

# VIVEK K MUTALIK, Ph. D.

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## EDUCATION

Indian Institute of Technology, Bombay (IITB), Mumbai, India  
Ph.D. in Chemical Engineering (Best Thesis) 2000- 2005  
*Thesis:* Quantifying biological signaling and regulatory circuits

Mumbai University Institute of Chemical Technology, India 1995- 1997  
M.Sc.Tech. in Bioprocess Technology (First class Honors)  
*Thesis:* Studies in process development -lactic acid extraction

Karnataka University, Belgaum, India 1991- 1995  
Bachelor of Pharmacy (First class Honors)

## RESEARCH EXPERIENCE

**Research Scientist,** 2012-current  
Lawrence Berkeley National Laboratory (LBNL), Berkeley, CA, USA  
Environmental Genomics & Systems Biology Division  
Biological Systems & Engineering Division

- Developed high-throughput functional discovery platform for thousands of microbial genes, phage genes and extended it to metagenomic samples (**manuscript in prep**).
- Discovery and engineering of bacteriophage-host interaction determinants and perform designed manipulation of microbial communities (**manuscript in prep**)
- Developing experimental methods for optimizing the process of predictable expression of enzymes involved in metabolic pathways for producing high-value chemicals such as bioproducts, drugs and antibiotics.

**Design Team Scientist** 2016-2017  
Agile BioFoundry, a consortium of nine national labs funded by DOE BETO  
Lawrence Berkeley National Laboratory (LBNL), Berkeley, CA, USA

- The Agile BioFoundry aims standardize and streamline the entire biomanufacturing pipeline by uniting computer-assisted biological pathway design, process integration, process scale-up and machine learning

**Design Team Lead** 2013-2016  
Berkeley Lab BioFoundry,  
Lawrence Berkeley National Laboratory (LBNL), Berkeley, CA, USA

- Building 'one-stop-shop' biomanufacturing pipeline for rapid design, assembly, implementation and assessment of target molecule production by iteratively uncovering and resolving critical biosynthesis bottlenecks.

**Team Lead** 2010-2012  
The BIOFAB: International Open Facility Advancing Biotechnology (BIOFAB)  
Joint Bioenergy Institute, Emeryville, CA, USA  
A joint effort between UC Berkeley, Stanford University, Lawrence Berkeley National Laboratory, BioBricks Foundation and Synthetic biology Engineering Research Center (SynBERC)

- Developed Generalized 'Expression Operating System' that will be useful for designing and programming gene expression in a predictable manner at genome-scale engineering efforts
- Managed multiple projects and professional staff in designing, building, and testing a collection of engineered genetic components that control constitutive RNA production, RNA processing and degradation, translation initiation, protein degradation and DNA

replication in bacteria

- Developed a method that allows for reliable functional coupling of prokaryotic transcription and translation control elements with user-specific coding sequences for genes of interest
- Spearheaded the effort in designing, engineering and characterizing more than 300 promoters, 100 terminators, 150 translational coupling elements and more than 2000 element-element combinatorial libraries. All of the datasets made freely available.
- Worked on Sequence-activity relationships and multivariate data analysis

**Project Scientist,**

2009-2010

*Laboratory of Prof. Adam Arkin*

Lawrence Berkeley National Laboratory (LBNL)

Physical Biosciences Division, Joint Bioenergy Institute, Emeryville, CA, USA

- Developed a minimal complexity, maximally predictive data-driven sequence-activity model to design thousands of translation repressors and an entire panel of orthogonal regulators for reliable engineering of gene expression in *E coli*
- The modeling approach is generally applicable to engineer other RNA elements

**Postdoctoral Fellow,**

2005- 2009

*Laboratory of Prof. Carol Gross*

University of California at San Francisco (UCSF)

Dept of Microbiology and Immunology, San Francisco, CA, USA

- High throughput experiments and multivariate data analysis techniques were used to obtain biophysical relationships between promoter activity of alternative sigma factors in *E coli* and promoter sequences
- This is the first comprehensive study of complete target set of sigma factors in *E coli*.

