Karthik Raman

BT 221, Block II, Bhupat and Jyoti Mehta School of Biosciences
Department of Biotechnology
Indian Institute of Technology Madras
Chennai – 600 036, INDIA

kraman@iitm·ac·in +91-44-2257-4139
http://home.iitm.ac.in/kraman/lab
RamanLab

Born: 1981—Chennai, INDIA
Nationality: Indian

Current Positions

2018– *Associate Professor*, Department of Biotechnology, Bhupat and Jyoti Mehta School of Biosciences, Indian Institute of Technology (IIT) Madras
2015– *Co-ordinator*, Initiative for Biological Systems Engineering (IBSE), IIT Madras
2017– *Core Faculty*, Robert Bosch Centre for Data Sciences and Artificial Intelligence (RBC-DSAI), IIT Madras
2018– *Co-founder & Director*, qBiome Research Private Limited, Chennai

Research Interests

Computational modelling and simulation of biological systems and networks • Algorithm development for systems biology • *In silico* Metabolic engineering • Design Principles of Biological Networks • Integrated analysis of massive biological datasets • High-performance computing (GPGPU) for systems biology

Research Skills

Formal education in bio-informatics and computational/systems biology, high-performance computing, data structures and algorithms, computational methods, pattern recognition
Number of publications: 40, plus posters/talks at scientific meetings.
Fluent in MATLAB, Python, scripting languages such as awk, sed. Working knowledge of C/C++.

Past Positions

2011–18 *Assistant Professor*, Department of Biotechnology, Bhupat and Jyoti Mehta School of Biosciences, Indian
2016 Jun–Jul Institute of Technology (IIT) Madras Visiting Research Scientist, Vantage Research, Chennai
2012 Jun–Jul Visiting Research Scientist, Samsung Advanced Institute of Technology (SAIT), Bangalore
2008–11 Post-doctoral researcher, Andreas Wagner Lab, Department of Biochemistry/Department of Evolutionary Biology and Environmental Studies, University of Zürich, Switzerland

Professional Affiliations

2011– International Society for Computational Biology (ISCB)
2018– Biological Engineering Society of India
2018 American Institute of Chemical Engineers (AIChE)
2018 Society for Biological Engineering (SBE)

Education

2009 PhD in *Systems Biology*, Supercomputer Education and Research Centre/Bioinformatics Centre, Indian Institute of Science, Bangalore, India
Thesis: Systems-level Modelling and Simulation of *Mycobacterium tuberculosis*: Insights for Drug Discovery PDF
Advisers: Nagasuma Chandra and Saraswathi Vishveshwara
Awarded the *Sir Vithal N. Chandavarkar Memorial Medal* for the best Ph. D. thesis of the year in the Supercomputer Education and Research Centre, Indian Institute of Science

2005 Awarded a transfer to the PhD programme, from an MTech in *Computational Science*, at the Supercomputer Education and Research Centre, Indian Institute of Science, Bangalore, India. Graduate courses GPA: 7.3/8.0.

2003 BTech in Chemical Technology (First class with distinction), Institute of Chemical Technology, University of Mumbai, India

Peer-reviewed Publications

Pre-prints and manuscripts under review

2021 Anjana Anilkumar Sithara, Devi Priyanka Maripuri, Keerthika Moorthy, Sai Sruthi Amirtha Ganesh, Philge Philip, Shayantan Banerjee, Malvika Sudhakar and **Karthik Raman*** "iCOMIC: a graphical interface-driven bioinformatics pipeline for analyzing cancer omics data" Manuscript preprint: RX doi

2021 Lavanya Raajaraam and **Karthik Raman*** "A computational framework to identify metabolic engineering strategies for the co-production of metabolites" Manuscript preprint: RX doi

2021 Rachita K Kumar, Nitin Singh, Sanjaay Balakrishnan, Ceth W. Parker, **Karthik Raman*** and Kasthuri Venkateswaran*, "Metabolic modeling of the International Space Station microbiome reveals key microbial interactions" Manuscript preprint: RX doi

2021 Priyan Bhattacharya, **Karthik Raman*** and Arun K. Tangirala*, "A generic systems-theoretic approach to identify biological networks capable of adaptation" Manuscript preprint: RX doi

2021 Aarthi Ravikrishnan and **Karthik Raman*** "Unraveling microbial interactions in the gut microbiome" Manuscript preprint: RX doi

2021 Attila Gabor, Marco Tognetti, ..., **Single Cell Signaling in Breast Cancer DREAM Consortium**, ..., Bernd Bodenmiller*, Julio Saez-Rodriguez* "Cell-to-cell and type-to-type heterogeneity of signaling networks: Insights from the crowd". Manuscript preprint: RX doi

2021 Sankalpa Venkatraghavan†, Sathvik Anantakrishnan† and **Karthik Raman*** "Probing Patterning in Microbial Consortia with picCASO: a Cellular Automaton for Spatial Organisation" Manuscript preprint: RX doi

2021 Vimaladhasan Senthamizhan, Sunanda Subramaniam, Arjun Raghavan and **Karthik Raman*** "CASTLE: A database of synthetic lethal sets predicted from genome-scale metabolic networks" Manuscript preprint: RX doi

2020 Maziya Ibrahim and **Karthik Raman*** "Two-species community design of Lactic Acid Bacteria for optimal production of Lactate" Manuscript preprint: RX doi

2020 Malvika Sudhakar, **Karthik Raman*** and Raghunathan Rengaswamy* "Novel ratio-metric features enable the identification of new driver genes across cancer types" Manuscript preprint: RX doi

Articles in international journals (44)

2021 Vimaladhasan Senthamizhan, Balaraman Ravindran and **Karthik Raman*** "NetGenes: A database of essential genes predicted using features from interaction networks" *Frontiers in Genetics* **12**:722198 Manuscript preprint: RX doi

