Pablo Cárdenas Ramírez

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I develop experimental and computational methods to engineer and study biology across scales, from the molecular to the population level. I use these tools to research evolution in a quantitative, systematic, and predictive manner.

I develop dedicated leadership and mentorship practices to build globally collaborative, supportive, and engaged scientific environments.

Education

Massachusetts Institute of Technology (MIT) — Cambridge, MA, USA **Sep 2024**
Doctor of Philosophy, Department of Biological Engineering; Advisor: Jacquin C. Niles; GPA: 5.0/5.0
Graduate Teaching Certificate, MIT Teaching and Learning Lab (received 2023)

Universidad de los Andes (Uniandes) — Bogotá, Colombia **Mar, 2018**
Bachelor of Science *Summa Cum Laude* in Microbiology, minor in Bioinformatics (GPA: 4.84/5.0)

Research

R.F. Smith School of Chemical & Biomolecular Engineering, Cornell University— Ithaca, NY, USA
Postdoctoral Research Fellow and Incoming Assistant Professor, MsEE Lab **Apr 2025 – ongoing**
→ Quantifying evolutionary likelihood through experimental and computational models, faculty start in 2026

Ragon Institute of Mass General Brigham (MGB), MIT, & Harvard— Cambridge, MA, USA
Postdoctoral Research Fellow, Schmidt Lab **Sep 2024 – ongoing**
→ Researching viral evolution and immune focusing in vaccine design (Prof. Aaron Schmidt)

Department of Biological Engineering (BE), MIT — Cambridge, MA, USA
Graduate Research Assistant, Niles Lab **Sep 2018 – Sep 2024**
→ Created an epidemiological modeling framework for pathogen population genetics and evolution, and applied it to the study of pathogen evolution across fitness valleys (self-led collaboration)
→ Constructed molecular and computational tools for transcriptional control, functional genomics, systems biology, and pharmaceutical development in *Plasmodium falciparum* malaria parasites (Prof. Jacquin Niles)

Department of Systems Biology, Harvard Medical School — Boston, MA, USA
Visiting Undergraduate Researcher, Paulsson Lab **Feb – Jul 2018**
→ Applied microfluidics and microscopy to study bacterial physiology and persistence (Prof. Johan Paulsson)

Eligo Bioscience, S.A. — Paris, France
Research Intern in Synthetic Biology, Eligo Bioscience **Aug 2017 – Jan 2018**
→ Screened and engineered synthetic phage against bacterial strains (supervisor Dr. Jesús Fernández R.)

Mathematical & Theoretical Biology Institute, Arizona State University — Tempe, AZ, USA
Visiting Undergraduate Researcher, MTBI (now QRLSSP) **Jun – Jul 2017**
→ Created a 3D, spatially explicit computational model of bacterial resistance to antibiotics in a biofilm

Department of Biological Sciences, Uniandes — Bogotá, Colombia
Undergraduate Researcher, CIMIC and BCEM Labs **May 2015 - Aug 2017**
→ Designed and experimentally tested an ODE model of phage-host dynamics (Prof. Martha Vives)

Publications

Peer-reviewed research *(*Contributed equally to the work; †Corresponding author)*

Treatment of STEC infection via CRISPR-Cas targeted cleavage of the Shiga toxin gene in animal models **2025**
M. Galtier, A. Krawczyk, F. J. Fuche, L. H. Charpenay, I. Stzepourginski, S. Pignotti, M. Arraou, R. Terrasse, A. K Brödel, C. Poquet, G. Prevot, D. Spadoni, B. Buhot, K. Munch, J. Havránek, **P. Cárdenas Ramírez**, M. Rouquette, A. Decrulle, O. Kerbarh, E. Lieberman, C. Bramorski, A. Grienenberger, E. M. Hessel, G. Salzano, D. J. Garry, A. Leveau, X. Duportet, D. Bikard, J. Fernandez-Rodriguez†
Science Translational Medicine, in press. Preprint at doi: 10.1101/2025.02.28.640725

CRISPR-Cas spacer acquisition is a rare event in the human gut microbiomes **2025**
A. Zhang, J.M. Gaston, **P. Cárdenas**, S. Zhao, X. Gu, & E.J. Alm†
Cell Genomics. doi: 10.1016/j.xgen.2024.100725

Genomic epidemiological models describe pathogen evolution across fitness valleys **2022**
P. Cárdenas†, V. Corredor, M. Santos-Vega
Science Advances. doi: 10.1126/sciadv.abo0173

