

Vinayak Agarwal

NIH Pathway to Independence Postdoctoral Research Scholar
Helen Hay Whitney Foundation Postdoctoral Research Scholar (2014-2016)
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Personal Statement

Human health is shaped in large part by our microbial neighbors. The language in which we talk to our surrounding microflora is chemistry, with small molecule *natural products* being the alphabets of this language. Microbial natural products range from antibiotics and pharmaceuticals that we use in the clinic, to exceptionally potent human toxins and pollutants that pervade our environment. **My research interests lie in understanding how microbes biosynthesize natural products, and how we can leverage this knowledge to drive scientific progress and human well-being.** I employ a diverse array of approaches in my research, including but not limited to microbial genetics and metagenomics, structural and biochemical enzymology, and synthetic and analytical chemistry.

Education

- 2007 – 2012** Ph.D., Biophysics and Computational Biology
University of Illinois Urbana-Champaign, Urbana, USA
Thesis: Structural studies of enzymes involved in antibiotic resistance and phosphonate degradation
- 2006 – 2007** M.Tech. (Master of Technology), Biochemical Engineering and Biotechnology
Indian Institute of Technology Delhi, New Delhi, India
Thesis: Engineering thermostable sugar hydrolases for biofuel production
- 2002 – 2006** B.Tech. (Bachelor of Technology), Biochemical Engineering and Biotechnology
Indian Institute of Technology Delhi, New Delhi, India

Research Experience

- 2012 – present** Scripps Institution of Oceanography, University of California San Diego, San Diego, USA
Postdoctoral Research Scholar
Mentor: Dr. Bradley S. Moore
Interrogating biosynthetic mechanisms for the production of polybrominated persistent organic pollutants by marine bacteria using genetic and biochemical tools
- 2012** Institute for Genomic Biology, University of Illinois Urbana-Champaign, Urbana, USA
Postdoctoral Research Associate
Mentor: Dr. Satish K. Nair
Discerning structural bases for novel enzymological transformations in the production of bacterial phosphonate antibiotics

- 2007 – 2012** Center for Biophysics and Computation Biology, University of Illinois Urbana-Champaign, Urbana, USA
Graduate Research Assistant
Mentor: Dr. Satish K. Nair
Querying the molecular mechanisms for bacterial degradation of peptidyl antibiotics and phosphonate molecules
- 2006 – 2007** Department of Biochemical Engineering and Biotechnology, Indian Institute of Technology Delhi, New Delhi, India
Masters Thesis Research
Mentor: Dr. Saroj Mishra
Engineering yeast sugar hydrolases for enhanced thermostability for their industrial application in biofuel production
- 2006** Molecular Biophysics Research Group, National Institute for Medical Research, Medical Research Council, London, UK
International Summer Student
Mentor: Dr. Katrin Rittinger
Studying structural bases for altered procaspase recruitment by tandem Caspase Recruitment Domains in Crohn's disease
- 2005** Max Planck Institute for Molecular Physiology, Dortmund, Germany
International Summer Student
Mentor: Dr. Wulf Blankenfeldt
Understanding the genetic and biochemical bases for the production of the virulence factors-phenazines by opportunistic human pathogen *Pseudomonas aeruginosa*

Awards

- 2016** US National Institutes of Health (NIH) K99/R00 Pathway to Independence award
- 2015** Young Scientist Award, 12th International Symposium on Persistent and Toxic Substances, University of California, Riverside
- 2014** Helen Hay Whitney Foundation postdoctoral research fellowship
Life Sciences Research Foundation postdoctoral research fellowship (*declined*)
- 2007** Department of Molecular and Cellular Biology, University of Illinois graduate research fellowship
- 2006** Department of Biotechnology, Government of India fellowship for masters' research
- 2005** German Academic Exchange Service (DAAD) fellowship for undergraduate research

Presentations

- 2016** A retrobiosynthetic approach to finding producers of marine natural product toxins and pollutants (**Oral**)
1st International Workshop on Cyanobacterial Natural Products, CENA, University of Sao Paulo, Brazil

A retrobiosynthetic approach to finding producers of marine natural product toxins and pollutants (**Poster**)
Marine Natural Product Gordon Research Conference. Ventura, USA

A retrobiosynthetic approach to finding producers of marine natural product toxins and pollutants (**Poster**)
Oceans and Human Health Grantee Meeting, National Institute of Environmental Health Sciences (NIEHS), Durham, USA

2015 Understanding natural production of polybrominated pollutants (**Oral**)
Young Microbiologists Symposium, John Innes Centre, Norwich, UK

Understanding natural production of polybrominated pollutants (**Oral**)
Helen Hay Whitney Foundation Annual Meeting, Dedham, USA