2021 Maziya Ibrahim†, Lavanya Raajaram† and **Karthik Raman*** "Modelling microbial communities: harnessing consortia for biotechnological applications" *Computational and Structural Biotechnology Journal* doi

2021 Sahana Gangadharan and **Karthik Raman*** "The art of molecular computing: whence and whither" *BioEssays* **43**:202100051 doi Manuscript preprint:

2021 Shayantan Banerjee, **Karthik Raman*** and Balaraman Ravindran* "Sequence neighborhoods enable reliable

prediction of pathogenic mutations in cancer genomes" *Cancers* **13**:2366

2021 Priyan Bhattacharya, **Karthik Raman*** and Arun Tangirala "Systems-theoretic approaches to design biological networks with desired functionalities", *Methods Mol Biol* **2189**:133–155

2020 Sarah M. Keating*, Dagmar Waltemath*, ..., **Karthik Raman**, ..., Henning Hermjakob, John C. Doyle, Michael Hucka*, and SBML Community members "SBML Level 3: an extensible format for the exchange and reuse of biological models" *Molecular Systems Biology* **16**:e91110

2020 Prem Jagadeesan, **Karthik Raman** and Arun K. Tangirala*, "A new index for information gain in the Bayesian framework", *IFAC-PapersOnLine* **53**:634–639
(Part of Special Issue: Advances in Control & Optimization of Dynamical Systems (ACODS) 2020)

2020 Ulf Liebal*, Thuy An Phan Nguyen, Malvika Sudhakar, **Karthik Raman** and Lars M. Blank, "Machine learning applications for mass spectrometry-based metabolomics" *Metabolites* **10**:243

2020 Kern Rei Chng, Tarini Shankar Ghosh, Yi Han Tan, Tannistha Nandi, Ivor Russel Lee, Amanda Hui Qi Ng, Chenhao Li, Aarthi Ravikrishnan, Kar Mun Lim, David Lye, Timothy Barkham, **Karthik Raman**, Swaine Chen, Louis Chai, Barnaby Young*, Yunn-Hwen Gan* and Niranjan Nagarajan* "Metagenome-wide association analysis identifies microbial determinants of post-antibiotic ecological recovery in the gut" *Nature Ecology and Evolution* **4**:1256–1267

2020 Kuldeep Sachdeva, Manisha Goel, Malvika Sudhakar, Mansi Mehta, Rajmani Raju, **Karthik Raman**, Amit Singh and Varadharajan Sundaramurthy* "*Mycobacterium tuberculosis* (*Mtb*) lipid–mediated lysosomal rewiring in infected macrophages modulates intracellular *Mtb* trafficking and survival" *Journal of Biological Chemistry* **295**:9192–9210

2020 Gayathri Sambamoorthy and **Karthik Raman*** "MinReact: an efficient algorithm for identifying minimal metabolic networks" *Bioinformatics* **36**:4309–4315

2020 Aarthi Ravikrishnan, Lars M. Blank, Smita Srivastava and **Karthik Raman** "Investigating metabolic interactions in a microbial co-culture through integrated modelling and experiments" *Computational and Structural Biotechnology Journal* **18**:1249–1258

2019 Devika N T and **Karthik Raman*** "Deciphering the metabolic capabilities of Bifidobacteria using genome-scale metabolic models" *Scientific Reports* **9**:18222

2019 Sarvenaz Choobdar, ..., **The DREAM Module Identification Challenge Consortium**, ..., Sven Bergmann*, Daniel Marbach* "Open Community Challenge Reveals Molecular Network Modules with Key Roles in Diseases". *Nature Methods* **16**:843

2019 Aparajitha Srinivasan, Vijayakumar S, **Karthik Raman** and Smita Srivastava* "Rational engineering of vitamin E metabolism for enhanced alpha-tocopherol production in *Helianthus annuus* cell culture" *Biochemical Engineering Journal* **151**:107256

2019 Abinaya Badri, **Karthik Raman*** and Guhan Jayaraman* "Uncovering novel pathways for enhancing hyaluronan synthesis in recombinant *Lactococcus lactis*: Genome-scale metabolic modelling and experimental validation" *Processes* **7**:343

2019 Beethika Tripathi, Srinivasan Parthasarathy, Himanshu Sinha, **Karthik Raman** and Balaraman Ravindran* "Adapting Community Detection Algorithms for Disease Module Identification in Heterogeneous Biological Networks" *Frontiers in Genetics* **10**:164

2019 Gayathri Sambamoorthy, Himanshu Sinha* and **Karthik Raman*** "Evolutionary Design Principles in Metabolism" *Proc Biol Sci* **286**:20190098

2019 Swagatika Sahoo*, Ranjith Kumar R, Brandon Nicolay, Omkar Mohite, Karthikeyan Sivaraman, Vikas Khetan, Pukhraj Rishi, Suganeswari Ganesan, Subramanian Krishnakumar, **Karthik Raman**, Wayne Miles and Sailaja V Elchuri* "Metabolite systems profiling identifies exploitable weaknesses in retinoblastoma" *FEBS Letters* **593**(1):23–41

2018 Karthik Azhagesan, Balaraman Ravindran* and **Karthik Raman*** "Network-based Features Enable Prediction of Essential Genes Across Diverse Organisms" *PLoS ONE* **13**: e0208722

2018 Gayathri Sambamoorthy and **Karthik Raman*** "Understanding the evolution of functional redundancy in metabolic networks" *Bioinformatics* **34**:i981–i987 (Part of Special Supplement: Proceedings of the 17th European Conference on Computational Biology (ECCB) 2018)