**Graduate student**

2000- 2005

*Laboratory of Prof. KV Venkatesh*

Indian Institute of Technology, Bombay (IITB)

Dept of Chemical Engineering, Mumbai, India

- Steady state modeling approach applied to different signaling and regulatory circuits to derive theoretical dose-response curves, analyze emergent properties and uncover design principles

**M.Sc. Tech Student,**

1995- 1997

*Laboratory of Prof. VV Mahajani*

Mumbai University Institute of Chemical Technology (MUICT)

Dept of Chemical Engineering, Mumbai, India

- Solvent extraction techniques applied to recover lactic acid from fermentation broth

**INDUSTRY EXPERIENCE**

Merind Limited (Wockhardt Enterprise), Mumbai, India

1998 - 2000

**Senior Executive**

- Coordinated and supervised a team of 10 technicians and 12 operators in Vitamin-B12 fermentation and processing department. Responsibilities included training operators, people management, analyzing fermentation profiles, reporting to plant manager and coordinating with other utility departments.

Torrent Gujarat Biotechnology Limited, Baroda, India

1997 -1998

**Executive**

- Supervised day-to-day production activities of fully automated 150,000 liter Penicillin G fermentation reactor plant. Monitored production schedules and material / resource requirements. Devised systemic tools to understand the source of contamination and implemented various contamination preventative measures to meet production targets.

## PATENTS

- US Patent App. 15/665,226, 2018: **VK Mutalik**, A Deutschbauer, AP Arkin, P Novichkov “Multiplex characterization of microbial traits using dual barcoded nucleic acid fragment expression library”

## PUBLICATIONS

1. **Vivek K. Mutalik**, Pavel S. Novichkov, Morgan N. Price, Trenton K. Owens, Mark Callaghan, Sean Carim, Adam M. Deutschbauer and Adam P. Arkin, “Dual-barcoded shotgun expression library sequencing for high-throughput characterization of functional traits in bacteria”, *Nature Communications*, 10(1), 308, 2019 *\*Highlighted in Nature Methods*
2. Thomas L Ruegg, Jose H Pereira, Joseph C Chen, Andy DeGiovanni, Pavel Novichkov, **Vivek K Mutalik**, Giovanni P Tomaleri, Steven W Singer, Nathan J Hillson, Blake A Simmons, Paul D Adams, Michael P Thelen, “Jungle Express is a versatile repressor system for tight transcriptional control”, *Nature Communication*, 9, 3617, 2018
3. Marcelo C Bassalo, Andrew D Garst, Andrea L Halweg-Edwards, William C Grau, Dylan W Domaille, **Vivek K Mutalik**, Adam P Arkin, Ryan T Gill, “Rapid and efficient one-step metabolic pathway integration in *E. coli*”, *ACS Synthetic Biology*, 5 (7), 561-568, 2016
4. Pouya Javidpour, Samuel Deutsch, **Vivek K Mutalik**, Nathan J Hillson, Christopher J Petzold, Jay D Keasling, Harry R Beller, “Investigation of proposed Ladderane biosynthetic genes from Anammox bacteria by heterologous expression in *E. coli*”, *PLOS one*, 11 (3), e0151087, 2016
5. Emily Freed, James Winkler, Sophie Weiss, Andrew Garst, **Vivek Mutalik**, Adam Arkin, Rob Knight and Ryan Gill, “Genome-wide tuning of protein expression levels to rapidly engineer microbial traits” *ACS Synthetic Biology*, 4 (11), 1244-1253, 2015.
6. Gregory Linshiz, Nina Stawski, Garima Goyal, Changhao Bi, Sean Poust, Monica Sharma, **Vivek Mutalik**, Jay D Keasling, Nathan J Hillson, “PR-PR: Cross-Platform Laboratory Automation System” *ACS Synthetic Biology*, 3 (8) 515-524, 2014
7. **Vivek Mutalik**, Joao Guimaraes, Guillaume Cambray, Colin Lam, Marc Juul Christoffersen, Quynh-Anh Mai, Andrew Tran, Paull Morgan, Adam Arkin and Drew Endy, “Precise and reliable gene expression via standard transcription and translation initiation elements”, *Nature Methods*, 10 (4), 354-360, 2013. *\*Highlighted in Nature, Nature Methods, Nature Reviews Genetics, Bioengineered, New Scientist, various Science news agencies.*
8. **Vivek Mutalik**, Joao Guimaraes, Guillaume Cambray, Quynh-Anh Mai, Marc Juul Christoffersen, Lance Martin, Ayumi Yu, Colin Lam, Cesar Rodriguez, Gaymon Bennett, Drew Endy and Adam Arkin, “Quantitative Estimation of Activity and Quality for Collections of Functional Genetic Elements”, *Nature Methods*, 10 (4), 354-360, 2013. *\*Highlighted in Nature, Nature Methods, Nature Reviews Genetics, Bioengineered, New Scientist, various Science news agencies.*
9. Sriram Kosuri, Daniel B. Goodman, Guillaume Cambray, **Vivek K. Mutalik**, Yuan Gao, Adam P. Arkin, Drew Endy, George M. Church “Composability of regulatory sequences controlling transcription and translation in *E. coli*” *Proceedings of the National Academy of Science, USA* 110 (34), 14024-14029, 2013
10. Cambray, G., Guimaraes, J., **Mutalik, Vivek**, Lam, C., Mai, Quynh-Anh, Thimmaiah, T., Carothers, J., Arkin, A., Endy, D., “Measurement and Modeling of Intrinsic Transcription

