# MICHAEL MANHART

Office: **CABM 306** Rutgers University, Robert Wood Johnson Medical School

Center for Advanced Biotechnology and Medicine E-mail: mmanhart@rutgers.edu Department of Biochemistry and Molecular Biology Phone: (+1) 848-445-9835

679 Hoes Lane West

Piscataway, NJ 08854, USA

Web: https://qevomicrolab.org

## Appointments

#### **Assistant Professor** 2023-present

Rutgers University, Robert Wood Johnson Medical School, Department of Biochemistry and Molecular Biology (primary) and Department of Medicine (secondary)

Member of the Center for Advanced Biotechnology and Medicine (resident) and the Rutgers University Microbiome Program

Member of graduate faculty in Molecular Biosciences, Microbial Biology, Ecology and Evolution, Physics and Astronomy, and Quantitative Biomedicine

#### 2018 - 2022Junior group leader (SNF Ambizione Fellow)

ETH Zurich (Swiss Federal Institute of Technology), Department of Environmental Systems Science, Institute of Integrative Biology

Eawag (Swiss Federal Institute of Aquatic Science and Technology), Department of Environmental Microbiology

#### Postdoctoral fellow (NIH Ruth L. Kirschstein NRSA Fellow) 2014-2018

Harvard University, Department of Chemistry and Chemical Biology

#### EDUCATION

## 2014, Ph.D., Physics, Rutgers University

Advisor: Prof. Alexandre V. Morozov

Dissertation: "Biophysics and Stochastic Processes in Molecular Evolution"

## 2009, B.S., Physics and Mathematics (with honors and Concentration in Theoretical Physics), Stanford University

Honors advisor: Prof. Jay G. Wacker

Thesis: "A Model-Independent Search for New Physics at the Large Hadron Collider"

### **Publications**

### Preprints and publications under review or in press

- 1. Corral López R, Bonachela JA, Dominguez-Bello MG, Manhart M, Levin SA, Blaser MJ, Muñoz MA. (2025) "Imbalance in gut microbial interactions as a marker of health and disease." bioRxiv preprint, doi: 10.1101/2025.04.30.651474. Under review.
- 2. Ramoneda J, Ma Y, Schmidt J, Manhart M, Angst DC, Johnson DR. (2023) "Physical contacts between sparse biofilms promote plasmid transfer and generate functional novelty." bioRxiv preprint, doi:10.1101/2023.02.01.526699. In revision.