2018 Aarthi Ravikrishnan, Meghana Nasre and **Karthik Raman*** "Enumerating all possible biosynthetic pathways in metabolic networks", *Scientific Reports* **8**:9932
Software available from /RamanLab/MetQuest/

2018 Priyan Bhattacharya, **Karthik Raman** and Arun K. Tangirala*, "A systems-theoretic approach towards designing biological networks that can achieve adaptation", *IFAC-PapersOnLine* **51**:307–312
(Part of Special Issue: Advances in Control & Optimization of Dynamical Systems (ACODS) 2018)

2018 **Karthik Raman***, Aditya Pratapa, Omkar Mohite and Shankar Balachandran "Computational Prediction of Synthetic Lethals in Genome-Scale Metabolic Models Using Fast-SL", *Methods Mol Biol* **1716**:315–336

2017 Aravind Sankar, Sayan Ranu* and **Karthik Raman***, "Predicting Novel Metabolic Pathways through Subgraph Mining", *Bioinformatics* **33**:3955–3963

2017 Purva Bhatter, **Karthik Raman***, and Vani Janakiraman* "Elucidating the biosynthetic pathways of volatile organic compounds in *Mycobacterium tuberculosis* through a computational approach". *Molecular BioSystems* **13**:750–755

2017 Nandakumar Rajasekaran, Swaathiratna Suresh, Soundhararajan Gopi, **Karthik Raman**, and Athi N. Naganathan* "A General Mechanism for the Propagation of Mutational Effects in Proteins". *Biochemistry* **56**:294–305

2015 Aditya Pratapa, Shankar Balachandran and **Karthik Raman***, "FAST-SL: An efficient algorithm to identify synthetic lethal sets in metabolic networks", *Bioinformatics* **31**:3299–3305

2015 Aarthi Ravikrishnan and **Karthik Raman***, "Critical Assessment of Genome-Scale Metabolic Networks: The Need for a Unified Standard" *Briefings in Bioinformatics* **16**:1057–1068

2014 Raghavendran Partha and **Karthik Raman*** "Revisiting robustness and evolvability: evolution in weighted genotype spaces" *PLoS ONE* **9**:e112792

2014 **Karthik Raman***, Nandita Damaraju and Govind Krishna Joshi "The organisational structure of protein networks: revisiting the centrality–lethality hypothesis" *Systems and Synthetic Biology* **8**:73–81

2013 Anuja Kulkarni, Laxmi Ananthanarayanan* and **Karthik Raman** "Identification of putative and cross-reactive chickpea (*Cicer arietinum*) allergens through an *in silico* approach" *Computational Biology & Chemistry* **47**:159–155

2011 **Karthik Raman** and Andreas Wagner "Evolvability and robustness in a complex signalling circuit" *Molecular BioSystems* **7**:1081–1092

2011 **Karthik Raman** and Andreas Wagner "The evolvability of programmable hardware" *Journal of the Royal Society Interface* **8**:269–281

2010 **Karthik Raman*** "Construction and analysis of protein–protein interaction networks" *Automated Experimentation* **2**:2 *(invited review)*

2010 **Karthik Raman**, Ashwini Gurudas Bhat and Nagasuma Chandra "A systems perspective of host–pathogen interactions: prediction of tuberculosis disease outcome" *Molecular BioSystems* **6**:516–530

2009 **Karthik Raman**, Rohit Vashisht and Nagasuma Chandra "Strategies for efficient disruption of metabolism in *Mycobacterium tuberculosis* from network analysis" *Molecular BioSystems* **5**:1740–1751

2009 **Karthik Raman** and Nagasuma Chandra "Flux balance analysis of biological systems: applications and challenges" *Briefings in Bioinformatics* **10**:435–449 *(invited review)*

2008 **Karthik Raman**, Yeturu Kalidas and Nagasuma Chandra "targetTB: A target identification pipeline for *Mycobacterium tuberculosis* through an interactome, reactome and genome-scale structural analysis" *BMC Systems Biology* **2**:109

2008 **Karthik Raman** and Nagasuma Chandra "*Mycobacterium tuberculosis* interactome analysis unravels potential pathways to drug resistance" *BMC Microbiology* **8**:234

2007 Ketki Verkhedkar, **Karthik Raman**, Nagasuma Chandra and Saraswathi Vishveshwara "Metabolome based reaction graphs of *M. tuberculosis* and *M. leprae*: A comparative network analysis" *PLoS ONE* **2**:e881

2007 **Karthik Raman**, Preethi Rajagopalan and Nagasuma Chandra "Hallmarks of Mycolic Acid Biosynthesis: A Comparative Genomics Study" *Proteins: Structure, Function and Bioinformatics* **69**: 358–368

2006 **Karthik Raman**, Preethi Rajagopalan and Nagasuma Chandra "Principles and Practices of Pathway Modelling" *Current Bioinformatics* **1**:147–160

2005 **Karthik Raman**, Preethi Rajagopalan and Nagasuma Chandra "Flux Balance Analysis of *Mycobacterium tuberculosis*: targets for anti-tubercular drugs" *PLoS Computational Biology* **1**:e46

Books (4)

2021 **Karthik Raman** "An Introduction to Computational Systems Biology: Systems-Level Modelling of Cellular Networks" CRC Press/Taylor & Francis, Boca Raton ISBN 978-1138597327

2018 Aarthi Ravikrishnan and **Karthik Raman** "Systems-Level Modelling of Microbial Communities: Theory and Practice" CRC Press/Taylor & Francis, Boca Raton ISBN 978-1138596719

2014 Vishwesh Kulkarni, Guy-Bart Stan and **Karthik Raman** "*A Systems Theoretic Approach to Systems and Synthetic Biology I: Models and System Characterizations*" Springer Verlag (London) ISBN 978-9401790406

