Pablo Cruz-Morales
Project scientist at the Joint BioEnergy Institute,
Lawrence Berkeley National Laboratory
University of California, Berkeley,

Research vision

I study the biosynthesis and evolution of specialized bacterial metabolism. I am working in the development of novel methods for the discovery and the production of bioactive molecules diversity using synthetic biology and the power of natural selection. I believe that new medicines can be discovered cheaper and faster by exploiting the combinatorial nature of natural product chemistry and genetics in an experimental evolution set up.

I am trained as an experimentalist and a bioinformaticists. I can predict new biosyntheic pathways from large genomic datasets, clone and manipulate biosynthetic pathways, extract, identify and modify the products, all the way from the computer to the vial. I have trained more than a dozen graduate and undergraduates tudents from diverse backgrounds and nationalities, raised funds for my research, led multiple projects and published several research articles as first author, co-author and co-corresponding author.

Skills

- **Bioinformatics**: Genomics (Nanopore, PacBio, Illumina), Phylogenomics, transcriptomics, functional genomics and genome mining pipeline development, perl, python.
- **Molecular genetics**: refactoring and heterologous expression of biosynthetic pathways in Streptomyces, E. coli and yeast.
- **Analytical chemistry**: Fermentation, extraction, LC-MS/GC-MS analysis of natural products.
- **Environmental Microbiology**: Multiple sampling expeditions desertic and rainforest areas. Isolation, taxonomic identification and mainteinance of bacterial strain collections
- **Communication**: Fluent in spoken and written english and spanish . Engaging and articulated speaker.
- **Mentorship**: Mentored and trained a dozen PhD, MSc and undergrad students from 3 different countries in wet lab and bioinformatics.
- **Fundraising**: Secured 140,000 USD in grant funding during 2017-2019.

Education

11/2013	PhD in Plant Biotechnology , Langebio-CINVESTAV, Irapuato, Mexico
02/2009	MSc in Biochemical Sciences, IBT-UNAM. Cuernavaca Mexico
08/2007	Biochemical Engineering, Villahermosa Institute of Technology, Villahermosa, Mexico

Employment history

2019 to date	Project Scientist Joint Bioenergy institute, Lawrence Berkeley National Laboratory, UC Berkeley, Emeryville CA, USA
2018-2019	Future professor (faculty position) Instituto Tecnologico y de Estudios Superiores de Monterrey (ITESM), Mexico
2018-2019	Guest Postdoctoral Fellow, Joint BioEnergy Institute, Lawrence Berkeley National Laboratory, UC Berkeley, Emeryville CA, USA Funded by SENER-CONACyT, fund for sustainable energy, Mexican goverment
2017	Endeavour Postdoctoral Fellow Austalian Institute of Bioengineering and Nanotechnology Institute for Molecular Bioscience University of Queensland, Brisbane, Australia. Funded by Endeavour fellowships, Australian government.
2015 - 2017	Scientific manager and partner StrainBiotech SAPI, Mexico
2014 - 2016	Langebio Postdoctoral Fellow National Laboratory of genomics for biodiversity, Irapuato, Mexico Funded by the Center for research and Advanced studies (CINVESATAV-IPN) with a visiting professor-level appointment (2C)

Honors and awards

2016-2019	Member of the Mexican National Research System (SNI-1) National council of science and technology of Mexico
2016	Jesus Kumate award for the best basic research work Mexican society of infectology and clinical microbiology, Monterrey, Mexico
2015	Weizmann prize for best PhD thesis in technology and engineering Mexican Academy of Sciences
2013	Best poster prize Biochemistry and molecular biology of bacteria meeting, Mexican society of biochemistry, Coahuila, Mexico
2013	Outstanding abstract Genetics of industrial Microorganisms conference, Cancun, Mexico
2011	Young scientist plenary session award International Symposium on the Biology of actinomycetes (ISBA), Puerto Vallarta, Mexico
2010	Scholarship for the John Innes/Rudjer Boskovic Summer School on Microbial Metabolites, Dubrovnik, Croacia