#### Research articles

- 3. Gould E et al. (310 authors including <u>Manhart M</u>) (2025) "Same data, different analysts: variation in effect sizes due to analytical decisions in ecology and evolutionary biology." *BMC Biol* **23**:35.
- 4. Held NA, Krishna A, Crippa D, Battaje RR, Devaux AJ, Dragan A, <u>Manhart M</u>. (2024) "Nutrient colimitation is a quantitative, dynamic property of microbial populations." *Proc Natl Acad Sci USA* **121**:e2400304121.
- 5. Fink JW, Manhart M. (2024) "Quantifying microbial fitness in high-throughput experiments." eLife 13:RP102635.
- 6. Fink JW, Held NA, <u>Manhart M</u>. (2023) "Microbial population dynamics decouple growth response from environmental nutrient concentration." *Proc Natl Acad Sci USA* **120**:e2207295120.
- 7. Jasinska W,\* <u>Manhart M</u>,\* Lerner J, Gauthier L, Serohijos AWR, Bershtein S. (2020) "Chromosomal barcoding of *E. coli* populations reveals lineage diversity dynamics at high resolution." *Nat Ecol Evol* 4:437–452. (\* equal contribution)
- 8. Lin J, <u>Manhart M</u>, Amir A. (2020) "Evolution of microbial growth traits under serial dilution." Genetics **215**:767–777.
- 9. Kheir Gouda M, <u>Manhart M</u>, Balázsi G. (2019) "Evolutionary regain of lost gene circuit function." *Proc Natl Acad Sci USA* **116**:25162–25171.
- 10. Kion-Crosby WB, <u>Manhart M</u>, Morozov AV. (2019) "Inferring biophysical models of evolution from genomewide patterns of codon usage." bioRxiv preprint doi:10.1101/578815.
- 11. <u>Manhart M</u>, Shakhnovich EI. (2018) "Growth tradeoffs produce complex microbial communities on a single limiting resource." *Nat Commun* **9**:3214.
- 12. <u>Manhart M</u>, Adkar BV, Shakhnovich EI. (2018) "Tradeoffs between microbial growth phases lead to frequency-dependent and non-transitive selection." *Proc R Soc B* **285**:20172459.
- 13. Adkar BV, Manhart M, Bhattacharyya S, Tian J, Musharbash M, Shakhnovich EI. (2017) "Optimization of lag phase shapes the evolution of a bacterial enzyme." Nat Ecol Evol 1:0149.
- 14. <u>Manhart M</u>, Morozov AV. (2015) "Protein folding and binding can emerge as evolutionary spandrels through structural coupling." *Proc Natl Acad Sci USA* **112**:1797–1802.
- 15. <u>Manhart M</u>, Kion-Crosby W, Morozov AV. (2015) "Path statistics, memory, and coarse-graining of continuous-time random walks on networks." *J Chem Phys* **143**:214106.
- 16. González C, Ray JCJ, <u>Manhart M</u>, Adams RM, Nevozhay D, Morozov AV, Balázsi G. (2015) "Stress-response balance drives the evolution of a network module and its host genome." *Mol Syst Biol* 11:827.
- 17. Bershtein S, Serohijos AWR, Bhattacharyya S, <u>Manhart M</u>, Choi J-M, Mu W, Zhou J, Shakhnovich EI. (2015) "Protein Homeostasis Imposes a Barrier on Functional Integration of Horizontally Transferred Genes in Bacteria." *PLoS Genet* 11:e1005612.
- 18. <u>Manhart M</u>, Morozov AV. (2015) "Scaling properties of evolutionary paths in a biophysical model of protein adaptation." *Phys Biol* **15**:045001. (In special issue on "Evolution of Biological Molecules and Networks")
- 19. Haldane A, <u>Manhart M</u>, Morozov AV. (2014) "Biophysical Fitness Landscapes for Transcription Factor Binding Sites." *PLoS Comput Biol* **10**:e1003683.
- 20. <u>Manhart M</u>, Morozov AV. (2013) "Path-Based Approach to Random Walks on Networks Characterizes How Proteins Evolve New Functions." *Phys Rev Lett* **111**:088102. (Editors' Suggestion)
- 21. <u>Manhart M</u>, Haldane A, Morozov AV. (2012) "A universal scaling law determines time reversibility and steady state of substitutions under selection." *Theor Popul Biol* 82:66–76.
- 22. Izaguirre E, <u>Manhart M</u>, Wacker JG. (2010) "Bigger, Better, Faster, More at the LHC." *J High Energ Phys* **12**:1–25.

## Reviews, opinions, and book chapters

- 23. Held NA, Manhart M. (2024) "Are microbes colimited by multiple resources?" Curr Opin Microbiol 80:102509.
- 24. Fink JW, <u>Manhart M</u>. (2023) "How do microbes grow in nature? The role of population dynamics in microbial ecology and evolution." Curr Opin Syst Biol 36:100470.
- 25. <u>Manhart M</u>, Bonhoeffer S. (2021) "The search for universality in evolutionary landscapes: Comment on 'From genotypes to organisms: State-of-the-art and perspectives of a cornerstone in evolutionary dynamics' by Susanna Manrubia, José A. Cuesta, et al." *Phys Life Rev* **39**:76–78.
- 26. Gorter FA, <u>Manhart M</u>, Ackermann M. (2020) "Understanding the evolution of interspecies interactions in microbial communities." *Phil Trans R Soc B* **375**:20190256. (In special issue on "Conceptual challenges in microbial community ecology")

- 27. Springer SA, <u>Manhart M</u>, Morozov AV. (2016) "Separating spandrels from phenotypic targets of selection in adaptive molecular evolution." *Evolutionary Biology*, ed. P. Pontarotti. Springer: Switzerland.
- 28. <u>Manhart M</u>, Morozov AV. (2014) "Statistical Physics of Evolutionary Trajectories on Fitness Landscapes." *First-Passage Phenomena and Their Applications*, eds. R. Metzler, G. Oshanin, and S. Redner. World Scientific: Singapore.