2014 Vishwesh Kulkarni, Guy-Bart Stan and **Karthik Raman** "*A Systems Theoretic Approach to Systems and Synthetic Biology II: Analysis and Design of Cellular Systems*" Springer Verlag (London) ISBN 978-9401790468

Book chapters (3)

2017 Abinaya Badri, Aparajitha Srinivasan and **Karthik Raman*** "In *Silico* Approaches to Metabolic Engineering" *In*: P. Gunasekaran, S. Noronha and A. Pandey (editors), *Current Developments in Biotechnology and Bioengineering*, Elsevier ISBN 978-0444636676

2011 **Karthik Raman** and Nagasuma Chandra "Systems Biology of Tuberculosis: Insights for drug discovery" *In*: W. Dubitzky, J. Southgate and H. Fuss (editors), *Understanding the Dynamics of Biological Systems: Lessons Learned from Integrative Systems Biology*, Springer ISBN 978-1441979636

2007 **Karthik Raman**, Yeturu Kalidas and Nagasuma Chandra "Model Driven Drug Discovery: Principles and Practices", *In*: J. Chen, A. S. Sidhu (editors), *Biological Database Modeling*, Artech House ISBN 978-1596932586

Software Tools

2020 Gayathri Sambamoorthy and **Karthik Raman*** "MinReact: an efficient algorithm for identifying minimal metabolic networks" Software available from /RamanLab/MinReact/

2018 Aarthi Ravikrishnan, Meghana Nasre and **Karthik Raman*** "MetQuest: A tool for enumerating all possible biosynthetic pathways in metabolic networks". Software available from /RamanLab/MetQuest/

2017 Aravind Sankar, Sayan Ranu* and **Karthik Raman***, "ReactionMiner: Predicting Novel Metabolic Pathways through Subgraph Mining" Software available from /RamanLab/ReactionMiner/

2015 Aditya Pratapa, Shankar Balachandran and **Karthik Raman***, "Fast-SL: An efficient algorithm to identify synthetic lethal sets in metabolic networks" Software available from /RamanLab/FastSL/

2008 **Karthik Raman** and Nagasuma Chandra "PathwayAnalyser: A systems biology tool for flux analysis of metabolic pathways". Poster presented at the 5^{th} *International Conference on Bioinformatics*, 2006, New Delhi, India. Available from *Nature Precedings* Software available from /karthikraman/pathwayanalyser/

Conference Presentations, Invited Talks & Posters

Conferences (selected)

2017 "Predicting Novel Metabolic Pathways through Subgraph Mining" at the *NetBIO COSI*, 25^{th} *Annual International Conference on Intelligent Systems for Molecular Biology (ISMB)*/16^{th} *European Conference on Computational Biology (ECCB)*, Prague, Czech Republic

2014 "Fast-SL: An efficient algorithm to identify synthetic lethal reaction sets in metabolic networks" at the *2014 RECOMB/ISCB Conference on Regulatory and Systems Genomics*, San Diego, USA

2009 "Systems–level modelling of pathogenic organisms for drug target identification", *Emerging Modelling Methodologies in Medicine and Biology*, Edinburgh, United Kingdom

Seminars & Invited talks (selected)

2021 "Introduction and application of synthetic biology in everyday life" at After iGEM (via video-conferencing)

2021 "Unravelling microbial interactions in the gut microbiome through computational approaches" at *7th BSSE Annual Research Symposium*, Centre for BioSystems Science and Engineering (BSSE) at the Indian Institute of Science (IISc), Bengaluru

2020 "Computational Approaches to Understand Biological Networks" at *The Centre for Predictive Human Model Systems (CPHMS), Atal Incubation Centre - Centre for Cellular and Molecular Biology (AIC - CCMB)* (via video-conferencing)

2020 "Learning on, using and from networks in biology" at *1st Joint 4EU+/HGS MathComp Annual Colloquium*

hosted by the Heidelberg Graduate School of Mathematical and Computational Methods in the Sciences (via video-conferencing)

2020 "Computational Approaches to Understanding Microbial Interactions in Communities" at *6th Annual Metagenomics and Metadesign of Subways and Urban Biomes (MetaSUB) Conference* (via video-conferencing)

2020 "Constraint-based models: standards, best practices & challenges for curation" at *HARMONY 2020*, Cambridge UK (via video-conferencing)

2020 "Computational insights into metabolic interactions in microbial communities" at *India | EMBO Symposium | Engineering meets evolution: Designing biological systems*, IIT Madras

2020 "Learning on, using and from networks in biology" at *Accelerating Biology 2020: SNiPs to SPiNs*, IISER Pune

2019 "Unravelling Molecular Mechanisms in Traditional Medicine: Systems Approaches to Understanding Diseases" at *Ved-Vigyan Sammelan (VVS) 2019: A Dialogue between Vedic and Modern Sciences*, IIT-BHU Varanasi

2019 "Unraveling microbial interactions in the gut microbiome associated with antibiotic recovery" at International Centre for Theoretical Studies (ICTS) Discussion Meeting on *Mathematical and statistical explorations in disease modeling and public health*

2019 "Computational Approaches to Understanding Complex Biological Networks", at Big Data Research Allahabad Summer School 2019, jointly organised by Allahabad University and Interdisciplinary Center for Scientific Computing (IWR) of Heidelberg University

2019 "Novel ratio-metric features enable the identification of new driver genes across cancer types", at the *3rd Pan-IIT Biotech Meet*, IIT Madras

2018 "Learning and Predicting Novel Metabolic Pathways through Subgraph Mining", at IISc Bengaluru

2018 "A Graph-Theoretic Approach to Understand Metabolic Interactions in Microbial Communities", at the *Annual meeting of Biological Engineering Society of India (BESCON) 2018*, IIT Bombay, Mumbai

