

## Biographical Sketch

Northen, Trent - Career Chemist Staff Scientist, Lawrence Berkeley National Laboratory

### **EDUCATION and TRAINING:**

<u>Institution and Location</u>	<u>Degree/Training</u>	<u>Year</u>	<u>Field of Study</u>
University of California Santa Barbara	B.Sc.	1996	Chemical Engineering
Arizona State University	Ph.D.	2006	Chemistry & Biochemistry
The Scripps Research Institute	N/A	2006-2008	Mass Spectrometry
Lawrence Berkeley National Laboratory	N/A	2008	Mass Spectrometry
UC Berkeley Haas School of Business Center for Executive Education/Berkeley Lab Leadership Development Program	N/A	2010	Management/ Leadership

### **RESEARCH and PROFESSIONAL EXPERIENCE:**

2015-Present Division Director, Environmental Genomics and Systems Biology  
2014-Present MassInsight, Founder and Scientific Advisory Board member  
2014-Present Radiant, Scientific Advisory Board member  
2013-Present Metabolomics Society Organizing Committee  
2012-Present Director of array-based assays, Joint Bioenergy Institute, Berkeley Lab  
2012-Present Adjunct Faculty  
2012-Present Member, West Coast Metabolomics Institute  
2012-2013 Nextval, Founder and Scientific Advisory Board member  
2011-Present Member, Synthetic Biology Institute, UC Berkeley  
2011-Present Director of Biotechnology, ENIGMA program  
2011-Present Career Chemist Staff Scientist, Life Sciences Division, Berkeley Lab  
2010 Berkeley Lab Emerging Leaders, Leadership Program, Haas Business School UC Berkeley  
2009-Present Berkeley Lab Carbon Cycle 2.0 steering committee  
2008-Present MetaCyc Scientific Advisory Board (SRI International)  
2008-2011 Chemist Research Scientist, Life Sciences Division, Berkeley Lab  
2007-2010 Collaborator and consultant, Sapphire Energy  
2006- 2008 The Scripps Research Institute Center for Mass Spectrometry under Prof. Gary Siuzdak  
2001-2005 Graduate Research/Teaching Assistant under Prof. Neal Woodbury, Arizona State University  
1999-2000 Associate marketing manager, Glad Brands, The Clorox Company  
1997-1999 Scientist and Process Engineer, Brita R&D, The Clorox Company  
1996-1997 Scientist and Process Engineer, Insecticides Department, The Clorox Company

## HONORS:

- DOE Early Career Award (2014)
- R&D100 Award for HT-NIMS (2013)
- Presidential Early Career Award in Science and Engineering (Awarded by Obama in 2010)
- NIH SPORE career development award (2009) & (2010)
- Awarded "Innovator of Tomorrow", Arizona State University (ASU)/AzTe (2006)
- Outstanding Research Assistant, Chemistry and Biochemistry Department, ASU (2005)
- Outstanding Teaching Assistant, Chemistry and Biochemistry Department, ASU (2003)
- NSF IGERT fellowship (2001-2005)
- Outstanding Chemical Engineering Student in graduating class (1996)
- Elected into Tau Beta Pi - Engineering Honor Society (since 1995)

## COMMITTEES:

- Session chair 12<sup>th</sup> Biennial Conference of Science and Management on the Colorado Plateau.
- Organizing committee for the 2015 metabolomics society international conference

## OUTREACH:

- **Elementary school science outreach** (2011-present), Buena Vista Elementary School, Walnut Creek CA). For the past two years I have volunteered at this school to teach all the 4<sup>th</sup> graders about microbial communities, the ecosystem services they provide and threats of climate change using the biological soil crust system. Kids gasp when I demonstrate how the crusts 'come back to life' upon wetting which really pulls them into the importance of microbes in our lives. I'm also one of the two 'Science Guys' at the school promoting and judging the science fairs.