## PRESENTATIONS

#### Invited talks

- Population Dynamics Seminar (Friedrich Schiller University of Jena), online (September 1, 2023)
- Seminar at the University of Helsinki (June 12, 2023)
- Seminar at the University of Turku (June 9, 2023)
- Seminar at the Technical University of Munich (June 7, 2023)
- Microbiology at Rutgers Symposium, Rutgers University (May 5, 2023)
- American Physical Society March Meeting, Las Vegas, NV (March 6–10, 2023)
- Graduate Program in Ecology and Evolution Seminar, Rutgers University (February 23, 2023)
- ENIGMA Seminar, Rutgers University (February 20, 2023)
- Forum on Economic Principles in Cell Physiology, online (February 7, 2023)
- Seminar at the Department of Physics of Complex Systems, Weizmann Institute of Science (November 14, 2022)
- Cologne Evolution Colloquium at the University of Cologne (October 26, 2022)
- Seminar at the Department of Chemistry, Pusan National University (November 11, 2021)
- Colloquium at the Department of Physics, University of Alberta (November 5, 2021)
- Seminar at the Center for Advanced Biotechnology and Medicine, Rutgers University (May 10, 2021)
- Seminar at the Department of Microbiology, University of Georgia (March 30, 2021)
- Seminar at the Max Planck Institute for Evolutionary Biology, Plön (February 23, 2021)
- Institut Henri Poincaré virtual conference on "Ecology and co-evolution: from models to data and back" (January 11–15, 2021)
- Seminar at the Structural and Computational Biology Unit, EMBL (November 10, 2020)
- Seminar at the Department of Computational Biology, University of Lausanne (October 21, 2020)
- Seminar at the Institute of Physics, EPFL (December 19, 2019)
- 23rd Evolutionary Biology Meeting, Marseilles, France (September 24–27, 2019)
- BIRS-CMO workshop on "Out-of-Equilibrium Processes in Evolution and Ecology," Oaxaca, Mexico (August 18–23, 2019)
- Seminar at the Biozentrum, University of Basel (February 18, 2019)
- Colloquium at the Department of Physics, University of Cincinnati (February 22, 2018)
- Seminar at the Laufer Center for Physical and Quantitative Biology, Stony Brook University (June 27, 2017)
- 9th European Conference on Mathematical and Theoretical Biology, Gothenberg, Sweden (June 15–19, 2014)
- Bauer Forum, FAS Center for Systems Biology, Harvard University (January 29, 2014)
- Biophysics theory symposium, Princeton University (November 20, 2013)
- American Physical Society April Meeting, Atlanta, GA (March 31 April 3, 2012)

### Contributed talks

- Gordon Research Conference on Stochastic Physics in Biology, Ventura, CA (January 12–17, 2025)
- American Society for Microbiology Microbe, Atlanta, GA (June 13–17, 2024)
- Workshop on "Microbial communities: current approaches and open challenges," Isaac Newton Institute, Cambridge (October 10–14, 2022)
- Microbial Ecology and Evolution Meeting on "Communities and Coevolution," Max Planck Institute for Evolutionary Biology, Plön (May 16-20, 2022)
- Virtual conference on "Stochastic Models and Experiments in Ecology and Biology" (June 22–25, 2021)
- Virtual EMBO Workshop on "Predicting Evolution" (June 14–16, 2021)
- American Physical Society March Meeting, Boston, MA (March 4–8, 2019)
- American Physical Society March Meeting, Los Angeles, CA (March 5–9, 2018)
- American Physical Society March Meeting, New Orleans, LA (March 13–17, 2017)

- Greater Boston Area Statistical Mechanics Meeting, Brandeis University (October 29, 2016)
- American Physical Society March Meeting, Denver, CO (March 3–7, 2014)
- 110th Statistical Mechanics Meeting, Rutgers University (December 15–17, 2013)
- American Physical Society March Meeting, Baltimore, MD (March 18–22, 2013)
- 108th Statistical Mechanics Meeting, Rutgers University (December 16–18, 2012)
- American Physical Society March Meeting, Boston, MA (February 27 March 2, 2012)