2018 "Exploiting alternate optima in linear programming to enumerate minimal cut sets in biochemical reaction networks", at the *33rd Annual Conference of the Ramanujan Mathematical Society (ACRMS-2018)*, New Delhi

2017 "Computational Approaches to Understand and Manipulate Metabolic Networks", National Centre for Biological Sciences, Bengaluru

2017 "Learning and Predicting Novel Metabolic Pathways through Subgraph Mining", at the *4th IITM-Tokyo Tech Symposium*, IIT Madras

2017 "Predicting Novel Metabolic Pathways through Subgraph Mining", as part of the *Summer School on "Dynamics of Complex Systems"*, at the International Centre for Theoretical Studies (ICTS) Bengaluru, (Week 3: May 23–25, 2017)

2016 "Towards Understanding the Design Principles of Circadian Oscillators" at *Aspects of Gene and Cellular Regulation*, Institute of Mathematical Sciences, Chennai

2016 "Metabolic Engineering of vitamin E Biosynthesis in Sunflower Cell Cultures"at *85th Annual meeting of the Society of Biological Chemists, India (SBCI)*, CFTRI, Mysore

2016 "Revisiting robustness and evolvability: evolution on weighted genotype networks" at *Network Theory: Conceptual Advances and Practical Applications*, Institute of Mathematical Sciences, Chennai

2015 "Fast-SL: An efficient algorithm to identify synthetic lethals in metabolic networks" at the *2015 Annual Meeting of the National Network of Mathematical and Computational Biology (NNMCB)*, Pune

2015 "*In Silico* Modelling Of Metabolic Networks: Insights for Metabolic Engineering" at *BioProcessing India 2015*, Chennai

2015 "Modelling Metabolic Networks: From Biofuels to Better Therapies" at the *2nd Sankara Nethralaya Genetics Convention*, Chennai

2014 "*In Silico* Identification of Drug Targets for Combinatorial Therapy" at the *XVII ADNAT symposium*, Thiruvananthapuram

2012 "Representation and Modelling of Metabolic Networks" at the *Workshop on Analysis of Biological Networks*, IIT Guwahati

2012 "Robustness and evolvability of biological networks" at the *International Conference on Mathematical and Theoretical Biology*, Pune

Posters (selected, *denotes presenting author)

2020 Gayathri Sambamoorthy and **Karthik Raman** "Understanding the evolutionary dynamics of microbial communities through in silico studies" at the *28th Annual International Conference on Intelligent Systems for*

Molecular Biology (ISMB), Virtual

2020 Rachita Kumar and **Karthik Raman** "Systems Modelling of the Skin Microbiome" at the *28th Annual International Conference on Intelligent Systems for Molecular Biology (ISMB)*, Virtual

2020 Malvika Sudhakar, **Karthik Raman** and Raghunathan Rengaswamy "BinOpt: An algorithm to optimally assign feature importance to classes" at the *28th Annual International Conference on Intelligent Systems for Molecular Biology (ISMB)*, Virtual

2018 Malvika Sudhakar*, **Karthik Raman** and Raghunathan Rengaswamy "Novel ratio-metric features enable the identification of new driver genes across cancer types" at the *17th European Conference on Computational Biology (ECCB)*, Athens, Greece

2018 Gayathri Sambamoorthy* and **Karthik Raman** "Understanding the evolution of functional redundancy in metabolic networks" at the *17th European Conference on Computational Biology (ECCB)*, Athens, Greece

2017 Aarthi Ravikrishnan*, Meghana Nasre and **Karthik Raman** "ComPass — A graph-based algorithm for pathway analysis in microbial communities" at the *25th Annual International Conference on Intelligent Systems for Molecular Biology (ISMB)/16th European Conference on Computational Biology (ECCB)*, Prague, Czech Republic doi

2016 Srikiran Chandrasekaran* and **Karthik Raman** "An Analysis of Stochastic Algorithms for Parameter Estimation in Biological Systems", at *Asia-Pacific Bioinformatics Conference 2016*, San Francisco, USA

2015 Aparajitha Srinivasan*, **Karthik Raman** and Smita Srivastava "Metabolic Engineering Of α-tocopherol in *Helianthus annuus* L.", at *2nd International Conference on Natural Products Utilization: From Plants to Pharmacy Shelf*, Plovdiv, Bulgaria

2015 Abinaya Badri*, **Karthik Raman** and Guhan Jayaraman "A genome scale metabolic model for studying hyaluronan synthesis in recombinant *Lactococcus lactis*", at the *5th International Conference on Biomolecular Engineering*, Austin, USA

2014 Nandita Damaraju* and **Karthik Raman** "Design Principles of Circadian Systems", at the *2014 RECOMB/ISCB Conference on Regulatory and Systems Genomics*, San Diego, USA

2013 Karthik Azhagesan and **Karthik Raman** "'Joint' phylogenetic profiling of protein pairs reveals novel unique protein-protein associations and evolutionarily conserved protein interactions", at the *NetBIO SIG meeting preceding ISMB-ECCB 2013*, Berlin, Germany

2011 **Karthik Raman**, Aditya Barve and Andreas Wagner "Metabolite pairs are predominantly decoupled in genome-scale metabolic networks", at the *Swiss Institute of Bioinformatics Days 2011*, Bienne, Switzerland

2009 **Karthik Raman** and Andreas Wagner "Novel phenotypes and robustness in a complex signalling circuit", at the workshop on *Emerging Modelling Methodologies in Medicine and Biology*, Edinburgh, United Kingdom

2008 Kalidas Yeturu*, **Karthik Raman** and Nagasuma Chandra "Drug Targetability Estimation through Comparative 'Pocket-omics' of Host and Pathogen: A Case Study in *Mycobacterium tuberculosis*" at the 9th *International Conference on Systems Biology*, Gothenburg, Sweden