- Terminators”, *Nucleic Acid Research*, 41 (9), 5139-5148, 2013. *\*Highlighted by New Scientist, various Science news agencies.*
11. Goldbeck C. P., Jensen H. M., TerAvest M. A., Beedle N., Appling Y., Hepler M., Cambray G., **Vivek Mutalik**, Angenent L. T. and Ajo-Franklin C. M. (2013). Tuning promoter strengths for improved synthesis and function of electron conduits in *Escherichia coli*. *ACS Synthetic Biology*, 2(3), 150-159, 2013. *\*Highlighted by various Synthetic biology and technology news agencies.*
  12. Chang Liu, Lei Qi, Julius Lucks, Thomas Segall-Shapiro, Denise Wang, **Vivek Mutalik**, and Adam Arkin, “An adapter from translational to transcriptional control yields composable regulators of gene expression”, *Nature Methods*, 9 (11),1088-1094, 2012. *\*Highlighted in commentary “Modular gene-circuit design takes two steps forward” by Jeffrey J Tabor in Nature Methods.*
  13. **Vivek K Mutalik**, L. Qi, J. C. Guimaraes, J.B. Lucks and A. P. Arkin, “Rationally designed families of orthogonal RNA regulators of translation”, *Nature Chemical Biology*, 8(5):447-54, 2012. *\*Highlighted in commentary “Automated Design of RNA Devices” by Farren Isaacs in Nature Chemical Biology.*
  14. L. Qi, J.B. Lucks, L.C. Chang, **Vivek K Mutalik** and A. P. Arkin, “Engineering naturally occurring trans-acting non-coding RNAs to sense molecular signals”, *Nucleic Acid Research*, 40(12):5775-86, 2012
  15. V. A. Rhodius, **Vivek K Mutalik** and C. A. Gross, “Predicting the strength of UP-elements and full-length *E coli*  $\sigma E$  promoters”, *Nucleic Acid Research*, 40(7):2907-24, 2012
  16. G. Cambray, **Vivek K Mutalik** and A. P. Arkin, “Towards rational design of bacterial genomes”, *Current Opinion in Microbiology*, 14 (5), 624-630, 2011
  17. J. B Lucks, L. Qi, **Vivek K Mutalik**, D, Wang and A. P. Arkin, “Versatile RNA-sensing transcriptional regulators for engineering genetic networks” *Proceedings of the National Academy of Sciences*, 108 (21), 8617-8622, 2011
  18. V. A. Rhodius and **Vivek K Mutalik**, “Predicting Strength and Function for Promoters of the *E. coli* Alternative Sigma Factor,  $\sigma E$ ”, *Proceedings of the National Academy of Sciences*, 107, 2854-2859, 2010.
  19. **Vivek K Mutalik**, G. Nonaka, S. Ades, V. A. Rhodius and C. A. Gross, “Promoter strength properties of the complete sigma-E regulon of *E coli* and *Salmonella*”, *J. Bacteriology*, 191(23), 7279-7287, 2009
  20. **Vivek. K. Mutalik** and K.V. Venkatesh, “A theoretical steady state analysis indicates that induction of *Escherichia coli* *glnALG* operon can display all-or-none behavior”, *BioSystems*, 90: 1-19, 2007
  21. I. L. Grigorova, N. J. Phleger, **Vivek. K. Mutalik**, and C. A. Gross, “Insights into transcriptional regulation and sigma competition from an equilibrium model of RNA polymerase binding to DNA”, *Proceedings of the National Academy of Sciences*, [103] (14), 5332–5337, 2006
  22. **Vivek. K. Mutalik** and K V. Venkatesh, “Effect of the MAPK cascade structure, nuclear translocation and regulation of transcription factors on gene expression”, *BioSystems*, 85(2):144-57, 2006
  23. **Vivek. K. Mutalik** and K V Venkatesh, “Quantification of glycogen cascade system: A highly ultrasensitive response of Glycogen Synthase in the liver and Phosphorylase in the muscle is due to distinctive regulatory design”, *Theoretical Biology and Medical Modelling* 2005, 2:19

