Dr. Balaji Prakash

Senior Principal Scientist

Head, Department of Molecular Nutrition

Research areas: Combining 'Structural Biology, Enzyme catalysis, and Bioinformatics' for the Rational Design of new Preservatives.

Profile: Prior to joining CSIR-CFTRI, Balaji Prakash, was a Professor, at Indian Institute of Technology, Kanpur. Using a combination of biochemistry, structural Biology and bioinformatics, his work addressed catalytic mechanisms of important family of enzymes like GTPases, kinases and sugar nucleotidylyltransferases. Targeting these, he develops novel peptides/molecules with potential applications and relevance to food science.

Positions held

- *Dec 2014 – Present : Senior Principal Scientist,* Department of Molecular Nutrition. Central Food Technological Research Institute, Mysuru 570 020. Karnataka.
- *Dec 2010 – Dec 2014:* Professor, Department of Biological Sciences and Bio-Engineering, Indian Institute of Technology, Kanpur 208 016, India.
- *Dec 2005 – Dec 2010* :Associate Professor, Department of Biological Sciences and Bio-Engineering, Indian Institute of Technology, Kanpur 208 016, India.
- *Nov 2002 – Dec 2005* :Assistant Professor, Department of Biological Sciences and Bio-Engineering, Indian Institute of Technology, Kanpur 208 016, India.
- *March 2002 – Oct 2002*: Assistant Professor, Special Center for Molecular Medicine, Jawaharlal Nehru University, New Delhi, India.

Post-Doctoral Experience

- *March, 1997- Feb 2002*
  Post Doctoral Fellow, Max Planck Institute for Molecular Physiology,
  Dortmund, Germany.

Professional Activities

- Member of the Editorial Board, *Nature Scientific Reports*.

- Member, Protein Society.
- Member, International Union of Crystallography.
- Reviewed manuscripts for reputed international Journals – Proteins, PloS ONE, FEBS Letters, GENE, Marine Biotechnology, Biopolymers etc.
- Reviewed Ph.D. thesis from various institutions in the country.
- Reviewed Project proposals from DST and DBT and Research Grants Council (RGC) of Hong Kong.
- Delivered popular Science lectures in several Schools and colleges.

Students & Post-docs

Following are the details of the students graduated from my lab.

- **Ph.D. :** So far, 7 students have defended their Ph.D. thesis; 2 more have submitted PhD thesis. (see table at the end).
- At CFTRI, three students have joined for a Ph.D.

- **M.Tech –** So far, 16 students have graduated at IIT-K and several of them are into R&D in academia or in the industry. Several have also pursued Ph.D. abroad.

- **Prospective PhD students** - Kindly apply as per the institute guidelines via ACSIR or contact me directly for admission via University of Mysore. Typically admissions are open twice a year (Jul and Dec).

- **Prospective post doctoral fellows** - Please write directly to me with a CV (including a brief statement describing research experience and scientific interests, and the contact information of at least 2-3 references). There are possibilities for external fellowship(s) which can be explored, after due discussion and ensuring that your expertise matches our requirements.

Work in Brief.

- ***Research and Development***

- *Molecular approach for the design of new Preservatives.*

A mechanistic understanding of enzyme catalysis at structural and biochemical level is critical to attempt structure-based drug design. Here, I intend to integrate my experience in structural biology and bioinformatics towards the rational design of new preservatives - a hitherto unexplored area in food science.

Towards this, our group aims to inhibit (a) Rel proteins that are responsible for bacterial survival under stress and (b) GTPases involved in ribosome biogenesis in the bacteria responsible for food spoilage.

- *Molecular Nutrition and Nutraceuticals.*

While on one hand, we wish to exploit the 'low side-effect' property of natural molecules from food sources for better health; on the other hand, there is a huge potential to fortify food if (anti)nutritional properties of bio-molecules in these food are thoroughly understood. An attempt to understand structure-function relationships of such molecules is another of our interest. In one of the projects, we focus on anti-nutritional properties of Protease inhibitors and lectins from field bean (a locally abundant food) for these.

Simultaneously, it is also possible to tailor the specificity of naturally occurring peptide inhibitors against food spoilage bacteria for designing new preservatives.

