EDO KUSSELL
Professor of Biology and Physics

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Education

May, 2002	Ph.D. in Biophysics, Harvard University
June, 1997	B.A. in Mathematics, *magna cum laude*, Harvard University

Appointments

2019-	Full Professor, Department of Biology, New York University
2017-	Director of PhD Graduate Studies, Department of Biology, New York University
2012-	Associate Professor (with tenure), Department of Biology, New York University
2007-	Affiliated Appointment, Department of Physics, New York University
2011-	External Member, Center for Complex Systems Biology, Tokyo University
2006-2012	Assistant Professor, Department of Biology, New York University
2002-2006	Postdoctoral Fellow, The Rockefeller University

Fellowships & Honors

2006-2011	Burroughs Wellcome Fund Career Award at the Scientific Interface
2003-2005	Alfred P. Sloan Foundation Fellowship in Computational Molecular Biology
2001, 2002	Certificate of Distinction in Teaching, Derek Bok Center, Harvard University
1998-2001	National Science Foundation Graduate Research Fellowship

Current Funding

National Institutes of Health R01-GM
Role: PI
Project Title: Revealing Stochastic Switches In Bacteria
Award Period: 9/15/2011 – 12/31/2020 (NCE through 12/31/2021)

National Institutes of Health R01-GM
Role: PI
Project Title: Memory in Bacterial Responses to Fluctuating Stress
Award Period: 7/1/2016 – 6/30/2020 (NCE through 6/29/2021)

Burroughs Wellcome Fund *Conference Grant*
Role: PI
Project Title: Information Processing in Single Cells / Summer Workshop 2019
Award Period: 2/15/2019 – 2/1/2020

Completed Funding

New York University Research Challenge Fund

Role: co-PI

Project Title: Emulsion Droplets as a Novel Platform for Bacterial Population Dynamics and Emergence of Antibiotic Resistance

Award Period: 7/1/2016 – 6/30/2018

Burroughs Wellcome Fund *Collaborative Research Travel Grant*

Role: PI

Project Title: Bacterial Autoimmunity and Horizontal Gene Transfer of Restriction-Modification Systems

Award Period: 6/1/2016 – 12/31/2017

James S. McDonnell Foundation *Studying Complex Systems Research Grant*

Role: PI

Project Title: Mapping The Microbial Survival Toolbox: Using Dynamic Age Distributions To Infer The Behavior Of Individuals Within Populations

Award Period: 1/1/2012 – 5/31/2017

Human Frontiers Science Program *Young Investigators' Grant*

Role: PI (co-PIs: Calin Guet, IST Austria; Yuichi Wakamoto, Univ. of Tokyo)

Project Title: Multi-Level Conflicts In Evolutionary Dynamics Of Restriction-Modification Systems

Award Period: 11/1/2011 – 10/31/2014

Burroughs Wellcome Fund *Career Award at the Scientific Interface*

Role: PI

Project Title: Evolution Of Microbial Physiologies

Award Period: 1/1/2006 – 12/31/2011

Publications

36. Skanata A and **Kussell E**. Ecological memory preserves phage resistance mechanisms in bacteria (***bioRxiv***, 10.1101/2020.02.23.961862).

35. Skanata A and **Kussell E**, Roadmap Article on 'Memory and adaptation in time-varying environments, ***Physical Biology*** (in press).

34. Lin WH, **Kussell E**, Young LS, Jacobs-Wagner C. Origin of exponential growth in non-linear reaction networks, *Proceedings of the National Academy of Sciences USA*, 117:27795 (2020).

33. Nozoe T and **Kussell E**. Cell-cycle heritability and localization phase transition in growing populations, *Physical Review Letters*, 125:268103 (2020).

32. Lin M and **Kussell E**. Inferring bacterial recombination rates from large scale sequencing datasets, ***Nature Methods***, 16:199-204 (2019).

31. Moxon R and **Kussell E**. The impact of bottlenecks on microbial survival, variation and phenotypic switching in host-pathogen interactions. ***Evolution*** 71:2803 (2017)

30. Nozoe T, **Kussell E**, and Wakamoto Y. Inferring fitness landscapes and selection on phenotypic states from single-cell genealogical data. ***PLoS Genetics*** 13:e1006653 (2017).