24. **Vivek. K. Mutalik**, A. P. Singh, J. S. Edwards and K. V. Venkatesh, "Equilibrium analysis of allosteric interactions shows zero order effects", *Cell Biochemistry and Biophysics Cell Biochemistry and Biophysics* [41] (2), 179-192, 2004.
25. **Vivek. K. Mutalik**, A. P. Singh, J. S. Edwards and K. V. Venkatesh, "Robust global sensitivity in multiple enzyme cascade system explains how the downstream cascade structure may remain unaffected by cross-talk", *FEBS Letters*, [558] (1-3), 79-84, 2004.
26. L. Giri\*, **Vivek. K. Mutalik\*** and K.V. Venkatesh, "A steady state analysis indicates that negative feedback regulation of PTP1B by Akt elicits bistability in insulin-stimulated GLUT4 translocation", *Theoretical Biology and Medical Modelling* 2004, **1:2** (3 August 2004), \*Equal Contribution
27. **Vivek. K. Mutalik**, P. Shah and K V Venkatesh, "Allosteric Interactions and Bifunctionality Make the Response of Glutamine Synthetase Cascade System of *Escherichia coli* Robust and Ultrasensitive", *The Journal of Biological chemistry*, [278] (29), 26327-26332, 2003.
28. **Vivek. K. Mutalik** and K V Venkatesh, "Steady state analysis of signaling pathways in living systems: use of dimensionless parameters akin to chemical plants", *Indian Chemical Engineers*, Section B [46](4), 261-265, 2004