Technology developed:

1. Title: Microbes based printing for fabrication of electronic circuits.
   Invention: IN-843732 (Open)
   Inventors: Deepak Gupta; Sunita Mehta; Saravanan Murugeson; Balaji Prakash.

2. A novel device for crystallizing proteins and protein complexes or other biological macromolecules**. (**Patent being prepared).

Awards and Honours

- 2013 – Elected, **Fellow of the National Academy of Sciences**, Allahabad, India
- 2011 – Elected Member, **Guha Research Conference** (GRC), India
- 2010 - **DBT National Bioscience Award** for the year 2009.
- 2006 - Invited participant at 2nd Indo-American Frontiers of Science Symposium in Irvine, California.
- 2004 - **International Senior Research Fellow** for Biomedical Science award by the **Wellcome Trust, U.K**. in 2004.

Publications

Total publications – 37 [in International Journals: 35; in National Journals: 2].
[as Corresponding author – 20].

1. Neha Vithani, Sahil Batra, **Balaji Prakash**[$] and Nisanth Nair[$]. Elucidating the GTP Hydrolysis Mechanism in FeoB – a Hydrophobic Amino Acid substituted GTPase. **ACS Catalysis** *(2016) in press*.

2. Soneya Majumdar, Abhishek Acharya, Sushil Kumar Tomar and **Balaji Prakash**[$]. Disrupting domain-domain interactions is indispensable for EngA-ribosome interactions. **BBA-Proteins and Proteomics.** *(2016) in press*

3. Sunita Mehta, Saravanan Murugeson, **Balaji Prakash**, Deepak[$]. Development of process for generating three dimensional microbial patterns amenable for engineering use. ***RSC Advances*** **(2016),** 6: 22586-22593. *[International Peer reviewed – Royal Soc. Chemistry]*.

4. Sunita Mehta, Saravanan Murugeson, **Balaji Prakash**, Deepak[$]. Fabrication of three dimensional patterns of wide dimensional range using microbes and their applications. ***Scientific Reports. (2015).*** 5:15416. doi: 10.1038/srep15416. *[International Peer reviewed – Nature press]*.

5. Neha Vithani and **Balaji Prakash**[$]. GlmU from Mycobacterium tuberculosis – Structure, function and the role of metal ions in catalysis. ***Encyclopedia of Inorganic and Bioinorganic Chemistry***. **(2015).** *In press. [International Peer reviewed – Wiley]. [Invited Review]*.

6. Vinod Kumar, Saravanan Murugeson, Neha Vithani, **Balaji Prakash** and Lalitha R Gowda[$]. A salt-bridge stabilized C-terminal hook is critical for the dimerization of a Bowman Birk inhibitor. ***Archives of Biochemistry and Biophysics.*** **(2015)** 566:15-25. *[International Peer reviewed – Elsevier]*.

7. Neha Vithani, Vaibhav Bais and **Balaji Prakash**[$]. GlmU (N-acetylglucosamine-1-phosphate uridyltransferase) bound to three magnesium ions and ATP at the active site. ***Acta Cryst. F (2014)*** 70, doi:10.1107/S2053230X14008279. *[International Peer reviewed – International Union of Crystallography]*.

8. Shiv Singh, Vaibhav Bais, **Balaji Prakash** and Nishith Verma[$]**.** Multi-scale carbon micro/nanofibers-based adsorbents for protein-immobilization. ***Materials Science and Engineering C*** **(2014***) 38, 46-54*. *[International Peer reviewed – Elsevier]*.

9. Nikhil Jain, Neha Vithani, Abu Rafay and **Balaji Prakash**[$]. Identification and characterization of a hitherto unknown nucleotide binding domain and an intricate inter-domain regulation in HflX, a ribosome binding GTPase. ***Nucleic Acids Research*** **(2013)** 41, 9557-69**.** *[International Peer reviewed – Oxford University Press]*.

10. Pravin Kumar Ankush Jagtap, Sunil Kumar Verma, Neha Vithani, Vaibhav Bais and **Balaji Prakash**[$]. Crystal structures identify an atypical two-metal ion mechanism for uridyl transfer in GlmU: Its significance to sugar nucleotidyltransferases. ***Journal of Molecular Biology.*** **(2013),** 425, 1745 -1759.*[International Peer reviewed – Elsevier]*.