Understanding natural production of polybrominated pollutants (**Oral**)
12th International Symposium on Persistent and Toxic Substances, UC Riverside, USA

Understanding natural production of polybrominated pollutants (**Oral**)
Pacifichem 2015, Honolulu, USA

2014 CYP450 mediated biosynthesis of mammalian toxins of marine origin (**Oral**)
12th International Symposium on Cytochrome P450 Biodiversity and Biotechnology. Kyoto, Japan

Biosynthesis of polybrominated natural products by marine bacteria (**Oral**)
Marine Natural Product Gordon Research Conference. Ventura, USA

Biosynthesis of polybrominated natural products by marine bacteria (**Poster**)
Oceans and Human Health Grantees Meeting. San Diego, USA

2013 Biosynthesis of polybrominated natural products by marine bacteria (**Oral**)
University of California San Diego Diversity Seminar. San Diego, USA

If halogens could kill: naturally produced polybrominated persistent organic pollutants (**Oral**)
Natural Product Affinity Seminar Series. San Diego, USA

2011 Phosphonate catabolism in *Sinorhizobium meliloti* (**Poster**)
Society for Industrial Microbiology. New Orleans, USA

2010 Mechanisms for self immunity and resistance against Microcin C7 (**Poster**)
American Society for Biochemistry and Molecular Biology. Anaheim, USA

Publications

- 2016** 23. Biosynthesis of coral settlement cue tetrabromopyrrole in marine bacteria by a uniquely adapted brominase-thioesterase enzyme pair
El Gamal AA, **Agarwal V**,* Diethelm S, Rahman I, Schron M, Sneed JM, Louie GV, Whalen KE, Mincer T, Noel JP, Paul VJ, Moore BS
Proc Natl Acad Sci U S A. 2016; 113(14):3797-3802.
*Equal contribution first author

[Highlighted by the Faculty of 1000 \(F1000\)](#)

22. Unusual flavoenzyme catalysis in marine bacteria
Teufel R, **Agarwal V**, Moore BS
Curr Opin Chem Biol. 2016; 31:31-39.

A metagenomic approach to understanding microbial production of polybrominated toxins and pollutants in the marine environment

Agarwal V, Blanton JM, Podell S, Taton A, Schorn MA, Paul VJ, Biggs JS, Golden JW, Allen EE, Moore BS

Submitted

Enzymatic halogenation and dehalogenation: pervasive with a lot of secrets

Agarwal V, El Gamal, AA, Miles Z, Winter, JC, Eustaquio AS, Moore BS

Submitted

- 2015** 21. Chemoenzymatic synthesis of acyl coenzyme A substrates enables *in situ* labeling of small molecules and proteins
Agarwal V, Diethelm S, Ray L, Garg N, Awakawa T, Dorrestein PC, Moore BS
Org Lett. 2015; 17:4452-4455.

Findings presented herein has formed the basis for a provisional patent application:

Chemoenzymatic methodology for the preparation of acyl coenzymeA molecules

Inventors: Moore BS, Agarwal V, Diethelm S.

University of California, San Diego

Application ID: 62/208,176

20. Complexity of naturally produced polybrominated diphenyl ethers revealed via mass spectrometry
Agarwal V, Li J, Rahman I, Borgen M, Aluwihare LI, Biggs JS, Paul VJ, Moore BS
Environ Sci Technol. 2015;49(3):1339-46.

- 2014** 19. Biosynthesis of polybrominated aromatic organic compounds by marine bacteria
Agarwal V, El Gamal AA, Yamanaka K, Poth D, Kersten RD, Schorn M, Allen EE, Moore BS
Nat Chem Biol. 2014;10(8):640-7.

[Highlighted by UCSD Health Sciences.](#)

[Highlighted by C&EN News.](#)

18. Enzymatic synthesis of polybrominated dioxins from the marine environment
Agarwal V, Moore BS
ACS Chem Biol. 2014;9(9):1980-4.
17. Fungal polyketide engineering comes of age
Agarwal V, Moore BS
Proc Natl Acad Sci U S A. 2014;111(34):12278-9.
16. Structure and function of phosphonoacetaldehyde dehydrogenase: the missing link in phosphonoacetate formation
Agarwal V, Peck SC, Chen JH, Borisova SA, Chekan JR, van der Donk WA, Nair SK
Chem Biol. 2014;21(1):125-35.
15. Exploring the substrate promiscuity of an antibiotic inactivating enzyme

Agarwal V, Gadakh B, Vondenhoff GH, Severinov K, Van Aerschot A, Nair SK
MedChemComm. 2014;5:1567-70.

14. Structural and biochemical basis for mannan utilization by *Caldanaerobius polysaccharolyticus* strain ATCC BAA-17
Chekan JR, Kwon IH, **Agarwal V**,* Dodd D, Revindran V, Mackie RI, Cann I, Nair SK
J Biol Chem. 2014; 289(50):34965-77.