29. Lin M and **Kussell E**. Correlated mutations and homologous recombination within bacterial populations. ***Genetics*** 205:891-917 (2017).

    Featured as a *Genetics Issue Highlights.*

28. Qian L and **Kussell E**. Genome-wide motif statistics are shaped by DNA binding proteins over evolutionary timescales. ***Physical Review X***, 6:041009 (2016)

27. Skanata A and **Kussell E**. Evolutionary phase transitions in random environments. ***Physical Review Letters***, 117:038104 (2016).

26. Lin W-H and **Kussell E**. Complex interplay of physiology and selection in the emergence of antibiotic resistance. ***Current Biology***, 26:1-8 (2016).

25. Hashimoto M, Nozoe T, Nakaoka H, Okura R, Akiyoshi S, Kaneko K, **Kussell E**, and Wakamoto Y. Noise-driven growth rate gain in clonal cellular populations. ***Proc Natl Acad Sci USA****,* 113:3251-3256 (2016).

24. Pleska M, Qian L, Okura R, Bergmiller T, Wakamoto Y, **Kussell E**, and Guet CC. Bacterial autoimmunity due to a restriction-modification system. ***Current Biology****,* 26:1-6 (2016).

    Featured in *Nature Reviews Microbiology, 14, 130 (2016).*

23. Lambert G and **Kussell E**. Quantifying selective pressures driving bacterial evolution using lineage analysis. ***Physical Review X***, 5:011016 (2015).

    Featured in *Physics, 8, 14 (2015).*

22. Lin W-H, Rocco MJ, Bertozzi-Villa, A and **Kussell E**. Populations adapt to fluctuating selection using derived and ancestral allelic diversity. ***Evolution***, 69:1448-1460 (2015).

21. Lambert G and **Kussell E**. Memory and fitness optimization of bacteria under fluctuating environments. ***PLoS Genetics***, 77:102602 (2014).

20. **Kussell E** and Vucelja M. Non-equilibrium physics and evolution: Adaptation, extinction, and ecology. ***Reports on Progress in Physics***, 77:192602 (2014).

19. **Kussell E**. Evolution in microbes. ***Annual Reviews of Biophysics***, 42:493-514 (2013).

18. Qian L and **Kussell E**. Evolutionary dynamics of restriction site avoidance. ***Physical Review Letters***,108:158105 (2012).

17. Sood R, Johnston R, and **Kussell E**. Stochastic de-repression of rhodopsins in single photoreceptors of the fly retina. ***PLoS Computational Biology***, 8(2):e1002357 (2012).

16. Lin W and **Kussell E**. Evolutionary pressures on simple sequence repeats in prokaryotic coding regions. ***Nucleic Acids Research***, 40:2399-2413 (2012).

15. Wakamoto Y, Grosberg AY, and **Kussell E**. Optimal lineage principle for age-structured populations. ***Evolution***, 66:115-134 (2011).

14. Birnbaum K and **Kussell E**. Measuring cell identity in noisy biological systems. ***Nucleic Acids Research***, 39: 9093-9107 (2011).

13. Johnston R, Otake Y, Sood P, Vogt N, Behnia R, Vasiliauskas D, McDonald E, Xie B, Cook T, Gebelstein B, **Kussell E**, Nagakoshi H, and Desplan C . Interlocked feedforward loops ensure robust rhodopsin expression in the *Drosophila* eye. ***Cell,*** 145:956–968 (2011).

12. Leibler S and **Kussell E**. Individual histories and selection in heterogeneous populations. ***Proc Natl Acad Sci USA****,* 107:13183-13188 (2010).

    Featured in *Nature Methods, 7:672-673 (2010).*

11. **Kussell E**, Leibler S, and Grosberg AY. Polymer-population mapping and localization in the space of phenotypes. ***Physical Review Letters***, 97:068101 (2006).

10. **Kussell E** and Leibler S. Phenotypic diversity, population growth, and information in fluctuating environments. ***Science***, 309: 2075-2078 (2005).

9. **Kussell E**, Kishony R, Balaban NQ, and Leibler S. Bacterial persistence: a model of survival in changing environments. ***Genetics***, 169: 1807-1814 (2005).

8. **Kussell E**. The designability hypothesis and protein evolution. ***Protein and Peptide Letters***, 12: 111-116 (2005).