Funding

2019	ITESM Mexico	30,000 USD	Evolutionary approaches for Natural Products early stage drug discovery (With Cuauhtemoc Licona-Cassani)
2018	UC-MexUS, USA-Mexico	25,000 USD	An Evolution-guided Synthetic biology approach to accelerate early-stage natural product discovery (With Jay D Keasling and Cuauhtemoc Licona-Cassani)
2017	SENER-CONACyT fund for sustainable energy Mexico	68,000 USD	Second generation biofuel synthesis using polyketide synthases with and evolutionary approach
2017	Endeavour fellowships, Australia	25,000 AUD	Implementation of a phylogenomics natural products discovery pipeline

Publications overview

Metrics

731	Total citations
10	H-index
3	Patent applications
24	Published articles, reviews and comments as coauthor
3	Preprints under review)

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Conference presentations, lectures and workshops

6	Conference presentations
12	Invited lectures and workshops
17	Posters
32	Total

Teaching

03-04/2016	Chemical biology and biophysics, Module 1, Part of the Integrative biology graduate program, National Laboratory of Genomics for Biodiversity, Irapuato, Mexico
10/2015	Bioinformatics / Next Generation Sequencing, National Autonomous University of Mexico (UNAM), Escuela Nacional de Estudios Superiores. Leon, Mexico, Part of the genetics course of the Agrogenomic sciences program
02/2014	Bacterial genetics, National Autonomous University of Mexico (UNAM), Escuela Nacional de Estudios Superiores. Leon, Mexico, Part of the genetics course of the Agrogenomic sciences program

Mentoring and training

01/2019-to date	Kevin Yin (PhD student) Department of Plant and Microbial Biology UC Berkeley, Polyketide synthases engineering.
03/2020-to date	Elizabeth Alcala (PhD student) Department of Plant and Microbial Biology UC Berkeley, Aminoglycoside biosynthesis and engineering.
09/2019-to date	Jesus del Rio (Biotechnology engineering) Tec de Monterrey-UC Berkeley. Aminoglycoside host development
09/2019-to date	Sofia Haile (Bioengineering undergraduate) UC Berkeley. Aminoglycoside combinatorial biosynthesis
09/2018-to date	Suneil Acharya (Chemcial Engineering undergraduate) UC Berkeley. Polyketide synthases heterologous expression.
08/2018-to date	Lauren Sermeno (Chemical Engineering undergraduate) UC Berkeley. Natural Products genome mining.
10-12/2019	Luisa Maria Trejo Alarcon (MSc Biotechnology) Tec de Monterrey Development of a yeast-based codon readthrough screening
10/2019-3-2020	Aidan Cowan (PhD student) Chemical Biology UC Berkeley, Polyketide synthases engineering.
08/2018	Yuka Murofushi (Masters in Science), Tokyo Institute of Technology. Combinatorial biosynthesis of natural products.
05-07/2018	Celeste Marsan (Undergraduate), Worcester Polytechnic Institute. *Streptomyces* host engineering.
2015-2016	Karina Gutierrez-Garcia (Plant Biotechnology PhD student), National Laboratory of Genomics for Biodiversity. Mexico. Phylogenomics and genome mining of natural product biosynthesis
2014-2015	Marco Antonio Morales-Escalante (Undergraduate, Thesis mentor),National Autonomous Univeristy of Mexico. Leupeptin biosynthesis
2015-2016	Paulina Mejia-Ponce (Integrative Biology MSc student), National Laboratory of Genomics for Biodiversity. Natural Products genome mining, molecular microbiology in streptomycetes
06-08/2013	Cinthia I. Avila-Dominguez (Biochemical engineering undergraduate), Morelia Institute of technology. Characterization of a phosphonate BGC from Streptomyces sviceus
06-08/2011	Paulina E. Valdez-Camacho (Biochemical engineering undergraduate), Tijuana Institute of technology. Relationships between enzyme promiscuity and recruitment