## PUBLICATIONS:

1. **Northen, Trent R**; Woodbury, Neal W. Light-Directed Movement of Polymer Microstructures. *Langmuir* (2005), 21 (11), 4949-4953. DOI: 10.1021/la047566b
2. **Northen, Trent R**; Brune, Daniel C.; Woodbury, Neal W. Synthesis and Characterization of Peptide Grafted Polymer Microstructures. *Biomacromolecules* (2006), 206 (7), 750-754. DOI: 10.1021/bm0506952
3. **Northen, Trent R**; Yanes, Oscar; Northen, Michael T; Marrinucci, Dena C; Uritboonthai, Winnie; Apon, Junefredo; Golledge, Stephen L; Nordström, Anders; Sizudak, Gary. Clathrate Nanostructures for Mass Spectrometry. *Nature* (2007), 449, 1033-1036. DOI: 10.1038/nature06195
4. **Northen, Trent R**; Wu, Hin-Koon; Northen, Michael T; Nordström, Anders; Uritboonthai, Winnie; Turner, Kimberly L, Siuzdak, Gary. High Surface Energy of Porous Silicon Drives Desorption of Intact Molecules. *JASMS* (2007), 18 (11), 1945-1949. PMCID: PMC2080661. DOI: 10.1016/j.jasms.2007.08.009
5. Woo, H-K, **Northen, Trent R**; Yanes, O; Siuzdak, G. Nanostructure-Initiator Mass Spectrometry (NIMS): A Protocol for Preparing and Applying NIMS Surfaces for High Sensitivity Mass Analysis. *Nature Protocols* (2008), 3, 1341-1349. DOI: 10.1038/nprot.2008.110

6. Nordström, Anders; Want, Elizabeth; **Northen, Trent R**; Gieschen, Andrew; Fisher, Steven; Siuzdak, Gary. A Multiple Ionization Mass Spectrometry Strategy Used to Reveal the Complexity of Metabolomics. *Analytical Chemistry* (2008), 80, 421-429. DOI: 10.1021/ac701982e
7. **Northen, Trent R**; Greving, M; Woodbury, N.W. Combinatorial Screening of Biomimetic Protein Affinity Materials. *Advanced Materials* (2008), 20, 1-7
8. **Northen, Trent R**; Lee, J-C; Hoang, L; Raymond, J; Hwang, D-R; Yannone, S.M; Wong, C-H; Siuzdak, G. A Nanostructure-Initiator Mass Spectrometry Based Enzyme Activity Assay. *PNAS* (2008), 105 (10), 3678-3683. PMID: PMC2268803. DOI: 10.1073/pnas.0712332105
9. Woo, Hin-Koon; Go, Eden P; Hoang, Linh; Trauger, Sunia A.; Bowen, Benjamin; Siuzdak, Gary; **Northen, Trent R**. Phosphonium Labeling for Increasing Metabolomic Coverage of Neutral Lipids Using ESI-MS. *Rapid. Comm. Mass Spec.* (2009), 23 (12), 1849-55. PMID: PMC2268803. DOI: 10.1002/rcm.4076
10. Yanes, Oscar; Woo, Hin-Koon; **Northen, Trent R**; Oppenheimer, Stacey; Schriver, Leah; Apon, Jon; Estrada, Myra; Potchoiba, Michael; Manchester, Marianne; Siuzdak, Gary. Nanostructure-Initiator Mass Spectrometry (NIMS) Tissue Imaging and Biofluid Analysis. *Analytical Chemistry* (2009), 81 (8), 2969-2975. PMID: PMC2676195. DOI: 10.1021/ac802576q
11. Baran, Richard; Reindl, Wolfgang; **Northen, Trent R**. Mass Spectrometry Based Metabolomics and Enzymatic Assays for Functional Genomics. *Current Op: in Microbiology* (2009), 12, 547-552 COVER.
12. Reindl, Wolfgang; **Northen, Trent R**. Rapid Screening of Fatty Acids Using Nanostructure-Initiator Mass Spectrometry. *Analytical Chemistry* (2010), 9, 3751-3755. DOI: 10.1021/ac100159y
13. Bowen, Benjamin P; **Northen, Trent R**. Dealing with the Unknown: Metabolomics and Metabolite Atlases. *JASMS* (2010), 21 (9), 1471-1476. DOI: 10.1016/j.jasms.2010.04.003
14. Jansson, Christer; **Northen, Trent R**. Calcifying Cyanobacteri: The Potential of Biomineralization for Carbon Capture and Storage. *Current Op: Biotechnol* (2010), Jun, 21 (3), 365-71. DOI: 10.1016/j.copbio.2010.03.017
15. Facciotti, M.T; Pang, W.L; Lo, F-Y; Whitehead, K; Koide, T; Masumura, K; Pan, M; Kaur, A; Larsen, D.J; Reiss, D.J; Hoang, L; Kalisiak, E; **Northen, Trent R**; Trauger, S.A; Siuzdak, G; Baliga, N.S. Large Scale Physiological Readjustment During Growth Enables Rapid, Comprehensive and Inexpensive System Analysis. *BMC Syst Biol* (2010), 4:64. PMID: PMC2880973. DOI: 10.1186/1752-0509-4-64
16. Lee, Do Yup; Bowen, Benjamin P; **Northen, Trent R**. Mass Spectrometry Based Metabolomics, Analysis of Metabolite-Protein Interactions and Imaging. *Biotechniques* (2010), 49 (2), 557-65 (COVER). PMID: PMC2967016. DOI: 10.2144/000113451
17. Baran, R; Bowen, BP; Bouskill, NJ; Brodie, EL; Yannone, SM; **Northen, Trent R**. Metabolite Identification in *Synechococcus* sp. PCC 7002 Using Untargeted Stable Isotope Assisted Metabolite Profiling. *Analytical Chemistry* (2010), 82 (21), 9034-9042. DOI: 10.1021/ac1020112
18. Wilmes, Paul; Bowen, Benjamin P; Thomas, Brian C; Mueller, Ryan S; Deneff, Vincent J; VerBerkmoes, Nathan C; Hettich, Robert L; **Northen, Trent R**; Banfield, Jillian F. Metabolome-Proteome Differentiation Coupled to Microbial Divergence. *mBio* (2010), 1 (5), 1-5. PMID: PMPC2962434
19. Reindl, Wolfgang E; Bowen, Benjamin P; Balamontis, Michael A; Green, Jeffery E; **Northen, Trent R**. Multivariate Analysis of a 3D Mass Spectral Image for Examining Tissue Heterogeneity. *Integrative Biology* (2011), 3: 460-467. PMID: PMC3495549. DOI: 10.1039/c0ib00091d