11. Anand Baskaran, Soneya Majumdar and **Balaji Prakash[$]**. The Structural Basis Unifying Diverse GTP Hydrolysis Mechanisms. ***Biochemistry*** **(2013)** 52,1122-30**.***[International Peer reviewed – American Chemical Society]*.

12. Megha Gulati, Nikhil Jain, Baskaran Anand, **Balaji Prakash** and Robert Britton. Mutational analysis of the ribosome assembly GTPaseRbgA provides insight into ribosome interaction and ribosome stimulated GTPase activation. ***Nucleic Acids Research* (2013),** 41, 3217–3227.*[International Peer reviewed – Oxford University Press]*.

13. Pravin Kumar Ankush Jagtap, Vijay Soni, Neha Vithani, Gagan Deep Jhingan, Vaibhav Singh Bais, Vinay Kumar Nandicoori[$], and **Balaji Prakash**[$]. Substrate bound crystal structures reveal features unique to Mycobacterium tuberculosis N-acetyl-glucosamine-1-phosphate uridyltransferase and a catalytic mechanism for acetyltransfer**.** ***Journal of Biological chemistry*** (2012) 287, 39524-37**.***[International Peer reviewed – American Society for Biochemistry and Molecular Biology]*.

14. Abu Rafay, Soneya Majumdar, and **Balaji Prakash**[$]. Exploring potassium-dependent GTP hydrolysis in TEES family GTPases. ***FEBS Open Bio*** (2012)2, 173-177.*[International Peer reviewed – Elsevier]*.

15. Sushil Kumar Tomar, Prashant Kumar, Soneya Majumdar, Varun Bhaskar, Prasun Dutta and **Balaji Prakash**[$]. Extended C-terminus and length of the linker connecting the G-domains arespecies-specific variations in the EngA family of GTPases. ***FEBS Open Bio*** (2012) 2, 191–195.*[International Peer reviewed – Elsevier]*.

16. Sushil Kumar Tomar, Prashant Kumar, **Balaji Prakash**[$]. Deciphering the catalytic machinery in a universally conserved ribosome binding ATPase YchF, ***Biochem. Biophys. Res. Commun.* (2011)**, 408, 459–464. *[International Peer reviewed – Elsevier]*.

17. Ashish Arora ,Nagasuma R. Chandra , Amit Das , Balasubramanian Gopal , Shekhar C. Mande, **Balaji Prakash**, Ravishankar Ramachandran, Rajan Sankaranarayanan, K. Sekar, Kaza Suguna, Anil K. Tyagi, Mamannamana Vijayan. Structural biology of Mycobacterium tuberculosis proteins: The Indian efforts, ***Tuberculosis* (2011)**, 91, 456-68.*[International Peer reviewed – Elsevier]*.

18. Baskaran Anand, Parag Surana and **Balaji Prakash**[$]. Deciphering the Catalytic Machinery in 30S Ribosome Assembly GTPaseYqeH. ***PloS ONE* (2010),** 5(4): e9944. doi:10.1371/journal.pone.0009944. *[International Peer reviewed – Public Library of Science]*.

19. Divya Tiwari, Rajnish Kumar Singh, Kasturi Goswami, Sunil Kumar Verma, **Balaji Prakash** and Vinay Kumar Nandicoori. The N-terminal region of protein kinase G from *Mycobacterium tuberculosis* plays a regulatory role in modulating kinase activity and survival in the host macrophages. ***Journal of Biological Chemistry* (2009)** 284**,** 27467-79.*[International Peer reviewed – American Society for Biochemistry and Molecular Biology]*.

20. Baskaran Anand, Parag Surana, Sagar Bhogaraju, Sushmita Pahari and **Balaji Prakash**[$]. Circularly permuted GTPaseYqeH binds 30S ribosomal subunit: Implications for its role

in ribosome assembly. ***Biochem. Biophys. Res. Commun*. (2009**), 386, 602–606. *[International Peer reviewed – Elsevier]*.

21. Sunil Kumar Verma, Mamta Jaiswal, Neeraj Kumar, Amit Parikh, Vinay Kumar Nandicoori, **Balaji Prakash[$]. ** Crystal structure of N-acetylglucosamine-1-phosphate uridyltransferase (GlmU) from *Mycobacterium tuberculosis* in a cubic space group. ***Acta Cryst. F.* (2009)**, 65: 435–439. *[International Peer reviewed – International Union of Crystallography]*.