7. **Kussell E**, Shimada J, and Shakhnovich EI. Side-chain dynamics and protein folding. ***Proteins***, 52: 303-321 (2003).

6. **Kussell E** and Shakhnovich EI. Glassy dynamics of side-chain ordering in a simple model of protein folding. ***Physical Review Letters***, 89: 168101 (2002).

5. **Kussell E**, Shimada J, and Shakhnovich EI. A structure-based method for derivation of all-atom potentials for protein folding. ***Proc Natl Acad Sci USA***, 99: 5343-5348 (2002).

4. **Kussell E**, Shimada J, and Shakhnovich EI. Excluded volume in protein side-chain packing. ***Journal of Molecular Biology***, 311: 183-193 (2001).

3. Shimada J, **Kussell E**, and Shakhnovich EI. The folding thermodynamics and kinetics of crambin using an all-atom Monte Carlo simulation. ***Journal of Molecular Biology*****,** 308: 79-95 (2001).

2. **Kussell E** and Shakhnovich EI. Analytical approach to the protein design problem. ***Physical Review Letters***, 83: 4437-4440 (1999).

1. Vendruscolo M, **Kussell E**, and Domany E. Recovery of protein structure from contact maps. ***Folding and Design***, 2: 295-306 (1997).

Invited Talks and Seminars

Departmental Seminars

Dec 2020	*Center for Studies in Physics and Biology,* The Rockefeller University
Dec 2020	*School of Natural and Computational Sciences,* Massey University, Auckland, NZ
Nov 2020	*Physics Colloquium*, Washington University, St. Louis
Apr 2020	*Molecular Genetics Seminar*, Weizmann Institute of Science, Israel (*postponed*)

Mar 2020 *Complex Systems Seminar*, University of Michigan, Ann Arbor (*postponed*)
Mar 2019 *Bioinformatics Seminar*, Courant Institute, New York University
Nov 2018 *Applied and Engineering Physics Seminar*, Cornell University
Oct 2018 *Biology Seminar*, New York University
May 2018 *Biophysics Seminar*, Technion – Israel Institute of Technology, Haifa, Israel
Apr 2018 *Biophysics Seminar*, Purdue University
Dec 2017 *Eugene Shakhnovich 60th Birthday Symposium*, Harvard University
Nov 2017 *Widely Applied Math Seminar*, Harvard University
Apr 2017 *Infectious Disease Epidemiology Seminar*, Harvard School of Public Health
Apr 2017 *Molecular Bioscience Colloquium*, University of Chicago
Nov 2016 *Systems Biology Seminar,* Institute for Advanced Study, Princeton
Nov 2016 *Biophysics and Systems Biology Seminar,* Rice University
Sep 2016 *Molecular, Cellular, and Developmental Biology Seminar,* Yale University
Jun 2016 *Biophysics Seminar,* ESPCI, Paris, France
Dec 2015 *Systems Biology Seminar,* Institute for Advanced Study, Princeton
Oct 2015 *Computational Biology and Bioinformatics Seminar,* Duke University
Apr 2015 *Biophysics Seminar,* Massachusetts Institute of Technology
Mar 2015 *Biology Seminar,* Emory University
Mar 2015 *Computational Biology Seminar,* Georgia Institute of Technology
Mar 2015 *Systems and Computational Biology Seminar,* University of Delaware
Jan 2015 *Systems Biology Seminar,* Yale Systems Biology Institute, Yale University
Dec 2014 *Systems Biology Seminar,* Institute for Advanced Study, Princeton
Mar 2014 *Quantitative Biology Seminar,* Los Alamos National Laboratory
Jan 2014 *Biophysics Seminar,* University of the Basque Country, Bilbao, Spain
Apr 2013 *Complex Systems Seminar,* University of Michigan
Feb 2013 *Evolution & Ecology Seminar,* University of Chicago
Jan 2013 *Biophysics Seminar,* École Normale Supérieure, Paris, France
Nov 2012 *Bioinformatics Seminar,* Memorial Sloan Kettering Cancer Center, New York
Oct 2012 *Systems Biology Seminar,* Weizmann Institute of Science, Rehovot, Israel
Jul 2012 *BioQuant Seminar,* University of Heidelberg, Heidelberg, Germany
Jan 2012 *Institute Colloquium,* Institute for Science and Technology, Vienna, Austria
Dec 2011 *Systems Biology Seminar,* Institute for Advanced Study, Princeton
Oct 2011 *Biology Department Seminar,* New York University
Oct 2011 *Soft Matter Physics Seminar,* New York University
Jun 2011 *Evolution and Ecology Seminar,* University of Montpellier, Montpellier, France
Sep 2010 *Genetics Department Seminar,* Cambridge University, Cambridge, UK
Sep 2010 *Cell Biology Seminar,* MRC Laboratory of Molecular Biology, Cambridge, UK
Apr 2009 *Biophysics Seminar,* Rutgers University
Nov 2008 *Center for Studies in Physics and Biology,* The Rockefeller University
Oct 2008 *Biology Department Seminar,* Queens College
Apr 2008 *Bioinformatics Seminar,* Courant Institute, New York University
Mar 2008 *Bioengineering Department Seminar,* Columbia University
Mar 2007 *Genomics Seminar,* Lewis-Sigler Institute, Princeton University
Feb 2007 *Computational Biology Seminar,* Skirball Institute, New York University
Jan 2007 *Applied Mathematics Seminar,* Courant Institute, New York University