20. Bowen, B; Fischer, C; Baran, R; Banfield, J; **Northen, Trent R**. Improved Genome Annotation through Untargeted Detection of Pathway-Specific Metabolites. *BMC Genomics* (2011), 12 (Suppl 1), S6. BioMed Central Ltd. PMID: PMC32223729. DOI: 10.1186/1471-2164-12-S1-S6
21. Reindl, Wolfgang; Deng, Kai; Gladden, John M; Cheng, Gang; Wong, April; Singer, Steven W; Singh, Seema; Lee, Jinq-Chyi; Yao, Chun-Hsu; Hazen, Terry C; Singh, Anup K; Simmons, Blake A; Adams, Paul D; **Northen, Trent R**. Colloid-Based Multiplexed Screening for Plant Biomass-Degrading Glycoside Hydrolase Activities in Microbial Communities. *Energy and Envir.Sci.* (2011), 4, 2884-2893. DOI: 10.1039/C1EE01112J
22. Baran, Richard; Bowen, Benjamin; **Northen, Trent R**. Untargeted Metabolic Footprinting Reveals a Surprising Breadth of Metabolite Uptake and Release by *Synechococcus* sp. PCC 7002. *Molecular BioSystems* (2011), 7, 3200-3206. DOI: 10.1039/c1mb05196b
23. Storm, P; Aits, S; Puthia, MK; Urbano, A; **Northen, Trent R**; Powers, S; Bowen, B; Chao, Y; Reindl, W; Lee, DY; Sullivan, NL; Zhang, L; Trulsson, M; Yang, H; Watson, JD; Svanborg, C. Conserved Features of Cancer Cells Define Their Sensitivity to HAMLET-Induced Death; c-Myc and Glycolysis. *Oncogene*, 30, 4765-4779. DOI: 10.1038/onc.2011.196
24. Deng, K; George, KW; Reindl, W; Keasling, JD; Adams, PA; Lee, TS; Singh, AK; **Northen, Trent R**. Encoding Substrates with Mass Tags to Resolve Stereospecific Reactions Using Nimzyme. *Rapid Comm. Mass Spectrometry* (2012), Mar 30; 26 (6): 611-5. DOI: 10.1002/rcm.6134
25. Fischer, CR; Wilmes, P; Bowen, BP; **Northen, Trent R**; Banfield, JF. Deuterium Exchange Metabolomics Identifies N-Methyl lyso Phosphatidylethanolamines as Abundant Lipids in Acidophilic Mixed Microbial Communities. (2012), 8 (4), 566-578. DOI: 10.1007/s11306-011-0344-x
26. Patti, G.J; Tautenhahn, R; Fonslow, B.R; Cho, Y; Deutschbauer, A; Arkin, A; **Northen, Trent R**; Siuzdak, G. Meta-Analysis of Global Metabolomics and Proteomics Data to Link Alterations with Phenotype. *Spectroscopy* (2011), 26 (3), 151-154 COVER
27. Greving, M; Cheng, K; Reindl, W; Bowen, B; Deng, D; Louie, K; Nyman, M; Cohen, J; Singh, A; Simmons, B; Adams, P; Siuzdak, G; **Northen, Trent R**. Acoustic Deposition with NIMS as a High Throughput Enzyme Activity Assay. *Anal Bioanal Chemistry* (2012), May, 403 (3): 707-11. Epub 2012 Mar 10. DOI: 10.1007/s00216-012-5908-8
28. Reindl, W; Deng, K; Cheng, X; Singh, AK; Simmons, B; Adams, P; **Northen, Trent R**. Nanostructure-Initiator Mass Spectrometry (NIMS) for the Analysis of Enzyme Activities. *Curr. Protocols in Chem. Biology* (2012), 4: 123-142. DOI: 10.1002/9780470559277.ch110221
29. Lee, DY; Platt, V; Bowen, B; Louie, K; Canaria, C; McMurray, C; **Northen, Trent R**. Resolving Brain Regions Using Nanostructure Initiator Mass Spectrometry Imaging of Phospholipids. *Integrative Biology* (2012), 4 (6), 693 – 699. DOI: 10.1039/c2ib20043k
30. Lee, DY; Bowen, B; Louie, K; Nguyen, D; Parsa, S; Huang, Y; Mao, JH; **Northen, Trent R**. Low-Dose Ionizing Radiation-Induced Blood Plasma Metabolic Response in a Diverse Genetic Mouse Population. *Radiation Research* (2012), Dec, 178 (6): 551-5. DOI: 10.1667/RR2990.1
31. Kamennaya, N; Ajo-franklin, C; **Northen, Trent R**; Jansson, C. Biomineralization by Calcifying Cyanobacteria - a Potential Means for Biological Carbon Capture and Storage. *Minerals* (2012), 2 (4), 338-364. DOI: [10.3390/min2040338](https://doi.org/10.3390/min2040338)