Entrepreneurship

2014 - 2016	Partner and scientific manager in Strain Biotech SAPI (Mexico)
2016 - 2017	Partner and advisor in MeBioMe SAPI (Mexico)
2019	Member of the advisory board at VastBiome (USA)

Outreach activities

- Organizer and speaker at the Bio to SynBio mini symposium. LANGEBIO, Guanajuato, Mexico. Jun 2019.
- Organizer and presenter at the Children academy of science of Guanajuato. In-classroom scientific Interactive acivities to engage kids in microbiology. Guanajuato, Mexico 2013-2016
- Clubes de Ciencia MX (as instructor). 1-week scientific activities focused in genomics and genome mining for undergrads and high school students. Monterrey, Mexico, august 2018

Scientific Communication

- Cruz-Morales P, Barona-Gómez F. Descubriendo el tesoro químico de los microbios, desde los días de Fleming hasta la era genómica. Ide@s. ISSN:2007-2716.

Peer-reviewer

- PloS One
- Antoine van Leuwenhoek
- Scientific reports
- Frontiers in microbiology
- Genome Biology and Evolution
- Microbial Cell factories

Complete list of publications

Research articles

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1. Revisiting the evolution and taxonomy of Clostridia, a phylogenomic update. **Cruz-Morales P**, Orellana CA, Moutafis G, Moonen G, Rincon G, Nielsen LK, Marcellin E. 2019. Genome Biology and Evolution 11 (7), 2035–2044.

2. Actinobacteria phylogenomics, selective isolation from an iron oligotrophic environment and siderophore functional characterization, unveil novel desferrioxamine molecular ecology and functional traits **Cruz-Morales P**, Ramos-Aboites HE, Selem-Mojica N, Licona-Cassani C.,Mejia-Ponce PM, Souza-Saldívar V, Barona-Gomez F.FEMS Microbiology Ecology 2017.

3. Phylogenomic analysis of natural products biosynthetic gene clusters allows discovery of arseno-organic metabolites in model streptomycetes.**Cruz-Morales P.***, Kopp JF, Martinez-Guerrero CE, Yanez-Guerra LA, Selem-Mojica N, Ramos- Aboites HE, Feldmann J, Barona-Gomez F. Genome Biology and Evolution. 2016. *** co-corresponding author**

4. The genome sequence of Streptomyces lividans 66 reveals a novel tRNA-dependent peptide biosynthetic system within a metal-related genomic island **Cruz-Morales P**, Vijgenboom E, Iruegas Bocardo F, Girard G, Yañez Guerra LA, Ramos Aboites HE, Pernodet JL, Anne J, van Wezel GP and Barona Gomez F. Genome Biology and Evolution. 2013. 5(6):1165-75. doi: 10.1093/gbe/evt082.

5. An iron (II) dependent oxygenase performs the last missing step of plant lysine catabolism M G. Thompson, J M. Blake-Hedges, JH Pereira, JA Hangasky, MS Belcher, WM Moore, JF Barajas, **P Cruz-Morales**, LJ Washington, RW Haushalter, CB Eiben, Y Liu, W Skyrud, VT Benites, TP Barnum, EEK Baidoo, HV Scheller, MA Marletta, PM Shih, PD Adams, JD Keasling. 2020. bioRxiv 2020.01.30.927905. Submitted Manuscript

6. Characterization of an ECF56-family sigma factor from Streptomyces venezuelae reveals a highly conserved regulome. MG. Thompson, A Zargar, **P Cruz-Morales**, T De Rond, S Chang, AN. Pearson, G Goyal, JF. Barajas, JM. Blake-Hedges, RM. Phelan, V Reyes-Umana, AC. Hernández, NJ. Hillson, PM. Shih, JD. Keasling. 2020. bioRxiv 2020.01.30.927608 Submitted Manuscript

7. Chemoinformatic-guided engineering of polyketide synthases. Zargar A, Lal R, Valencia L, Wang J, Backman T, **Cruz-Morales P**, Kothari A, Werts M, Wong A, Bailey C, Loubat A, Liu Y, Benites V, Chang S, Hernandez A, Barajas J, Thompson MG, Barcelos C, Garcia-Martin H, Mukhopadhyay A, Baidoo E, Keasling JD. Under Review,