Conferences, Workshops, and Symposia

Jan 2021 Invited Speaker, *Ecology and co-evolution: from models to data and back*, IHP Institut Henri Poincaré, Paris

Jan 2020	Invited Participant, *Quantitative Methods in Microbiome Population Genetics Workshop*, Chan-Zuckerberg Biohub, San Francisco, CA.
Sep 2019	Invited Talk, *23rd Evolutionary Biology Meeting at Marseilles,* Marseille, France.
July 2019	Invited Talk, *Prospects in Theoretical Physics: Great Problems in Biology for Physicists,* Institute for Advanced Study, Princeton, New Jersey.
July 2019	Principal organizer, *Information Processing in Single Cells*, Aspen Center for Physics, Aspen, Colorado.
Mar 2019	Contributed Talk, American Physical Society March Meeting, Boston.
Sep 2018	Invited Talk, *Physical Approaches to Understanding Microbial Life*, PALM Summer School, Centre Frachon, Gif-sur-Yvette, France.
Jul 2018	Invited Talk, *Workshop on Operations Research of Biological Systems*, International Center for Theoretical Physics, Trieste, Italy.
Mar 2018	Invited Talk, *Invited Session on Implications of Single Cell Variability: From Cells to Populations*, American Physical Society March Meeting, Los Angeles.
Mar 2018	Co-organizer, Focus Session on Evolutionary Dynamics of Genomes, American Physical Society March Meeting, New Orleans.
Jun 2017	Invited Talk*, John Lederberg–John von Neumann Symposium on Quantitative Biology, The Rockefeller University*
May 2017	Invited Talk*, 117th Statistical Mechanics Conference,* Rutgers University
Mar 2017	Co-organizer, Focus Session on Evolutionary Dynamics of Genomes, American Physical Society March Meeting, New Orleans.
Jul 2016	Invited Talk, *Physics of Biological Systems: From Biomolecular Nanomachines to Tissues and Organisms,* Int'l Summer School 'Nicolás Cabrera', Madrid, Spain
Jun 2016	Invited Talk, *Quantitative Laws II: From Physiology to Ecology,* Lake Como School of Advanced Studies, Como, Italy
May 2016	Invited Talk, *Information, Probability and Inference in Systems Biology Conference*, Institute for Science and Technology, Vienna, Austria
Mar 2016	Contributed Talk, American Physical Society, March Meeting, Baltimore, MD
Jan 2016	Organizer, *Populations, Evolution, and Physics,* Aspen Center for Physics, Aspen
Sep 2015	Invited Talk, *Evolutionary Cell Biology Conference,* KITP, UC Santa Barbara
May 2015	Invited Talk, *Stochastic Processes in Biology,* CUNY Graduate Center, New York
Mar 2014	Invited Talk, *Computational Theories of Evolution Workshop* Simons Institute for Theory of Computing, UC Berkeley, CA
Jan 2014	Invited Talk, *Cellular Decision Making Colloquium* Centro Nacional de Biotecnologia, Univ. Autonoma de Madrid, Madrid, Spain
Dec 2013	Invited Talk, *Quantitative Methods in Gene Regulation II,* Cambridge Univ., UK
Apr 2013	Invited Talk, *4th Microbial Genome Maintenance Meeting ,* Univ. of Oslo, Norway
Nov 2012	Invited Talk, *Quantitative Immunology,* KITP, UC Santa Barbara
Mar 2012	Invited Talk, *From Geochemistry to Biochemistry and the Origin of Life* American Chemical Society, National Meeting, San Diego.
Feb 2012	Invited Talk, *Focus Session on Evolutionary Systems Biology* American Physical Society, March Meeting, Boston.
May 2011	Invited Talk, *Biological Frontiers of Polymer and Soft Matter Physics,* KITP, UCSB
Feb 2011	Invited Talk, *Conference on Microbial and Viral Evolution*, KITP, UCSB
Feb 2011	Invited Talk, *Computational Biology Day,* Courant Institute, New York University
Sep 2010	Invited Talk, *Stochastic Effects in Microbial Infection Workshop* National e-Science Institute, University of Edinburgh, Scotland.
Sep 2010	Invited Talk, *Quantitative Biology: From Complex Networks to Simple Models*