32. Baran, R; Bowen, BP; Price, MN; Arkin, AP; Deutschbauer, AM; **Northen, Trent R**. Metabolic Footprinting of Mutant Libraries to Map Metabolite Utilization to Genotype. *ACS Chemical Biology* (2013), 8 (1), 189-199. DOI: 10.1021/cb300477w
33. Mosier, AC; Justice, NB; Bowen, BP; Baran, R; Thomas, BC; **Northen, Trent R**; Banfield, JF. Metabolites Associated with Adaptation of Microorganisms to an Acidophilic, Metal-Rich Environment Identified by Stable Isotope Enabled Metabolomics. (2013), Mar 12, 4 (2): e00484-12. PMID: PMC3604775. DOI: 10.1128/mBio.00484-12
34. De Rond, T; Peralta-Yahya, P; Cheng, X; **Northen, Trent R**; Keasling, JD. Versatile Synthesis of Probes for High-Throughput Enzyme Activity Screening. *Anal Bioanal Chemistry* (2013), May, 405 (14): 4969-73. DOI: 10.1007/s00216-013-6888-z
35. McAndrew, Ryan P; Park, Joshua; Reindl, Wolfgang; Friedland, Gregory D; D'haeseleer, Patrik; **Northen, Trent R**; Sale, Kenneth L; Simmons, Blake A; Adams, Paul D. From Soil to Structure: A Novel Dimeric Family 3  $\beta$ -Glucosidase Isolated from Compost Using Metagenomics. *Journal of Biochemistry* (2013), 288 (21): 14985-92. DOI: 10.1074/jbc.M113.458356
36. Louie, KB; Bowen, BP; McAlhany, S; Huang, Y; Mao, JH; Hellerstein, M; **Northen, Trent R**. Kinetic Mass Spectrometry Imaging for In Situ Kinetic Histochemistry. *Nature Scientific Reports* (2013), Apr 15; 3: 1656. PMID: PMC3625901. DOI: 10.1038/srep01656
37. Ho, JC; Storm, P; Rydström, A; Bowen, B; Alsin, F; Sullivan, L; Ambite, I; Mok, KH; **Northen, Trent R**; Svanborg, C. Lipids as Tumoricidal Components of Human Alpha-Lactalbumin Made Lethal to Tumor Cells (HAMLET): Unique and Shared Effects on Signaling and Death. *J Biol Chem.* (2013), Jun 14; 288 (24): 17460-71. DOI: 10.1074/jbc.M113.468405. Epub 2013 Apr 29
38. Rajeev, L; Nunes, da Rocha U; Klitgord, N; Luning, EG; Fortney, J; Axen, SP; Shih, PM; Bouskill, NJ; Bowen, BP; Kerfield, C; Garcia-Pichel, F; Brodie, EL; **Northen, Trent R**; Mukhopadhyay, A. Dynamic Cyanobacterial Response to Hydration and Dehydration in a Desert Biological Soil Crust. *ISME Journal* (2013), 7, 2178–2191. DOI: 10.1038/ismej.2013.83
39. Fischer, CR; Bowen, BP; Pan, C; **Northen, Trent R**; Banfield, JF. Stable-Isotope Probing Reveals Hydrogen Isotope Fractionation in Proteins and Lipids in a Microbial Community are Different and Species-Specific. *ACS Chemical Biology* (2013), 8 (8), 1755–1763. DOI: 10.1021/cb400210q
40. Baran, R; **Northen, Trent R**. Robust Automated Mass Spectra Interpretation and Chemical Formula Calculation Using Mixed Integer Linear Programming. *Analytical Chemistry* (2013), 85 (20), 9777–9784. DOI: 10.1021/ac402180c
41. Baran, R; Ivanova, N; Jose, N; Garcia-Pichel, F; Kyrpides, N; Guggen, M; **Northen, Trent R**. Functional Genomics of Novel Secondary Metabolites from Diverse Cyanobacteria Using Untargeted Metabolomics. *Marine Drugs* (2013), 11 (10), 3617-3631. DOI: [10.3390/md11103617](https://doi.org/10.3390/md11103617)
42. Louie, Katherine B; Bowen, Benjamin P; Cheng, Xiaoliang; Berleman, James; Chakraborty, Romy; Deutschbauer, Adam; Arkin, Adam; **Northen, Trent R**. Replica-Extraction-Transfer For Nanostructure-Initiator Mass Spectrometry Imaging Of Acoustically Printed Bacteria and Microbial Communities. *Analytical Chemistry* (2013), 85 (22), 10856-62. DOI: 10.1021/ac402240q