## **GRANTS AWARDED**

- **Innovative Genomic Institute (IGI) grant (\$242,000/yr, 3 years)**, "Discovery and engineering of host-phage interaction determinants for designed manipulation of microbial communities" Project from Jan 2018-Jan 2021. PIs: Vivek K Mutalik and Adam Arkin
- **ENIGMA Discovery grant (\$200,000/yr, 2 years)**, "Multiplex characterization of functional traits using dual-barcoded genome fragments in diverse bacteria" project from Oct 2015-Oct 2017. PIs: Adam Arkin, Adam Deutschbauer, Vivek K Mutalik
- **ENIGMA Discovery grant (\$200,000/yr)**, "Phage editing of Pseudomonad communities isolated from Oak Ridge FRC site to study community dynamics" project from Oct 2016-Oct 2017. PIs: Adam Arkin, Adam Deutschbauer, Vivek K Mutalik
- **LDRD Grant (\$700,000/yr)** from Laboratory directed research and development, Lawrence Berkeley National Lab, for "Berkeley Lab Biological Foundry" project from Oct 2013-Oct 2014. PIs: Vivek K Mutalik, Nathan Hillson, Sam Deutsch, Paramvir Dehal, Trent Northen.

## **INVITED TALKS**

1. **Vivek K. Mutalik**, "High-throughput genome-wide screens to discovery host factors important in phage infection and resistance", *co-organizer and speaker*, Viral EcoGenomics and Applications (VEGA) Symposium, Joint Genome Institute, JGI User meeting 2018.
2. **Vivek K. Mutalik**, "Multiplex characterization of microbial traits using high-throughput functional genomic tools", *Invited Speaker*, Wholebiome, Seminar series, Feb 2, 2018
3. **Vivek K. Mutalik**, "Discovery and engineering of phage-host interaction determinants for designed manipulation of microbial communities", *Invited Speaker*, Geneweave (Roche), Seminar, July 21, 2017
4. **Vivek K Mutalik**, "Multiplex characterization of functional traits using standardized expression platform in diverse bacteria" *Invited Speaker*, Joint Genome Institute, JGI

- Science and Technology Seminar series, Walnut creek, CA May 4, 2017
5. **Vivek K Mutalik**, "A high-throughput screening platform for assigning function to microbial dark matter" *Invited Speaker*, New lineages of life (NeLLi) workshop, Joint Genome Institute, Science and Technology Seminar series, Walnut creek, CA April 5, 2017
  6. **Vivek K Mutalik**, "Multiplex characterization of functional traits using dual-barcoded genome fragments in diverse bacteria" *Invited Speaker*, 5<sup>th</sup> Annual Microbiology Retreat, Department of Plant and microbial biology, UC Berkeley, March 23, 2017
  7. **Vivek K Mutalik**, "Developing tools and technologies for rationally engineer biosynthetic systems", *Invited Speaker*, Advanced Synthetic Biology training at the EMBO Synthetic Biology in Action, EMBL Heidelberg, June 8-20, 2015
  8. **Vivek K Mutalik**, "Technical challenges in Synthetic Biology", *Invited Speaker*, iBiology, Open access video series, June 8-20, 2015
  9. **Vivek K Mutalik**, "Developing tools and technologies for rationally engineer biosynthetic systems", *Invited Speaker*, EMBO | EMBL SYMPOSIUM: Enabling Technologies for Eukaryotic Synthetic Biology, June 21-23, 2015
  10. **Vivek K Mutalik**, "Developing tools and technologies for next generation synthetic biology", *Invited Speaker*, NSF Indo-US workshop on Systems and Synthetic Biology, New Delhi, India, Nov 9-12, 2014
  11. **Vivek K Mutalik**, "Developing tools to rational engineer biosynthetic systems", *Invited Speaker*, Genencor Technology center, Dupont Industrial Biosciences, Palo Alto, CA, USA, March, 2014
  12. **Vivek K Mutalik**, "Next generation Synthetic Biology", *Invited Speaker*, DNA 2.0 Inc, Menlo Park, CA, USA, March, 2014
  13. **Vivek K Mutalik**, "Developing tools and technologies for rational engineering of biosynthetic systems", *Invited Speaker*, NASA Ames research Center, Mountain View, CA, USA, February 14, 2014
  14. **Vivek K Mutalik**, "Standardization approaches to rationally engineer genetic parts and pathways", *Invited Speaker*, SynBio Club, University of Colorado, Boulder, USA, November 27, 2012
  15. **Vivek K Mutalik**, "Standardization approaches to rationally engineer genetic parts and pathways", *Invited Speaker*, QB3 Postdoc seminar series, University of California, Berkeley, USA, October 12, 2012
  16. **Vivek K Mutalik**, "Standardization approaches to rationally engineer genetic parts and pathways", *Invited Speaker*, SynBio Super Group, University of California, Berkeley, USA Sept, 2012
  17. **Vivek K Mutalik**, "Standardization approaches for synthetic biology", *Invited Speaker*, SyntheticBiology Group, May 1, 2012, California Institute of Technology, Pasadena, CA, USA
  18. **Vivek K Mutalik**, "Reliable and Precise Gene Expression via Active Translational Coupling", *Invited Speaker* at "PepTalk", Cambridge Healthtech Institutes, 11<sup>th</sup> Annual The Protein Science Week, Jan 9-10, 2012 at Coronado USA
  19. **Vivek K Mutalik**, "Wetware tools for Synthetic Biology" *Invited Speaker* at SB5.0, June 15-17, 2011 at Stanford University, Stanford, CA, USA
  20. **Vivek K Mutalik**, "Standardization approaches for synthetic biology", *Invited Speaker*, Energy Biosciences Institute seminar, University of California, Berkeley, June 2011