2006 **Karthik Raman** and Nagasuma Chandra, "Protein–protein influences in *Saccharomyces cerevisiae*" at the *7th International Conference on Systems Biology, Yokohama, Japan*

Grants & funding

Extra-mural Funding

2021 Principal investigator on a project "INCENTIVE - Indo-European Consortium for Next-Generation Influenza Vaccine Innovation" (funded by Department of Biotechnology, GoI) for a period of five years (₹146 lakhs), with Dr. Himanshu Sinha (PI), Manikandan Narayanan (co-PI), Nirav Bhatt (co-PI), Ravindran B (co-PI)

2021 Principal investigator on a project "Understanding microbial interactions in microbiomes through metabolic modelling" (funded by Science and Engineering Board, GoI) for a period of three years (₹6.6 lakhs)

2020 Co-investigator on a project "GenomeIndia 10K: Cataloguing the genetic variation in Indians" (funded by Department of Biotechnology, GoI) for a period of five years (₹146 lakhs), with Dr. Himanshu Sinha (IITM, PI) and Dr. Manikandan Narayanan (IITM, co-PI)

2017 Principal investigator on a project "A Computational Pipeline for Identifying the Context of Key Mutations in Cancer Genomes" (funded by the Department of Biotechnology, Government of India) for a period of three years (₹52.8 lakhs), with Dr. Raghunathan Rengaswamy (IITM, co-PI) and Dr. B. Ravindran (IITM, co-PI)

2017 nVidia Hardware Grant, of Titan X graphics processing unit for research

2013 Principal investigator on a project "Metabolic network analysis of pathogenic organisms for designing novel therapeutic intervention strategies" (funded by the Department of Biotechnology, Government of India) for a period of three years (₹24.4 lakhs), with Dr. Manoj N (IITM, co-PI)

2013 Co-investigator on a project "Control of *in vivo* polymerisation by synthetic biology approaches" (funded by the Department of Biotechnology, Government of India) for a period of four years (₹136 lakhs), with Prof. Guhan Jayaraman (IITM, PI)

2013 *CUDA Research Centre* grant from nVidia, including gift of nVidia Tesla K20 graphics processing unit for research

2012 Co-investigator on a project "Enhanced production of α-tocopherol by genetically transformed cell culture of *Helianthus annus L.*" (funded by the Department of Biotechnology, Government of India) for a period of three years (₹29 lakhs), with Dr. Srivastava S (IITM, PI), Dr. Baskar R (IITM, co-PI)

2011 *CUDA Research Centre* grant from nVidia, including gift of nVidia Tesla C2070 graphics processing unit for research

Intra-mural Funding

2018 Principal investigator on a project "Reconstruction and Modelling of a *Lactobacillus* Co-culture for Metabolic Engineering of Lactic Acid" for a period of one year (₹800,000)

2015 Co-investigator on a large team project "Interdisciplinary Laboratory for Data Sciences", along with Dr. Ravindran Balaraman (PI, IITM) and several others

2014 Principal investigator on a project "Engineering a consortium of microbes for production of Bio-ethanol" (exploratory research project funded by IIT Madras) for a period of one year (₹500,000), with Dr. Smita Srivastava (IITM, co-PI)

2012 Principal investigator on a project "MetREC: A Database of Systematically Annotated Genome-Scale Metabolic Reconstructions" (new faculty seed grant funded by IIT Madras) for a period of three years (₹523,000)

Industrial Consultancy

2017–19 Co-investigator on "Robert Bosch Centre for Data Science and Artificial Intelligence (RBC-DSAI)" funded by Robert Bosch Engineering and Business Solutions Private Limited (₹700 lakhs)

2016–17 Retainer Consultancy Project "Systems-level modelling approaches for quantitative systems pharmacology" from Vantage Research Private Limited, Chennai (₹3.58 lakhs)

Honours & awards (selected)

2021 *Institute Research and Development Award (Early Career)* (IIT Madras), for outstanding achievements in teaching, scholarship and creative research work

2015 *Young Faculty Recognition Award* (IIT Madras), for excellence in teaching and research

2011 *Sir Vithal N. Chandavarkar Memorial Medal* for the best Ph. D. thesis of the year in the Supercomputer Education and Research Centre, Indian Institute of Science

Teaching

Graduate and undergraduate courses

BT 1010 – Module on "Big Data in Biology" (Jul 2017)
BT 2020 – Numerical Methods for Biology (Jan 2018, 2019)
BT 3051 – Data Structures and Algorithms for Biology (Jul 2014–2019)
BT 3240 – Metabolic Regulation (Jul 2011–2013)
BT 4110 – Computational Biology Lab (Jul 2015–2017)
BT 4310 – Current Topics in Synthetic Biology (Jul 2014, 2019)
BT 5240 – Computational Systems Biology (Jan 2013–2021, Winter 2017)

Workshops & Schools

2019 Lecture and Lab sessions on "Introduction to Network Biology" at the "A National Workshop on Scientific computations using MATLAB", at Banasthali Vidyapeeth, Rajasthan (January 19, 2019)

2018 "Introduction to Constraint-Based Modelling of Metabolic Networks", at the IFCAM Summer School, IISc Bengaluru (July 23, 2018)

2018 Co-taught at the "Training Workshop on Systems Biology", at the National Institute of Biomedical Genomics (NIBMG), Kalyani, West Bengal (July 21, 2018)

2017 Co-taught a summer school on "Dynamics of Complex Systems", at the International Centre for Theoretical Studies (ICTS) Bengaluru, (Week 3: May 23–25, 2017)