43. Rübél, Oliver; Greiner, Annette; Cholia, Shreyas; Louie, Katherine; Bethel, E. Wes; **Northen, Trent R**; Bowen, Benjamin P. OpenMSI: High-Performance Web-Based Visualization, Analysis and Management of Mass Spectrometry Imaging Data. *Analytical Chemistry* (2013), 85 (21): 10354-61. DOI: 10.1021/ac402540a
44. Cheng, X; Hiras, J; Deng, K; Simmons, BA; Adams, PD; Singer, SW; **Northen, Trent R**. HT NIMS Screening of Environmental Microbial Isolate Growth Conditions for Maximal Enzyme Activity. *Frontiers in Microbiology* (2013), 4, 365. DOI: 10.3389/fmicb.2013.00365
45. Deng, K; Takasuka, TE; Heins, R; Cheng, X; Bergeman, LF; Shi, J; Aschenbrenner, R; Deutsch, S; Singh, S; Sale, KL; Simmons, BA; Adams, PD; Singh, AK; Fox, BG; **Northen, Trent R**. Rapid Kinetic Characterization of Glycosyl Hydrolases (GHs) Based on Oxime Derivatization and Nanostructure-Initiator Mass Spectrometry (NIMS). *ACS Chemical Biology* (2014), 9 (7), 1470-1479. DOI: 10.1021/cb5000289. COVER
46. Heins, R; Cheng, X; Nath, S; Deng, K; Bowen, B; Chivian, D; Datta, S; Friedland, G; D'Haeseleer, P; Wu, D; Tran-Gyamfi, M; Scullin, C; Singh, S; Shi, W; Hamilton, M; Bendall, M; Sczyrba, A; Thompson, J; Feldman, T; Guenther, J; Gladden, J; Cheng, JF; Adams, P; Rubin, E; Simmons, BA; Sale, K; **Northen, Trent R**; Deutsch, S. Phylogenomic Guided Identification of Industrially Relevant GH1  $\beta$ -Glucosidases Through Coupled DNA Synthesis and Nanostructure-Initiator Mass Spectrometry. *ACS Chemical Biology* (2014), 19 (9), 2082-91. DOI: 10.1021/cb500244v
47. Vandehey, Nicholas; Brodie, Eoin; **Northen, Trent R**; O'Neil, James. Non-Invasive Mapping of Photosynthetic Heterogeneity in Biological Soil Crusts by Positron Emission Tomography: Carbon Fixation. *Environmental Science & Technology Letters* (2014), 1 (10), 393-398. DOI: 10.1021/ez500209c
48. Berleman, J; Allen, S; Danielewicz, M; Remis, J; Gorur, A; Cunha, J; Hadi, M; Zusman, D; **Northen, Trent R**; Witkowska, H. Ewa; Manfred, Auer. The Lethal Cargo of Myxococcus xanthus Outer Membrane Vesicles. *Frontiers in Microbiology* (2014), 5, 274, 1-11. DOI: 10.3389/fmicb.2014.00474
49. De Rond, T; Danielwicz, M; **Northen, Trent R**. High Throughput Screening of Enzyme Activity with Mass Spectrometry Imaging. *Current Opinion in Biotechnology* (2015), 31, 1-9. DOI: 10.1016/j.copbio.2014.07.008
50. Swenson, T; Jenkins, S; Bowen, B; **Northen, Trent R**. Untargeted Soil Metabolomics Methods for Analysis of Extractable Organic Matter. *Soil Biology and Biochemistry* (2015), 80, 189-198. DOI: 10.1016/j.soilbio.2014.10.007
51. Kurczyk, M; **Northen, Trent R**; Trauger, S.A; Siuzdak, G. Nanostructure Imaging Mass Spectrometry: The Role of Fluorocarbons in Metabolite Analysis and the Road to Yoctomole Level Sensitivity. *Methods in Mol. Bio.* (2015), 1203, 141-149. DOI: 10.1007/978-1-4939-1357-2\_14
52. Castellanos-Martín; Castillo-Lluva; del Mar Sáez-Freire; Blanco-Gómez; Hontecillas-Prieto; Patino-Alonso; Galindo-Villardón; del Villar, Pérez; Martín-Seisdedos, Carmen; Isidoro-García, María; del Mar Abad-Hernández; Cruz-Hernández; Rodríguez-Sánchez; González-Sarmiento; Alonso-López; De Las Rivas; García-Cenador; Lee; Bowen; Reindl; **Northen, Trent R**; Mao; Pérez-Losada. Unraveling Heterogeneous Susceptibility and the Evolution of Breast Cancer by a Systems Biology Approach. *Genome Biology* (2015), 16, 40, 2-23. DOI: 10.1186/s13059-015-0599-z