*Equal contribution first author

13. The RimL transacetylase provides resistance to translation inhibitor microcin C
Kazakov T, Kuznedelov K, Semenova E, Mukhamedyarov D, Datsenko KA, Metlitskaya A, Vondenhoff GH, Tikhonov A, **Agarwal V**, Nair S, Van Aerschot A, Severinov K
J Bacteriol. 2014;196(19):3377-85.

2013

12. Structural and functional insight into an unexpectedly selective N-methyltransferase involved in plantazolicin biosynthesis
Lee J, Hao Y, Blair PM, Melby JO, **Agarwal V**, Burkhart BJ, Nair SK, Mitchell DA
Proc Natl Acad Sci U S A. 2013;110(32):12954-9.

11. A microfluidic approach for protein structure determination at room temperature via on-chip anomalous diffraction
Perry SL, Guha S, Pawate AS, Bhaskarla A, **Agarwal V**, Nair SK, Kenis PJ
Lab Chip. 2013;13(16):3183-7.

2012

10. Structures of cyanobactin maturation enzymes define a family of transamidating proteases
Agarwal V, Pierce E, McIntosh J, Schmidt EW, Nair SK
Chem Biol. 2012;19(11):1411-22.

9. Structure of the enzyme-acyl carrier protein (ACP) substrate gatekeeper complex required for biotin synthesis
Agarwal V, Lin S, Lukk T, Nair SK, Cronan JE
Proc Natl Acad Sci U S A. 2012;109(43):17406-11.

8. Biochemical and structural insights into xylan utilization by the thermophilic bacterium *Caldanaerobius polysaccharolyticus*
Han Y, **Agarwal V**,* Dodd D, Kim J, Bae B, Mackie RI, Nair SK, Cann IK
J Biol Chem. 2012;287(42):34946-60.
*Equal contribution first author

7. Structure and function of a serine carboxypeptidase adapted for degradation of the protein synthesis antibiotic microcin C7
Agarwal V, Tikhonov A, Metlitskaya A, Severinov K, Nair SK
Proc Natl Acad Sci U S A. 2012;109(12):4425-30.
[Highlighted by UofI News.](#)

6. Aminoacyl tRNA synthetases as targets for antibiotic development
Agarwal V, Nair SK
MedChemComm. 2012;3:887-98.

5. Mutations that stabilize the open state of the *Erwinia chrisanthemi* ligand-gated ion channel fail to change the conformation of the pore domain in crystals
Gonzalez-Gutierrez G, Lukk T, **Agarwal V**, Papke D, Nair SK, Grosman C
Proc Natl Acad Sci U S A. 2012;109(16):6331-6.

- 2011**
4. Structural and mechanistic insights into C-P bond hydrolysis by phosphonoacetate hydrolase
Agarwal V, Borisova SA, Metcalf WW, van der Donk WA, Nair SK
Chem Biol. 2011;18(10):1230-40.
 3. Structural basis for microcin C7 inactivation by the MccE acetyltransferase
Agarwal V, Metlitskaya A, Severinov K, Nair SK
J Biol Chem. 2011;286(24):21295-303.
- 2010**
2. Circular logic: nonribosomal peptide-like macrocyclization with a ribosomal peptide catalyst
McIntosh JA, Robertson CR, **Agarwal V**, Nair SK, Bulaj GW, Schmidt EW
J Am Chem Soc. 2010;132(44):15499-501.
 1. Mutational insights into the roles of amino acid residues in ligand binding for two closely related family 16 carbohydrate binding modules
Su X, **Agarwal V**, Dodd D, Bae B, Mackie RI, Nair SK, Cann IK
J Biol Chem. 2010;285(45):34665-76.
- Book chapter** Antibiotics for emerging pathogens
Agarwal V, Nair SK
2012. Robert A. Meyers (ed.) Encyclopedia of Sustainability Science and Technology.

Teaching

2008 – 2012 University of Illinois Urbana-Champaign, Teaching Assistant
8 semesters Physical Biochemistry I (Fall)
 Physical Biochemistry II (Spring)
 Instructors: Dr. Satish K. Nair and Dr. Robert B. Gennis
 Attendance: Over 100 senior undergraduate and graduate students every semester

References

Dr. Bradley S. Moore
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Dr. Wilfred A. van der Donk
Richard E. Heckert Endowed Chair in Chemistry
Howard Hughes Medical Institute Investigator
Department of Chemistry
University of Illinois Urbana-Champaign
vddonk@illinois.edu
Ph: 217-244-5360

Dr. Satish K. Nair
Professor
Department of Biochemistry
University of Illinois Urbana-Champaign
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