2017 Organised an AICTE-approved short-term training programme on "Computational Systems Biology" for faculty from colleges in India (Feb 6–11, 2017)

2016 Lecture on "Genome-Scale Modelling of Metabolic Networks: Insights for Metabolic Engineering" as part of the Global Initiative on Academic Networks Course on Metabolic Engineering at Indian Institute of Technology Madras (July 9, 2016)

2016 "Introduction to Constraint-Based Modelling of Metabolic Networks" at *NNMCB Second Instructional School on Mathematical and Computational Biology*, Indian Institute of Science, Bangalore

2016 Taught a pre-school on computational biology preceding the NNMCB Second Instructional School on Mathematical and Computational Biology, at Indian Institute of Science, Bangalore (May 18–21, 2016)

2015 Taught employees from Cognizant Technology Solutions a module on "*Basics of Biology/Computation for Biology*" in a "Short Term Certification Programme on Bioinformatics"

Other instruction-related activities

2019 Mentored two schoolchildren from Chennai on a project related to DNA Computing, as part of the RSI-Chennai 2019

2018 Mentored four schoolchildren from Chennai on projects related to DNA Computing and Network Biology, as part of the Research Science Initiative Chennai (RSI-Chennai) 2018

2017 Mentored two schoolchildren from Chennai on a project related to DNA Computing, as part of the RSI-Chennai 2017

2016 Mentored two schoolchildren from Chennai on a project related to DNA Computing, as part of the RSI-Chennai 2016

2015 Mentored two schoolchildren from Chennai on a project related to Network Biology, as part of the RSI-Chennai 2015

Academic Mentorship

PhD (major advisor/co-advisor)

2013–2019 Aarthi Ravikrishnan (co-advised by Dr. Smita Srivastava)

2014–2021 Gayathri S

2015– Malvika Sudhakar (co-advised by Prof. Raghunathan Rengaswamy, Chemical Engineering)

2016– Prem Jagadeesh (co-advised by Prof. Arun Tangirala, Chemical Engineering)

2016– Priyan Bhattacharya (co-advised by Prof. Arun Tangirala, Chemical Engineering)

2017– Lavanya Raajaraam

2018– Debomita Chakraborty (co-advised by Prof. Raghunathan Rengaswamy, Chemical Engineering)

2019– Indumathi P (co-advised by Dr. Himanshu Sinha)

2020– Pratyay Sengupta

PhD (minor advisor)

2011–2020 Aparajitha Srinivasan (co-advised by Dr. Smita Srivastava)

MS (major advisor)

2013–15 Aditya Pratapa, "*Design of efficient algorithms for synthetic lethality analysis*" (co-advised by Dr. Shankar Balachandran, Computer Science)

2015–19 Beethika Tripathi, "*Applications of Community Detection and Link Prediction on Multi-relational Networks*" (co-advised by Prof. B. Ravindran, Computer Science

2015–18 Karthik Azhagesan, "*Machine Learning Approaches to Predict Essential Genes Across Organisms*" (co-advised by Prof. B. Ravindran, Computer Science)

2016–2021 Shayantan Banerjee "*Sequence neighborhoods enable reliable prediction of pathogenic mutations in cancer genomes*" (co-advised by Prof. B. Ravindran, Computer Science)

2017– Samyugdha V M

2020– Dinesh Kumar K B

MS (minor advisor)

2013–16 Abinaya Badri, "*Investigation of metabolic capabilities of recombinant* Lactococcus lactis *for hyaluronan production using a genome-scale metabolic model*" (co-advised by Prof. Guhan Jayaraman)

Post-doctoral fellows

2016–19 Dr. Devika N.T.

2017– Dr. Maziya Ibrahim

2021– Dr. Aswathy Raghu

MTech projects

2020–21 Sanjaay Balakrishnan "A toolbox for the analysis of microbiomes: Aapplications to ocular and ISS microbiomes"

MTech (Dual Degree thesis projects)

2021– Prashant Govindarajan

2020–21 Ninad Rajandekar "*A computational study of microbial community formation upon evolution*"

2020–21 Rohan Jebin Anbiah "*Identification of Strain Optimization Strategies for Single Organisms and Communities in Metabolic Engineering*"

2020–21 Raghav Moar "*Phylogenetic analysis of Metabolic Pathways: An On-line Tool*"

2019–20 Rohini J S "*Comparing Circadian Oscillators Across Organisms*"

2019–20 Shreya Swaminathan "*Efficient Enumeration of Synthetic Lethal Reactions for Pan Cancer Lethality Analysis*"

2019–20 Anand A R "*Goal-directed Molecule Generation using Reinforcement Learning*" (with Prof. B. Ravindran, Computer Science)

2018–19 Soorya G (with Prof. Arun Tangirala, Chemical Engineering)

2018–19 Sachin Agrawal, "*Deep Learning for Network Chemistry and Network Biology*" (with Prof. B. Ravindran, Computer Science)

2018–19 Vishnu Narayan, "*Parallelisation of Dynamic Model Simulations*"

2018–19 Abhijeet Mavi, "*Topological Sensitivity Analyses of Target-of-Rapamycin pathway in Saccharomyces cerevisiae*"

2016–18 Saransh Umale (with Prof. Raghunathan Rengaswamy, Chemical Engineering), "*Design Principles of Modular Gene Oscillators: An ODE-based approach*"

2016–18 Muthukumarasamy Saravanan, "*Learning and Predicting Reactions from Metabolic Networks*"

2017–18 Pradeep Natarajan, (with Prof. Raghunathan Rengaswamy, Chemical Engineering), "*Design Principles for the Synthesis of Modular Genetic Oscillators*"

2016–17 Omkar Mohite, "*Understanding redundancy in metabolic networks through analysis of Synthetic Lethals*"