## WORKSHOP

**Vivek K Mutalik** and Drew Endy, Advancements in synthetic biology at the Biotechnology Industry Organization (BIO)'s Pacific Rim Summit on Industrial Biotechnology and Bioenergy, on Dec., 11-14, 2010, Hilton Hawaiian Village Beach Resort, Honolulu, USA. The workshop highlighted the work performed at the world's first design, build and test facility, **BIOFAB: International Open Facility Advancing Biotechnology**. The workshop demonstrated how physically well characterized, standardized DNA parts will shorten the development time and time-to-market for products as well as lower the cost of synthetic biology for both academia and the industrial sector. This type of characterization may eventually enable researchers to produce new antibiotics, health care products, biofuels, renewable chemicals and biobased products.

## AWARDS AND RECOGNITION

- R & D 100 award Winner, "Double Barcoded Shotgun Expression Library Sequencing (Dubseq) technology" 2017
- 'Best Computational PART Design award' on Poster "Rationally designed families of orthogonal RNA regulators of translation" at International Synthetic biology conference SB5.0 (June 15-17, 2011) held at Stanford University, Stanford, CA, USA
- 'IIT Bombay Research Paper Award 2008' to Vivek. K. Mutalik, P. Shah and K V Venkatesh, on their work "Allosteric Interactions and Bifunctionality Make the Response of Glutamine Synthetase Cascade System of Escherichia coli Robust and Ultrasensitive", Published in The Journal of Biological chemistry, [278] (29), 26327-26332, 2003. This award was based on citations on the publications across Indian Institute of Technology, Bombay across all divisions and among hundreds of publications.
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## MEMBERSHIPS/SERVICE

- Member, The Society for Biological Engineering, 2013 (Yearly membership)
- Member, The American Society for Microbiology, 2013 (Yearly membership)
- Ad Hoc Reviewer, Nature Methods, Nature Biotechnology, Bioinformatics, Nucleic Acid Research, BMC Systems Biology, Journal of Biological Systems, ACS Synthetic Biology, 2009-present

## MANAGERIAL EXPERIENCE

- Currently **mentoring** one Postdoc, two graduate students and one research assistant at LBNL.
- **Managed and overlooked the entire operation** of World's First Design, Build, and Test Facility, BioFAB at the Joint Bioenergy Institute, Emeryville, CA.
- **Managed and trained** 5 professional staff at the BioFAB, trained 4 undergrads and oversaw 1 graduate student project
- **Trained** 8 graduate students in research laboratories and 10 technicians in industry, belonging to different age groups.