22. Sushil Kumar Tomar, Neha Dhimole, Moon Chatterji and **Balaji Prakash[$]**. Distinct GTP/GDP bound states of the tandem G-domains of *Escherichia Coli* EngA regulate ribosome binding. **Nucleic Acids Research *(2009)*** 37(7):2359-70**.** *[International Peer reviewed – Oxford University Press]*.

23. Mathew Sajish, Sissy Kalayil, Sunil Kumar Verma, Vinay Kumar Nandicoori[$] and **Balaji Prakash[$]**. The Significance of ExDD and RxKD Motifs Conservation in Rel Proteins. ***Journal of Biological Chemistry* (2009),** 284, 9115-9123. *[International Peer reviewed – American Society for Biochemistry and Molecular Biology]*.

24. Nikhil Jain, Neha Dhimole, Abu Rafay Khan, Debojyoti De, Sushil Kumar, Tomar, Mathew Sajish, DipakDutta, PradeepParrack and **Balaji Prakash[$]**. *E.coli* HflX interacts with 50S ribosomal subunits in presence of nucleotides. **Biochem. Biophys. Res. Commun. (2009**), 379, 201-5. *[International Peer reviewed – Elsevier]*.

25. Amit Parikh[*], Sunil Kumar Verma[*], Shazia Khan, **Balaji Prakash[$]**&Vinay Kumar Nandicoori[$]. PknB mediated phosphorylation of a novel substrate, N-acetylglucosamine-1-phosphate uridyltransferase (GlmU), modulates its acetyltransferase activity. ***Journal of Molecular Biology.* (2009)**, 386, 451-64. *[International Peer reviewed – Elsevier]*.

26. Mathew Sajish, DivyaTiwari, Dimple Rananaware, Vinay Kumar Nandicoori[$] and **Balaji Prakash[$]**. A Charge Reversal Differentiates (p)ppGpp Synthesis by Monofunctional and BifunctionalRel Proteins. ***Journal of Biological Chemistry.* (2007)** 282, 34977-34983. *[International Peer reviewed – American Society for Biochemistry and Molecular Biology]*.

27. Baskaran Anand, Sunil Kumar Verma, **Balaji Prakash[$]**. Structural stabilization of GTP-binding domains in circularly permuted GTPases: Implications forRNA binding. ***Nucleic Acids Research.* (2006)**34, 2196-2205. *[International Peer reviewed – Oxford University Press]*.

28. Rajeev Mishra, Sudheer Kumar Gara, ShambhaviMishra, **Balaji Prakash[$]**. Analysis of GTPases carrying hydrophobic amino acid substitutions in lieu of the catalytic glutamine: Implications for GTP hydrolysis. ***Proteins: Structure, Function, and Bioinformatics*** (**2005**) 59, 332-338. *[International Peer reviewed – Wiley]*.

From Post-Doctoral and Doctoral Work: 8.

29. Gerrit.J.K.Praefcke, Stephen Kloep, UtzBenscheid, HankeLilie, **Balaji Prakash** and Christian Herrmann. Identification of Residues in the Human Guanylate-binding Protein 1 Critical for Nucleotide Binding and Cooperative GTP Hydrolysis. ***J. Mol. Biol.*** (**2004**) **344**, 257-269. *[International Peer reviewed – Elsevier].*

30. **Balaji Prakash**[*], HolgerRehmann[*], Eva Wolf[*], Alma Rueppel, Johan de Rooij, Johannes. L. Bos& Alfred Wittinghofer. Structure and Regulation of the cAMP binding domains of Epac2. ***Nature. Struct. Biol.***(**2003**)10, 26-32. *Cover Article*
(* refers to equal contributors)*[International Peer reviewed – Nature press].*

31. **Balaji Prakash*,** Louis Renault*, Gerrit.J.K.Praefcke, Christian Herrmann & Alfred Wittinghofer.Triphosphate structure of guanylate-binding protein 1 and implications for nucleotide binding and GTPase mechanism. ***EMBO Journal*** (**2000**), 19, 4555-4564