#### Posters

- Gordon Research Conference on Applied and Environmental Microbiology, South Hadley, MA (July 16–21, 2023)
- 18th International Symposium on Microbial Ecology, Lausanne, Switzerland (August 15–19, 2022)
- Microbial Ecology and Evolution Virtual Conference (August 12–14, 2020)
- Conference on Evolutionary Systems Biology, Wellcome Genome Campus, UK (February 12–14, 2020)
- Gordon Research Conference on Molecular Mechanisms in Evolution, Easton, MA (June 9–14, 2019)
- Gordon Research Conference on Microbial Population Biology, Andover, NH (July 9–14, 2017)
- Gordon Research Conference on Molecular Mechanisms in Evolution, Easton, MA (June 11–16, 2017)
- 2nd American Society for Microbiology Conference on Experimental Microbial Evolution, Washington, DC (August 4–7, 2016)
- 22nd Boston Bacterial Meeting, Boston, MA (June 14–15, 2016)
- Conference on Populations, Evolution, and Physics, Aspen Center for Physics (January 3–8, 2016)
- DIMACS Workshop on Bio-computing, Genomics, and Epigenomics, Rutgers University (September 13, 2012)
- International Conference on Stochastic Processes in Systems Biology, Genetics, and Evolution, Rice University (August 21–25, 2012)
- 5th q-bio Conference on Cellular Information Processing, St. John's College (August 10–13, 2011)

## AWARDS AND FUNDING

## Fellowships and grants

- NIGMS R35 MIRA (2025–2030)
- Rutgers NJMS-RWJMS Pilot Grant (2025)
- Human Frontier Science Program Early-Career Research Grant (2024–2027)
- Swiss National Science Foundation Ambizione grant (2018–2022)
- NIH Ruth L. Kirschstein NRSA Postdoctoral Fellowship (2015–2018)
- Rutgers University Excellence Fellowship (2009–2010)
- Rutgers University Henry C. Torrey Graduate Fellowship (2009–2010)

#### Travel awards

- American Physical Society DBIO Shirley Chan Student Travel Award (2014)
- American Physical Society FGSA Travel Award for Excellence in Graduate Research (2012)
- ICSP Travel Award (2012)

#### Teaching awards

- Rutgers University Graduate School-New Brunswick Dean's Award for Innovation (2012)
- Rutgers University Department of Physics and Astronomy Richard J. Plano Outstanding Teaching Assistant Award (2011)

### Academic awards

- Stanford University Center for Teaching and Learning and Undergraduate Advising and Research Award for Excellence in Honors Thesis Presentation (2009)
- Highbridge Book Award in Mathematical Problem Solving for achievement on the William Lowell Putnam Mathematical Competition (2006)

## TEACHING EXPERIENCE

## **Rutgers University**

Small group facilitator (led small group activities)

- Ethical Scientific Conduct, ~15 graduate students (Spring 2024 and Spring 2025, two sessions each)
- Cells to Structure, DNA repair jigsaw, ~30 medical students (Fall 2024 and Fall 2025, one session)

Co-instructor (developed and taught all aspects of the course, in collaboration with 3 graduate students)

■ Physics 106: Concepts of Physics for Humanities and Social Science Students, ~100 undergraduate students (Spring 2013)

Teaching assistant (led sections, graded assignments, held office hours)

- Physics 611: Statistical Mechanics, ~10 graduate students (Spring 2012)
- Physics 567: Physics of Living Matter, ~10 graduate students (Spring 2012)
- Physics 116: Extended Analytical Physics II (introductory physics for engineering students), ~40 undergraduate students (Spring 2011)
- Physics 202: Extended General Physics II (introductory physics for life science students), ~80 undergraduate students (Fall 2010)
- Physics 204: General Physics II (introductory physics for life science students), ~40 undergraduate students (Summer 2010)