8. Structural control of regioselectivity in an unusual bacterial acyl-CoA dehydrogenase. Blake-Hedges JM, Pereira JH, **Cruz-Morales P**, Thompson MG, Barajas JF, Chen J, Krishna RN, Chan LJG, Nimlos D, Alonso-Martinez C, Chen Y, Gin JW, Katz L, Petzold CJ, Adams PD, Keasling JD. 2020. J. Am. Chem. Soc. 142, 2, 835-846

9. Comparative genomics and metabolomics analyses of clavulanic acid-producing Streptomyces species provides insight into specialized metabolism and evolution of beta-lactam biosynthetic gene clusters. AbuSara NF, Piercey BM, Moore MA, Shaikh AA, Nothias

LF, Srivastava SK, **Cruz-Morales P**, Dorrestein PC, Barona-Gómez F, Tahlan K. 2019. Frontiers in Microbiology. 10:2550

10. Omics-driven identification and elimination of valerolactam catabolism in Pseudomonas putida KT2440 for increased product titer. Thompson MG, Valencia LE, Blake-Hedges JM, **Cruz-Morales P**, Velasquez AE, Pearson AE, Sermeno LN, Sharpless WA, Benites VT, Chen Y, Baidoo E, Petzold CJ, Deutschbauer AM, Keasling JD. 2019. Metabolic Engineering Communications

11. A computational framework for systematic exploration of biosynthetic diversity from large-scale genomic data.Navarro-Munoz J, Selem-Mojica N, Mullowney M, Kautsar S, Tryon J, Parkinson E, De Los Santos E, Yeong M, **Cruz-Morales P**, Abubucker S, Roeters A, Lokhorst W, Fernandez-Guerra A, Dias- Cappelini LT, Thomson R, Metcalf W, Kelleher N, Barona-Gomez F, Medema MH. 2019. Nature Chemical Biology 16 (1), 60-68

12. Robust characterization of two distinct glutarate sensing transcription factors of Pseudomonas putida L-lysine metabolism. 2019. Thompson MG, Costello Z, Hummel N, **Cruz-Morales P**, Blake-Hedges JM, Krishna RN, Skyrud W, Pearson AN, Matthew R. Incha MR, Shih PM, Garcia-Martin H, Keasling JD. ACS synthetic Biology. 8 (10), 2385-2396

13. Massively parallel fitness profiling reveals multiple novel enzymes in Pseudomonas putida lysine metabolism. Thompson MG, Blake-Hedges JM, **Cruz-Morales P**, Barajas JF, Curran SC, Harris NC, Benites VT, Gin JW, Eiben CB, Sharpless WA, Krishna RN, Baidoo E, Petzold CJ, Arkin AP, Deutschbauer AM, Keasling JD. 2019. mBio 10: e02577-18

14. Expanding gene families helps generate the metabolic robustness required for antibiotic biosynthesis.Schniete JK, **Cruz-Morales P**, Selem N, Fernandez-Martinez LT, Hunter IS, Barona-Gomez F, Hoskisson P. MBio 9 (1), e02283-17. 2019.

15. Talaropeptides AD: Structure and biosynthesis of extensively N-methylated linear peptides from an Australian marine tunicate-derived Talaromyces sp. Dewapriya P, Khalil ZG, Prasad P, Salim AA, **Cruz-Morales P**, Marcellin E, Capon RJ. Frontiers in chemistry 6: 394. 2018.

16. Inter–Kingdom Beach Warfare: A Tale of Two Microbes. Nitric oxide activation of silent chemical defenses. Khalil Z, **Cruz-Morales P**, Licona-Cassini C, Marcellin E; Capon RJ. 2019 The ISME journal 13 (1), 147.