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54. Nunes da Rocha, Ulisses; Cadillo-Quiroz, Hinsby; Karaoz, Ulas; Rajeev, Lara; Klitgord, Niels; Dunn, Sean; Truong, Viet; Buenrostro, Mayra; Bowen, Benjamin Paul; Garcia-Pichel, Ferran; Mukhopadhyay, Aindrila; **Northen, Trent R**; Brodie, Eoin L. Isolation of a Significant Fraction of Non-Phototroph Diversity from a Desert Biological Soil Crust. *Frontiers in Microbiology* (2015). DOI: 10.3389/fmicb.2015.00277
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56. Ceja-Navarro, J. A.; Vega, F. E.; Karaoz, U; Hao, Z; Jenkins, S; Lim, H. C.; Kosina, P; Infante, F; **Northen, Trent R**; Brodie, E. L. Gut Microbiota Mediate Caffeine Detoxification in the Primary Insect Pest of Coffee. *Nature Communications* (2015), 6: 7618. DOI: 10.1038/ncomms8618
57. Yee Ngan, CY; Wong, CH; Choi, C; Yoshinaga, Y; Louie, K; Jia, J; Chen, C; Bowen, B; Cheng, H; Leonelli, L; Kuo, R; Baran, R; García-Cerdán, J; Pratap, A; Wang, Mei; Lim, Joanne; Tice, Hope; Daum, C; Xu, J; **Northen, Trent R**; Visel, A; Bristow, J; Niyogi, K; Wei, CL. Lineage-Specific Chromatin Signatures Reveal a Regulator of Lipid Metabolism in Microalgae. *Nature Plants* (2015), 1: 15107. DOI:10.1038/nplants.2015.107
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60. Swenson, T; Nico, P; Bowen, B; **Northen, Trent R**. Competitive Adsorption of Microbial Metabolites to Ferrihydrate. *Soil Biology and Biochemistry* (in press)
61. Walker, JA; Takasuka, T; Deng, K; Bianchetti, CM; Udell, HS; Prom, BM; Kim, H; Adams, PD; **Northen, Trent R**; Fox, BG. Substrate Binding Effects of Carbohydrate Binding Modules on the Catalytic Activity of a Multifunctional Cellulase. *Biophysical Journal* (2015), 108 (2). DOI: 10.1016/j.bpj.2014.11.1244
62. Deng, K; Guenther, JM; Gao, J; Bowen, BP; Huu, T; Vimalier, RO; Chen, X; Sathitsuksanoh, N; Heins, R; Takasuka, TE; Bergman, L; Geertz-Hansen, H; Deutsch, S; Loque, D; Sale, K; Simmons, B; Adams, PD; Singh, AK; Fox, BG; **Northen, Trent R**. Development of a High Throughput Platform for Screening Glycoside Hydrolases Based on Oxime-NIMS. *Front. Bioeng. Biotechnol.* (2015), 3: 153. DOI: 10.3389/fbioe.2015.00153
63. Deng, K; Takasuka, TE; Bianchetti, CM; Bergman, LF; Adams, PD; **Northen, Trent R**; Fox, BG. Use of Nanostructure Initiator Mass Spectrometry (NIMS) to Deduce Selectivity of Reaction in Glycoside Hydrolases. *Front. Bioeng. Biotechnol.* (2015), 3: 165. DOI: 10.3389/fbioe.2015.00165