	Brookhaven National Laboratory
May 2010	Invited Talk, *Division Group Symposium on Microbial Individuality* American Society for Microbiology General Meeting, San Diego
Apr 2010	Invited Talk, *Workshop on Decision Making in Cells,* NSF, Arlington, Virginia
Jan 2010	Invited Talk, *Rare Events in Biology Symposium,* Princeton University
Jan 2010	Organizer, *Populations, Evolution, and Physics,* Aspen Center for Physics, Aspen
Sep 2009	Invited Talk, *Evolution of Stress Responses Workshop,* Univ. of Aberdeen, UK
Jun 2009	Invited Talk, *Evolution, Dynamics, and Spatial Organization,* ICTP, Trieste, Italy
Dec 2008	Invited Talk, *Computational Biology Day,* Courant Institute, New York University
Oct 2008	Invited Talk, *Evolution of Microbial Heterogeneity and Complexity Workshop* The Rockefeller Foundation, Bellagio, Italy
Mar 2008	Invited Talk, *New Frontiers in Biol. Physics,* APS March Meeting, New Orleans
Jan 2008	Invited Talk, *Decision Making in Single Cells,* Aspen Center for Physics, Aspen
Dec 2007	Invited Talk, *Symposium for Eugene Shakhnovich's 50th Birthday,* Harvard Univ.
Jun 2007	Invited Talk, *International Workshop on Physical and Chemical Foundations of Bioinformatics*, Max Planck Institute, Dresden, Germany
Aug 2005	Invited Talk, *International Biophysics Congress,* Montpellier, France
Jul 2004	Invited Talk, *SIAM Conference on the Life Sciences,* Portland, Oregon
Jul 2000	Invited Talk, *Protein Folding, Evolution, and Design* International School of Physics "Enrico Fermi", Varenna, Italy

Postdoctoral Fellows (total 5)

Asher Preska Steinberg (PhD in Chemistry, California Institute of Technology)

Takashi Nozoe (PhD in Physics, University of Tokyo)

Antun Skanata (PhD in Physics, Brown University)

Matthew Eames (PhD in Biophysics, UC San Francisco; Current position: Private sector)

Guillaume Lambert (PhD in Physics, Princeton University; Current position: Assistant Professor, Department of Applied and Engineering Physics, Cornell University)

PhD Students (total 7)

Spencer Hobson-Gutierrez (Biology)

Dan Pollack (Biology)

Mingzhi Lin (Biology, PhD 2017; *Dean's Dissertation Fellowship*, 2016; *Eugene Bell Research Award*, 2013; Current position: Software Engineer, Google)

Wei-Hsiang Lin (Biology, PhD 2015; *Horizon Dissertation Fellowship*, 2012; Current position: Postdoctoral Fellow, Jacobs-Wagner Lab, Yale University)

Long Qian (Biology, PhD 2014; *Dean's Dissertation Fellowship*, 2012; Current position: Research Faculty, Center for Quantitative Biology, Peking University)

Varuni Prabhakar (Biology, PhD 2013; Current position: Outreach Associate, The Institute of Mathematical Sciences, Chennai, Tamil Nadu, India)

Pranidhi Sood (Biology, PhD 2012; *Dean's Dissertation Fellowship*, 2011; Current position: Postdoctoral Fellow, Marshall Lab, University of California San Francisco)