AWARDS

Branco Weiss Fellowship *~$660K over 5 years to support postdoc-to-faculty transition* 2024 – 2029
Awarded to 7/360 applicants worldwide across sciences, engineering, humanities
Quantitative Biology Ph.D. Fellowship *Harvard University* 2019 – 2021
Certificates of Distinction in Teaching *Harvard University* March 2018, September 2018
DBIO Graduate Student Travel Award *to present at APS March Meeting* January 2017
National Defense Science and Engineering Graduate Fellowship June 2016
Princeton Kusaka Memorial Prize in Physics June 2016
Princeton Applied and Computational Mathematics Independent Project Prize June 2016
Princeton Quantitative and Computational Biology Award June 2016
Member, Phi Beta Kappa Society; Society of Sigma Xi June 2016
Princeton Allen G. Shenstone Prize in Physics May 2015
2015 Education Committee Travel Award *to present at Biophysical Society Meeting* February 2015
Princeton Shapiro Prize for Academic Excellence December 2014
Presidential Scholar Semifinalist; National Merit Scholarship Finalist January 2012

PUBLICATIONS

O. Kimchi, Y. Meir, N. S. Wingreen. *Lytic and temperate phage naturally coexist in a dynamic population model.* ISME Journal 18(1), wrae093 (2024).

O. Kimchi[*], B. B. Larsen[*], O. R. S. Dunkley, A. J. W. te Velthuis, C. A. Myhrvold. *RNA structure modulates Cas13 activity and enables mismatch detection.* bioRxiv 560533 (2023).

O. Kimchi[†], E. M. King, M. P. Brenner. *Uncovering the mechanism for aggregation in repeat expanded RNA reveals a reentrant transition.* Nature Communications 14 (2023).

A. I. Curatolo, **O. Kimchi**, C. P. Goodrich, R. K. Krueger, M. P. Brenner. *A computational toolbox for the assembly yield of complex, heterogeneous structures.* Nature Communications 14 (2023).

T. Chiang, **O. Kimchi**, H. K. Dhaliwal, D. A. Villarreal, F. F. Vasquez, M. P. Brenner, V. Manoharan, R. Garmann. *Measuring intramolecular connectivity in long RNA molecules using two-dimensional DNA patch-probe arrays.* bioRxiv 532302 (2023).

O. Kimchi[†], M. P. Brenner, L. J. Colwell. *RNA structure prediction including pseudoknots through direct enumeration of states: A user's guide to the LandscapeFold algorithm.* RNA structure prediction, Methods in Molecular Biology Springer (2022).

O. Kimchi[†], C. P. Goodrich, A. Courbet, A. I. Curatolo, N. B. Woodall, D. Baker, M. P. Brenner. *Self-assembly based post-translational protein oscillators*. Science Advances 6(51) (2020).

J. Kames, D.D. Holcomb, **O. Kimchi**, M. DiCuccio, N. Hamasaki-Katagiri, T. Wang, A. A. Komar, A. Alexaki, C. Kimchi-Sarfaty. *Sequence analysis of SARS-CoV-2 genome reveals features important for vaccine design*. Scientific Reports 10, 15643 (2020).

O. Kimchi[†], T. Cragnolini, M. P. Brenner, L. J. Colwell[†]. *A polymer physics framework for the entropy of arbitrary pseudoknots.* Biophysical Journal 117(3):520-532 (2019).

O. Kimchi, S. L. Veatch, B. B. Machta**.** *Ion channels can be allosterically regulated by membrane domains near a de-mixing critical point*. Journal of General Physiology 150(12):1769-1777 (2018). Accepted for cover.

M. Watts, J. Ha, **O. Kimchi**, A. Sherman. *Paracrine Regulation of Glucagon Secretion: The β-α-δ Model.* American Journal of Physiology—Endocrinology & Metabolism 310(8):E597-E611 (2016).

[*]Co-first authors [†]Corresponding author

SELECTED PRESENTATIONS

Competition and coexistence in phage and bacteria 2024
Invited speaker, APS March Meeting

RNA structure can inhibit Cas13 activity and enables SNP detection 2023
Poster, Soft condensed matter physics Gordon Research Conference, Winter Q-Bio conference, Biophysical Society Annual Meeting

A reentrant transition in RNA aggregation 2023
Speaker & session chair, APS March Meeting

RNA hybridization in and out of equilibrium 2021
Invited speaker, Boston College Biology Seminar

Towards a synthetic post-translational protein oscillator 2020
Selected oral presentation, 1st Annual Biodesign Research Conference
Speaker & session chair, APS March Meeting; Speaker & poster, Harvard QBio symposium

RNA structure and kinetics including pseudoknots through complete landscape enumeration 2019
Speaker, APS March Meeting; Poster, Stochastic Physics in Biology GRC

A complete free energy landscape for RNA structure 2018
Speaker, APS March Meeting; Poster, Cargèse summer school

Regulation by a Critical Membrane 2017
Speaker, APS March Meeting; Poster, Intracellular Phase Transitions Meeting

RESEARCH EXPERIENCE

Princeton University Lewis-Sigler Institute for Integrative Genomics *Princeton, NJ*
Independent postdoctoral fellow Fall 2021 – Present