32. **Balaji Prakash,** GerritJ.K.Praefcke, Louis Renault, Alfred Wittinghofer& Christian Herrmann. Structure of human Guanylate-binding protein-1 representing a class of GTP-binding proteins with unique properties. ***Nature*** (**2000**), 403, 567-571. *[International Peer reviewed – Nature press].*

33. **Balaji Prakash**, M.R.N.Murthy, Y N Sreerama, D RajagopalRao&Lalitha R Gowda. Studies on simultaneous inhibition of trypsin and chymotrypsin by horsegram Bowman-Birk inhibitor. ***Journal of Biosciences*** (**1997**), 22(5), 545-554. *[National Peer reviewed – Indian Academy of Sciences].*

34. **Balaji Prakash** & M.R.N.Murthy. Source and target enzyme signature in serine protease inhibitor active site sequences. ***Journal of Biosciences*** (**1997**), 22(5), 555 -556. *[National Peer reviewed – Indian Academy of Sciences].*

35. M. R.N. Murthy, M. Bhuvaneshwari, **Balaji Prakash**, K. Gopinath, & H. S. Savithri. Structure of sesbania mosaic virus at 2.8 A resolution. **Progress in Biophysics and Molecular Biology. (1996)** Supplement I. **65,** (12)

36. **Balaji Prakash**, S.Selvaraj, M.R.N.Murthy, Y.N.Sreerama, D. Rajagopal Rao & L.R.Gowda. Analysis of amino acid sequences of Plant Bowman-Birk Inhibitors. ***Journal of Molecular Evolution***. (**1996**) 42, 560-569. *.[International Peer reviewed – Springer].*

37. **Balaji Prakash**, M.R.N.Murthy, Y.N.Sreerama, P.R.Rama Sarma & D.Rajagopala Rao. Crystallization and preliminary X-ray diffraction studies on a Trypsin/Chymotrypsin double headed inhibitor from horse gram seeds. ***Journal of Molecular Biology***. (**1994**) 235, 364-366. *.[International Peer reviewed – Elsevier].*

(Note - * refers to equal contributors, $ to co- corresponding authors).

Details of Ph.D students

	Ph.D. Degree Awarded / Thesis Defended	Name	Year in which Degree Awarded/Thesis Defended	Title of the Thesis	Present Position
1	Degree Awarded	Dr. Sajish Mathew	May, 2009	Motif Specific Regulation of (p)ppGpp Synthesis in Rel Proteins.	Post Doctoral Fellow, Scripps Research Institute, California, USA
2	Degree Awarded	Dr. Anand Baskaran	Feb 2010	Structure-Function Relationships in Circularly Permuted GTPases.	Assistant Professor, Dept of Biotechnology, Indian Institute of Technology, Guwahati.
3	Degree Awarded	Dr. Sunil Kumar Verma	Feb 2010	Structural studies on N-acetylglucosamine-1-phosphate uridyltransferase (GlmU) from Mycobacterium tuberculosis.	Post Doctoral Fellow, Baylor College of Medicine, Texas, USA

4	Degree Awarded	Dr. Sushil Kumar Tomar	Dec 2010	Elucidating a double switch mechanism and inter-domain regulation in a unique ribosome binding bacterial GTPase EngA.	Post Doctoral fellow, RNA research center, Ohio State University, USA
5	Degree Awarded	Dr. Nikhil Jain	Jan 2011	Structure based biochemical investigations on HflX - a GTPase and an ATPase likely involved in ribosome assembly.	Post doctoral Fellow, University of Michigan, USA
6	Degree Awarded (Co-supervised)	Dr. Sunita Mehta	Oct 2016	Development of microbes based three dimensional patterns and their use demonstrated in microlenses, braille and source-drain of thin film transistors	
7	Degree awarded	Soneya Majumdar	Jan 2017	Investigating diversity in GTP hydrolysis mechanisms with special emphasis on Rab GTPases and a ribosome binding GTPase EngA.	
8	Thesis Submitted	Vaibhav. S. Bias	June 2016	Characterization of sugar nucleotidylyltransferases and the design of inhibitors against Ser/Thr protein kinases.	

9	Thesis Submitted	Saravanan Murugeson	July 2016	Two dimensional diffusion crystallization: a novel process to crystallize proteins	