GeneTargeter: automated, in silico *design for genome editing in the malaria parasite,* P. falciparum **2022**
P. Cárdenas, L.Y. Esherick, G. Chambonnier, S. Dey, C.V. Turlo, A.S. Nasamu, J.C. Niles†.
The CRISPR Journal. doi: 10.1089/crispr.2021.0069

Preventing antibiotic-induced dysbiosis with an engineered live biotherapeutic **2022**
A. Cubillos-Ruiz, M.A. Alcantar, N.M. Donghia, **P. Cárdenas**, J. Ávila-Pacheco, J.J. Collins†.
Nature Biomedical Engineering. doi: 10.1038/s41551-022-00871-9

Resolving drug selection and migration in an inbred South American Plasmodium falciparum *population with identity-by-descent analysis* **2022**
M. Carrasquilla*, A.M. Early*, A.R. Taylor, A. Knudson, D.F. Echeverry, T.J.C. Anderson, E. Mancilla, S. Aponte, **P. Cárdenas**, C.O. Buckee, J.C. Rayner, F.E. Sáenz, D.E. Neafsey†, V. Corredor†
PLoS Pathogens. doi: 10.1371/journal.ppat.1010993

dCas9 regulator to neutralize competition in CRISPRi circuits **2021**
H.-H. Huang*, M. Bellato*, Y. Qian, **P. Cárdenas**, L. Pasotti, P. Magni, D. Del Vecchio†.
Nature Communications; doi: 10.1038/s41467-021-21772-6.

Host resistance, genomics and population dynamics in a Salmonella *Enteritidis and phage system* **2019**
A.V. Holguín, **P. Cárdenas**, C. Prada-Peñaranda, L. Rabelo Leite, C. Buitrago, V. Clavijo, G. Oliveira, P. Leekitcharoenphon, F. M. Aarestrup, & M.J. Vives†
Viruses. doi: 10.3390/v11020188

Preprints & submitted work: *(*Contributed equally to the work; †Corresponding author)*

Orthogonal, synthetic transcriptional control in the malaria parasite Plasmodium falciparum **—**
P. Cárdenas, S. Smick, S. Dey, & J.C. Niles†
Under review. Manuscript shared for private viewing here.

An essential, multifunctional lipocalin from P. falciparum *with heme-related antioxidant functions* **—**
M. Nakashima, K. T. Osman, S.J. Saha, A.S. Nasamu, A.M. Goren, **P. Cárdenas**, C.L. Drennan, & J.C. Niles†
Under review.

Using Big Data to inform decision-making on COVID-19 in Colombia: a framework of micro-territorial experimental design for urban interventions and policy evaluation **2022**
A. Feged-Rivadeneira†, F. González-Casabianca, A. Parra-Salazar, J. Salcedo-Ortiz, F. Andrade-Rivas, **P. Cárdenas**, A. Morales, J.M. Damelines-Pareja, D.S. Ríos-Oliveros, C. Salazar, S. Usma, M. Muñoz, L.H. Patiño, N. Ballesteros, J.D. Ramírez, A. Ángel, T. Rodríguez, J. Cascante, H. Galindo-Silva, S. Majerowicz, & V. Corredor.
doi: 10.21203/rs.3.rs-2148358/v1

Reviews and commentary:

Starting from scratch: a workflow for building truly novel proteins **2021**
P. Cárdenas. *Synthetic Biology 6*(1), ysab005, doi: 10.1093/synbio/ysab005

Designing for durability: new tools to build stable, non-repetitive DNA **2020**
P. Cárdenas. *Synthetic Biology, 5*(1), ysaa016, doi: 10.1093/synbio/ysaa016

Research Talks & Seminars

Contributed talks:

Synthetic transcriptional control in the malaria parasite Plasmodium falciparum **17 Sep 2024**
15 min contributed talk at the XXXV Molecular Parasitology Meeting (Woods Hole, MA)

Genomic models describe epidemiological determinants of pathogen evolution **25 Jan 2024**
20 min contributed talk at the First Andean School on Host-Pathogen Dynamics (Bogotá, Colombia)

Genomic models describe epidemiological determinants of pathogen evolution **3 Aug 2023**
15 min contributed talk at the Gordon Research Conference on Dynamics of Ecological and Evolutionary Change (Smithfield, RI, United States)

Genomic models describe epidemiological determinants of pathogen evolution **30 Jul 2023**
20 min contributed talk at the Gordon Research Seminar on Dynamics of Ecological and Evolutionary Change (Smithfield, RI, United States)

Genomic models describe epidemiological determinants of pathogen evolution **28 Feb 2023**
20 min contributed talk at the Society for Mathematical Biology's conference on Mathematical Epidemiology and Population Dynamics, Ecology, & Evolution (SMB Epi-PDEE) (online)