17. The cycad coralloid root contains a diverse endophytic bacterial community including cyanobacteria encoding specific biosynthetic gene clusters. Gutiérrez-Garcia KG, Bustos-Díaz ED, Corona-Gomez JA, Ramos-Aboites HE, Selem-Mojica N, **Cruz-Morales P**, Perez-Farrera MA, Barona-Gómez F, Cibrián-Jaramillo A. 2019. Genome biology and evolution 11 (1), 319-334.

18. Diverse cone-snail species harbor closely related Streptomyces species with conserved chemical, genetic and bioactivity profiles, including Polycyclic Tetramate Macrolactams. Quezada M, Licona-Cassani C, **Cruz-Morales P**, Salim AA, Marcellin E, Barona-Gomez F, Capon RJ. Front Microbiol. 8:2305.

19. Increased transcript diversity: novel splicing variants of Machado-Joseph disease gene (ATXN3). Bettencourt C, Santos C, Montiel R, Costa C, **Cruz-Morales P**, Santos LR, Simoes N, Kay T, Vasconcelos J, Maciel P, Lima M. 2010. Neurogenetics. 11(2):193-202.

Reviews and commentaries

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20. Engineering Natural Product Biosynthetic Pathways to Produce Commodity and Specialty Chemicals. Liu Y, Gan Y, **Cruz-Morales P** & Keasling JD. Book chapter in press (Elsevier 2020)

21. Minimum Information about a Biosynthetic Gene cluster. Medema MH, Kottmann R, Yilmaz P, Cummings M, Biggins JB, Blin K, de Bruijn I, Chooi YH, Claesen J, Coates RC, **Cruz-Morales P**. and 47 more co-authors. 2015. Nat Chem Biol. 11(9):625-31. doi: 10.1038/nchembio.1890.

22. Systems Biology Approaches to Understand Natural Products Biosynthesis. Licona-Cassani C,**Cruz-Morales P**, Manteca A, Barona-Gomez F, Nielsen LK, Marcellin E. 2015. Front Bioeng Biotechnol. 9;3:199. doi: 10.3389/fbioe.2015.00199.

23. Synthetic biology of avermectin for production improvement and structure diversification. Zhuo Y, Zhang T, Wang Q, **Cruz-Morales P**, Zhang B, Liu M, Barona-Gómez F, Zhang. L. 2014. Biotechnol J. 9(3):316-25. doi: 10.1002/biot.201200383.

24. What can genome-scale metabolic network reconstructions do for prokaryotic systematics?Barona-Gómez F, **Cruz-Morales P**, Noda-García L. 2012. Antonie Van Leeuwenhoek. 101(1):35-43. doi: 10.1007/s10482-011-9655-1.

Genome announcements

- Hayano-Kanashiro C, López-Arredondo DL, Cruz-Morales P, Alcaraz LD, Olmedo G, Barona- Gómez F, Herrera-Estrella L. 2011. First draft genome sequence of a strain from the genus Citricoccus. J Bacteriol. 193(21):6092-3. doi: 10.1128/JB.06045-11.

- Steffani-Vallejo JL, Zuñiga C, Cruz-Morales P, Lozano L, Morales M, Licona-Cassani C, Revah S, Utrilla J. 2017. Draft Genome Sequence of Sphingobacterium sp. CZ-UAM, Isolated from a Methanotrophic Consortium. Genome Announc. 5(33). pii: e00792-17. doi:10.1128/genomeA.00792-17.

Patent applications

- **Cruz-Morales P**, Barona-Gómez F, Ramos-Aboites HE. Genetic system for producing a proteases inhibitor of a small peptide aldehyde type. International patent application (WO 2016097957 A3)

- **Cruz-Morales P**, Barona-Gómez F, Ramos-Aboites HE, Morales Escalante MA. Genetic system for leupeptin production and its use for production of heterologous proteins. International patent application (WO2016193954 A2)

- **Cruz-Morales P**, Barona-Gómez F, Martínez-Guerrero CE. EvoMining, un nuevo sistema filogenómico para identificar clústers de genes para la biosíntesis de productos naturales novedosos. Mexican patent application: MX/A/2015/007200