2015–16 Aravind Sankar (with Dr. Sayan Ranu, Computer Science), "*Predicting Chemical Reactions through Graph Mining*"

2015–16 Pallavi Gudipati (with Prof. B. Ravindran, Computer Science), "*Neighborhood Analysis of Genomic Data*"
2015–16 Abhishek Sivaram (with Prof. Raghunathan Rengaswamy, Chemical Engineering), "*Application of Variants of Principal Component Analysis to Biological Systems — A Source Separation Framework*"
2015–16 Aparnna Suresh, "*Identifying Network Topologies That Can Exhibit Switch-Like Behaviour*"
2015–16 Dileep Kishore, "*Discovering the Design Principles of Circadian Rhythms using GPGPUs*"
2014–15 Pankaj Kumar (with Dr. Sayan Ranu, Computer Science), "*Identifying novel reaction routes to synthetic metabolites*"
2014–15 Parthasarathy Gopavarapu (with Prof. B. Ravindran, Computer Science), "*Predicting Essential Genes in Microbes*"
2013–14 Govind Krishna Joshi, "*Multi-timescale multi-algorithm simulation of a cell*"
2013–14 Raghavendran Partha, "*Revisiting robustness and evolvability: evolution on weighted genotype networks*"
2012–13 Sagar Laygude, "*GPU-based massively parallel* in silico *phenotyping*"
2012–13 Namrata Kamat, "*Microbial community modelling*"

BTech (Undergraduate thesis projects)

2014–15 Narasimhan Balakrishnan (with Prof. Arun Tangirala, Chemical Engineering)
2014–15 Adarsh Chavakula (with Prof. Shankar Narasimhan, Chemical Engineering)
2014–15 Balaji Kumar
2014–15 Srikiran Chandrasekaran
2014–15 Sanjan T P
2014–15 Aravindabharathi Ramakrishnan
2013–14 Nandita Damaraju
2012–13 Aditya Sriganesh
2012–13 Shashank Garlapati

Junior Research Fellows/Project Associates

2020– Sai Sruthi A (Junior Research Fellow)
2020– Shreyansh Umale (IBSE post-baccalaureate fellow)
2020– Rachita Kumar (IBSE post-baccalaureate fellow)
2019– Senthamizhan V (IBSE post-baccalaureate fellow)
2019– Keerthika Moorthy (Project Associate)
2018–20 Anjana A S (Project Associate)
2017–19 Priyanka Maripuri (Project Associate)
2015–16 Smrithi Krishnan (Project Associate)
2017–18 Likith Reddy (Junior Research Fellow)
2015–16 Sivaratna Kumari Narisetti (Project Associate)
2014–15 Murali Karthikeyan (Project Associate)
2013–15 Priyanka Barman (Project Associate)

Outreach Activities

International Outreach Activities

2016 Represented IIT Madras at the *Graduate Program India–Heidelberg* meeting organised by *University of Heidelberg*, Jun 21–23, Heidelberg; also gave a talk on "Computational Approaches to Understand and Manipulate Metabolic Networks"
2011 Represented IIT Madras at the *Seminar on Synthetic Biology* organised by the *Academy of Finland*, Nov 21–22, Helsinki

Lectures at Industries

2017 Lecture on "Robustness and Evolvability in Complex Systems" at Culture Machine, Mumbai (January 4, 2017)

2016 Lectures on "Introduction to Mathematical Modelling and Systems Biology" at Vantage Research Private Limited, Chennai (June 2016)
2014 Lecture on "Engineering Metabolic Networks using *in silico* approaches" at Hindustan Petroleum Corporation Limited, Bangalore (January 30, 2014)
2012 Lecture on "Metabolic Engineering" at Samsung India Software Operations, Bangalore (April 20, 2012)

Professional Service

Institutional Service — IIT Madras

Course allotment committee (2014 Aug—)
Department Faculty Meeting Secretary (2011)
Ph. D/M. S. admission committee (2011 Dec–2015 Dec)
Faculty applications screening committee (2013, 2015)

Editorial Responsibilities

2019– *Scientific Reports*, **Editorial Board Member**
Responsibilities: Assess whether manuscripts should be sent for peer review, manage peer review of manuscripts, make final editorial decisions
2021– *ACS Synthetic Biology*, **Editorial Advisory Board**

Conference Committees

2020 *ISMB 2020* (Programme Committee Member of NetBio COSI: Network Biology)
2020 *2nd IBSE International Symposium — EMBO | India Symposium | Engineering meets Evolution: Designing biological systems*, at IIT Madras, January 30–February 1 2020 (Co-organiser)
2020 *Advances in Control & Optimization of Dynamical Systems (ACODS) 2020* (Associate Editor)
2019 *ISMB/ECCB 2019* (Programme Committee Member of NetBio COSI: Network Biology)
2018 *ISMB 2018* (Programme Committee Member of NetBio COSI: Network Biology)
2018 *Advances in Control & Optimization of Dynamical Systems (ACODS) 2018* (Associate Editor)
2018 *1st IBSE International Symposium — From Genotype to Phenotype: Computational Approaches to Understand Biological Systems*, at IIT Madras, January 22–24 2018 (Co-organiser)

Journal Referee

BBA Molecular Basis of Disease, *Biochemical Society Transactions*, *Bioinformatics*, *Bioresource Technology*, *BMC Bioinformatics*, *BMC Genomics*, *BMC Systems Biology*, *Computers in Biology and Medicine*, *Computational and Structural Biotechnology*, *Frontiers in Bioengineering and Biotechnology*, *Gigascience*, *Journal of Theoretical Biology*, *Mathematical Biosciences*, *Pathogens and Disease*, *Physica A*, *PLoS Computational Biology*, *PLoS ONE*, *Tuberculosis*