Invited talks:

A synthetic transcriptional control platform for genomics and engineering in malaria parasites **10 Oct 2023**
15 min talk for the MIT BE Department Retreat (Boston, MA, USA)

Genomic models describe epidemiological determinants of pathogen evolution **20 Apr 2023**
1 h invited seminar for the Max Planck Institute for Infection Biology, Berlin, Germany (online)

Opqua, a tool for modeling genomic epidemiology **20 Feb 2023**
1 h invited seminar for Novodan Ltd. & the Department of Biotechnology and Biomedicine, Danmarks Tekniske Universitet (DTU), Kgs. Lyngby, Denmark (online)

Opqua, a tool for genomic epidemiological modeling **13 Jan 2023**
1 h invited seminar at Global Pervasive Computational Epidemiology NSF Expedition in Computing, University of Virginia Biocomplexity Institute (online)

Computational models describe parasite evolution across fitness valleys **17 Oct 2022**
30 min invited seminar for the Boston Area Parasitology Seminar (Cambridge, MA, United States)

Academic Service

Peer reviewer for *Journal of Computational biology* (Mary Ann Liebert, Inc.) **Oct 2025**
Peer reviewer for *Communications Biology* (Springer Nature) **Aug 2024**
Peer reviewer for *Evolution* (Oxford University Press) **Aug 2023**
Peer reviewer for *Nucleic Acids Research* (Oxford University Press) **Apr 2022**
Peer reviewer for *Wellcome Open Research* (F1000; open review available here) **Jun 2021**

Awards & Fellowships

Graduate:

Honorable Mention—Best Talk (Molecular Parasitology Meeting XXXV)
Sep 2024
Elected by attendee vote along with 5 other talks from 60 submitted talks (200 USD)

Siebel Scholar in Bioengineering, Class of 2024 (Siebel Scholars Foundation) **Sep 2023**
Awarded to outstanding final year graduate students across 16 universities (total 35,000 USD)

Cornell 2023 FIRST Future Faculty Scholar (Dept. of Microbiology, Cornell University) **Aug 2023**
Awarded by competition to researchers planning to go on the academic job market in the next few years. Symposium training on job search and information on the Cornell FIRST Program (Sep 2023)

Best Talk (Gordon Research Seminar on Dynamics of Ecological and Evolutionary Change) **Jul 2023**
Voted best of 10 contributed talks at the seminar by attendees.

Teaching Development Fellowship (Teaching and Learning Lab, MIT) **Jul 2022**
Awarded to 21 applicants to develop training and support for graduate student teaching (2000 USD)

S. & P. Eurnekian Biotechnology Fellowship (Office of Graduate Education, MIT) **Apr 2021**
Awarded to one MIT student pursuing research in biotechnology per year
(1 semester tuition, insurance, stipend; ≈43,000 USD)

Teaching Assistant Excellence Award (Department of Biological Engineering, MIT) **Dec 2020**
Awarded to the best teaching assistant in the department during the Fall 2019 (1000 USD)

Viterbi Graduate Fellowship (Department of Biological Engineering, MIT) **Sep 2018**
Awarded at admission to select students in the MIT Biological Engineering PhD program
(1 semester tuition, insurance, stipend; ≈42,000 USD)

Selected Undergraduate:

Summa Cum Laude (Faculty of Sciences, Uniandes) **Mar 2018**
Awarded to top 1% of historic graduates in the Faculty of Sciences who also show strong community service

Alberto Magno Award (Uniandes) **Oct 2013**
Given to the top ten application scores among admitted students university-wide in a semester

Selected Teaching, Mentorship, & Community

Ragon Institute of MGB, MIT, & Harvard— Cambridge, MA, USA
Postdoctoral Research Fellow, Schmidt Lab **Sep 2024 – ongoing**
- → Leading research technician Connor Murphy in research project on influenza immunity and evolution
- → Mentored first-year graduate student Jiachen Lin (Harvard Virology) in a 6-week experimental research rotation project on influenza A virus immunology and evolution
- → Coadvised student Íngrid Vanessa Mora Sánchez (Uniandes Biology) in their senior undergraduate thesis project on mathematical models of persistent malaria parasite infections in seasonal environments

Teaching and Learning Lab, MIT — Cambridge, MA, USA
Teaching Development Fellow, MIT Teaching and Learning Lab **Sep 2022 – Jun 2023**
- → Developed resources to support teaching and mentorship skills for graduate students across MIT
- → Designed and conducting teaching and mentorship workshops and recitation class observations