#### ETH Zurich

## Teaching assistant

- Infectious Disease Dynamics (conducted oral exams and evaluated students; Spring 2021, Spring 2022)
- Environmental Biology (supervised projects on "forecasting evolution"; Fall 2020, Fall 2021)

## NJ State Correctional Facilities (Prison Teaching Initiative)

<u>Co-instructor</u> (gave lectures, graded assignments)

- BIO 114: Visualizing Environmental Science, ~15 students (Spring 2012)
- MAT 037: Introduction to Algebra, ~15 students (Fall 2011, Fall 2010, Spring 2010)
- MAT 135: Intermediate Algebra, ~15 students (Spring 2011)

## MENTORING EXPERIENCE

#### Postdoctoral fellows

- Ernesto Berríos-Caro, Rutgers University (January 2025 present)
- Justus Fink, Rutgers University (January 2024 July 2024)
- Rachana Rao Battaje, Rutgers University (August 2023 present)
- Duhita Sant, Rutgers University (August 2023 present)

### Ph.D. students (thesis)

- Smruti Dixit, Rutgers University (September 2024 present)
- Justus Fink, ETH Zurich (May 2019 September 2023)

#### Ph.D. students (rotation)

- Shahnewaz Ahmed, Rutgers University (November 2024 May 2025)
- Joelle Reich, Rutgers University (December 2023 February 2024)

#### Master's students

- Valeria Cardenas, Rutgers University (May 2025 present)
- Jakob Löffler, ETH Zurich (December 2021 June 2022)
- Aswin Krishna, ETH Zurich (February 2021 July 2021)
- Alexander Stein, ETH Zurich (September 2019 December 2019)

## Research assistants

- Tomas Lio Grudny, ETH Zurich (March 2022 May 2023)
- Anastasia Dragan, ETH Zurich (October 2022 March 2023)

## Undergraduate (bachelor's) students

- Shreya Bhardwaj, Rutgers University (June 2024 August 2024)
- Shivali Vanodia, Rutgers University (December 2023 present)
- Dhru Desai, Rutgers University (June 2023 August 2024)
- Atharv Jayprakash, Rutgers University (January 2023 present)
- Kevin Thomas, Rutgers University (January 2023 May 2023)

## High school students

- Arun Kalyanaraman, High Technology High School: "Biophysical models of protein evolution" (summer 2013 summer 2014)
- Rishabh Pipada, West Windsor Plainsboro High School North: "Sequence-specificity of nucleosomal loop dynamics" (summer 2012)
- Aditya Bhagavathi, West Windsor Plainsboro High School North: "Exploring the limits of phylogenetic inference of protein energetics" (summer 2011)

## Student advisory committees

- Alan Gao, Rutgers Physics and Astronomy M.S. program (May 2025)
- Kristen Warrington, Rutgers Ecology and Evolution Ph.D. program (May 2025 present)
- Erin Chille, Rutgers Ecology and Evolution Ph.D. program (February 2025 present)
- Avi Shah, Rutgers NJMS M.D./Ph.D. program (July 2024 present)
- Laura Sanchis Pia, EMBL/U. Heidelberg (July 2025 present)

#### SERVICE ACTIVITIES

### Professional activities

- Reviewer for PLOS Computational Biology (5x), eLife (2x), PLOS Biology (1x), Nature Communications (1x), Molecular Systems Biology (1x), Molecular Biology and Evolution (1x), mSystems (1x), mSphere (1x), Microbiome (1x), Proceedings B of the Royal Society, Physical Review Letters (1x), Philosophical Transactions of the Royal Society B (1x), Journal of the Royal Society Interface (1x), Journal of Molecular Evolution (1x), Physical Biology (1x), Physica A (1x), Biology (1x), Life (1x)
- Conference organizer
  - 2018 American Physical Society March Meeting focus sessions on "Evolutionary Systems Biology" and "Single-Cell Variability and Dynamics"
  - 2014 American Physical Society March Meeting invited session on "Physical Principles of Molecular Evolution"

## University service

- Rutgers University Microbiome Program seminar committee (2023 present)
- CABM microbiome faculty search (2023 2024)
- CABM seminar host (2023 present)