- *How does RNA secondary structure affect Cas13 activity?* with Cameron Myhrvold
  – Initiated experimental collaboration to probe effects of RNA structure on Cas13
  – Designed experiments and developed model to interpret results, driving new experimental directions
- *Why are homotypic RNA clusters so prevalent?* with Liz Gavis and Ned Wingreen
  – Formulated hypothesis for the ubiquity of RNA homotypic clusters in *Drosophila* embryogenesis
  – Designed experiments to test hypothesis, currently being carried out by Gavis lab
- *How do lytic and lysogenic phage coexist?* with Ned Wingreen
  – Coded and analyzed ODE-based model for ecological dynamics of lytic and lysogenic phage
- *Are homo- or hetero-polymers more prone to phase separation?* with Ned Wingreen
  – Worked with student to write molecular dynamics simulations for polymeric phase separation
- *What drives phase separation for repeat RNA?* with Michael Brenner
  – Constructed new analytical framework for RNA condensates based on multimer enumeration
  – Coded dynamic programming model to complement statistical mechanics theory

Google Research *Palo Alto, CA*
Summer Intern Summer 2019

- *What information is encoded by continuous glucose monitors?*
  - Analyzed large time-series datasets of patient continuous glucose monitoring data
  - Employed machine learning, neural networks (LSTMs, CNNs, FCNs)
- *Are correlations in language truly long-range?* Advisor: Bill Bialek
  - Conducted large-scale dataset analysis on English text documents
  - Used information theory approaches to compare correlations to those expected by chance

Harvard University Departments of Applied Mathematics and Physics *Cambridge, MA*
Ph.D. Researcher; Advisor: Michael Brenner Fall 2016 – May 2021

- *How can we leverage hybridization to improve structure prediction for large RNA?*
  - Developed new collaborations on DNA/RNA hybridization with Manoharan lab (Harvard)
  - Worked closely with collaborators to design high throughput microarray-based hybridization experiments
  - Developed novel analysis method employing automatic differentiation of microarray data
- *How can we optimize the yields of* de novo *designed protein assemblies?*
  - Formulated equilibrium statistical mechanics theory for yield of asymmetric protein self-assembly
  - Worked in team of 6 students/postdocs to develop theory, simulations, and experiments concurrently
- *Can current protein design tools enable the construction of a synthetic post-translational protein oscillator?*
  - Developed new collaborations on protein self-assembly with Baker lab (UW)
  - Constructed differential equation-based models for experimentally realizable protein oscillators
- *Enumerating RNA free energy landscapes including pseudoknots*
  - Constructed Feynman diagram formalism for entropies of complex RNA structures (pseudoknots)
  - Developed algorithm to predict complete energy landscape of arbitrary RNA sequences
- *The epistatic landscape of compensatory evolution in* S. cerevisiae; Advisor: Michael Desai Winter 2017
  - Conducted collaborative experimental rotation project
  - Techniques used include: PCR, gel electrophoresis, cell culturing, transfections, Illumina sequencing

Princeton University Lewis-Sigler Institute for Integrative Genomics and Dept. of Physics *Princeton, NJ*
Undergraduate Researcher Summer 2014 – Spring 2016

- *How are ion channels affected by the nearly-critical cell membrane?* Advisor: Ben Machta
  - Developed large-scale algorithm to simulate Ising model dynamics with embedded lattice channel
  - Analyzed results using statistical mechanics scaling laws to demonstrate biological relevance of model
- *How does a 30S ribosome find its target on an mRNA?* Advisor: Ned Wingreen
  - Formulated and probed feasibility of testable quantitative theories for ribosome search
- *Monte Carlo analysis of the Potts Model phase transition.* Advisor: David Huse
  - Performed Monte Carlo simulations on fractal-dimensional lattice to probe phase transition order

National Institutes of Health Laboratory of Biological Modeling *Bethesda, MD*
Summer Intern Summer 2013

- *What leads to anti-synchronous pancreatic insulin/glucagon oscillations?* Advisor: Arthur Sherman
  - Developed and numerically solved large ODE system predicting biological α/β cell coupling

TEACHING, MENTORSHIP, AND COMMUNITY ACTIVITIES

Conference organizer January 2024

- Co-organized workshop "Bacteria vs. Phage: The Main Event" at Princeton Center for Theoretical Science.
- Recruited speakers, emphasizing diversity across different axes; led discussions throughout workshop

DEI community service Winter 2024 – present

- Member, LSI Climate Committee, Princeton University

Research advisor Fall 2021 – present

- Provided mentorship on experimental design and presentations to graduate and post-bac students
- Wrote recommendation letter for post-bac student, who started graduate school at Stanford in Fall 2023

Preceptor and course instructor Fall 2021, Summer 2022

- Co-led precepts for Integrated Science, an intensive Freshman course
- Organized discussion group for Princeton Summer Undergraduate Program about scientific presentations

Research advisor Summer 2020

- Provided thought leadership and technical mentorship to undergraduate researchers
- Research topics focused on developing synthetic dynamical systems and covid-19 modeling

Course developer and instructor Summer 2020

- Developed and taught quantitative biology course about how to read and understand scientific papers
- Course aimed at 12 minority and underrepresented students performing summer research at Harvard

Seminar leader Fall 2019-Spring 2021

- Ran Kavli seminar: weekly seminar series with diverse speakers fostering intra-Harvard collaborations
- Shepherded seminar into virtual space in March 2020, maintaining high attendance and engagement

Teaching fellow

- Graduate student teaching fellow Fall 2017, Spring 2018, Fall 2020
  - Constructed problem sets, led recitations, and mentored students in independent projects
  - Courses were at both graduate and undergraduate level in mathematical modeling
- QuantLab tutor at Princeton University Freshman Scholars Institute Summers 2014-2015
  - Mentored students in problem sets and labs to make quantitative majors more accessible
  - Program was for incoming freshmen to Princeton from minority, low-income backgrounds