Teaching Track Certificate, MIT Teaching and Learning Lab **Jul 2022 – Nov 2022**
- → Certified courses on Subject Design, Lesson Planning, Microteaching, and Inclusive Teaching
- → Designed and rehearsed an original course, "Fighting, Harnessing, and Reshaping Evolution"

Científico Latino, Inc.; MIT BE Application Assistance Program — Cambridge, MA, USA
Prospective Graduate School Application Mentor **2018 – 2024**
- → Mentored 34 graduate school applicants from 10 different countries providing feedback on their research materials and advising them on PhD program selection
- → Mentees have gone on to pursue graduate studies at Cornell, ETH Zurich, Harvard, New York University, Princeton, Universitat de Barcelona, and University of Pennsylvania, among others

Department of Biological Engineering (BE), MIT — Cambridge, MA, USA
Guest Lecturer in Evolution, Malaria Biology, and Genomics **2022–2024**

- → Prepared and taught a lecture on malaria biology and genomics for a course of ≈30 undergraduates for the MBIO2304 *Parasitology* course at Uniandes taught by Prof. Camila González (Jan 2022)
- → Prepared and taught lectures on designing for evolution in infectious disease for a course of 15–25 senior undergraduates; course 20.380 *Senior Design Course in Biological Engineering* taught by Prof. Christopher Voigt, Dr. Prerna Bhargava, Dr. Sean Clarke (2022) and Prof. Angela Koehler, Prof. James Collins (2024)

Coding Fellow, Biological Engineering Data Lab **Mar 2020 – May 2024**

- → One of the inaugural fellow at the Biological Engineering Data Lab, created to support computational teaching and learning in bioscience at MIT during the COVID-19 pandemic lockdown and beyond
- → Provided >80 coding/data analysis coaching sessions to undergraduates, graduate students, and postdocs
- → Designed and conducted workshops for 10–40 students on Introductory Python, Ordinary Differential Equation Modeling, and Statistical Curve Fitting (taught each one three times)
- → Mentored an undergraduate student through a semester-long individual project in SARS-CoV-2 phylogenomics as an Experiential Learning Opportunity course (student: Dawit Girma)

Teaching Assistant, Principles of Molecular Bioengineering **Sep – Dec 2019**

- → Helped design and grade assignments and exams, conducted review lecture sessions, and provided one-on-one tutoring for 40 students (Prof. Ernest Fraenkel and Prof. Alan Jasanoff)
- → Received an overall instructor rating of 6.9/7.0 (18 responses) with student feedback including "*really tried to help us understand not just get the problem set done* [sic]", "*has a fantastic grasp of the material*", and "*hands-down one of the best TAs I have ever had*"
- → Awarded best Fall 2019 teaching assistant at MIT BE (out of 25) based on student and faculty input

Graduate Research Assistant, Niles Lab **Mar 2019 – Sep 2024**

- → Trained incoming postdoc Dr. Shubhra Saha in parasite tissue culture and molecular cloning
- → Mentored four first-year graduate students in 6- or 8-week experimental research rotation projects, students: Mirna Kheir Gouda (MIT Biological Engineering), Allison Rojas (MIT-Harvard Health Science and Technology), Alyssa Haynes (MIT Microbiology)

Peer Counselor, BE Resources for Easing Friction and Stress (REFS) **Jan 2019 – Jun 2023**

- → Provided 1-on-1 confidential counseling for graduate students at MIT BE as a member of BE REFS
- → Co-developed and conducted workshops on different graduate school milestones and experiences
- → Underwent a week-long training course on conflict coaching and support resources for grad students, including training from the office of the Institute Discrimination & Harassment Response (IDHR)

Department of Biomedical Engineering, Uniandes — Bogotá, Colombia

Teaching Assistant, Quantitative Human Physiology I and II **Jan – Dec 2016**

- → Designed and graded assignments, provided review sessions, and taught main lectures during two professor absences for ≈100 students (Prof. Juan Manuel Cordovez)

Department of Student Affairs, Uniandes — Bogotá, Colombia

Teaching Assistant, Social Practice Program **Jul – Dec 2015**

- → Trained, guided, and evaluated 60 Uniandes students serving as tutors for low-income high school students in Bogotá (Instructors David Parga and María del Pilar Pérez)

Volunteer Tutor, Social Practice Program **Jan – Jun 2015**

- → Provided academic tutoring and review 3 h/week for 10 low-income high school students in Bogotá

Department of Biological Sciences, Uniandes — Bogotá, Colombia

Teaching Assistant, Parasitology Laboratory **Jan – Jun 2015**

- → Provided review sessions and tutoring, helped develop and grade assignments, and prepared and presented microscopy slides for various human pathogens (Prof. Camila González)