## **PATENTS:**

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2. Flagler; Robert W. (Pleasanton, CA); **Northen; Trent R.** (Oakland, CA); Ball; Alan D. (Somerville, MA); Schnakenberg, III; George H. F. (Cambridge, MA). Patent US D437,027 Water filter reservoir (2001)
3. **Northen; Trent R.** (Oakland, CA); Patent WO0223989. Insecticidal Microcrystalline Dry Aerosol Spray (2002).
4. **Northen; Trent, Russell** (Tempe, Az); Woodbury; Neal, Walter. (Tempe, Az); Full Patent Application PCT/US05/15764, U.S. provisional applications 60/569,370, 60/608,774, and 60/623,181 (2004). Microarray of Three-Dimensional Heteropolymer Microstructures and Method Therefor (2005).
5. **Northen; Trent, Russell** (Tempe, Az); Greving; Matthew (Phoenix, Az), Woodbury; Neal, Walter. (Tempe, Az); Full patent application Ser. No. **01231.0039P1** Microstructure and microdomain microarrays, methods and uses therefore (2006). U.S. provisional application Characterization and Synthesis of Three-Dimensional Heteropolymer Microstructure Arrays and Method Therefore (2005)
6. **Northen; Trent, Russell** (San Diego, Ca); Nordström; Anders (La Jolla, Ca); Siuzdak; Gary (La Jolla, Ca); U.S. Patent application 11/852,863. Nanostructure-Initiator Mass Spectrometry (2007).
7. Matthew P. Greving, Neal Woodbury and **Trent Northen**. Porous Acrylate Copolymer Films and Uses Therefor (US 12/018,398) 2008
8. Leclerc, Marion; Bowen, Benjamin P.; **Northen, Trent R.** Provisional Patent Application "NIMS Biometrics" U.S. Patent Application Ser. No: 61/540,794 (2011)
9. **Trent R. Northen**, Wolfgang E. Reindl, Kai Deng, Seema Singh, And Anup K. Singh. Multiplexed screening of enzyme activities using nanostructure-initiator mass spectrometry. US No. 13/363,695
10. Bowen, Benjamin P.; Hellerstein, Marc; Louie, Katherine B.; **Northen, Trent R.** Provisional Patent Application based on technology "NIMS Flux imaging" U.S. Patent Application Ser. No: 61/532,522
11. **Northen, Trent R.**; Deng, Kai; De Rond, Tristan P.; Peralta-Yahya, Pamela P.; Cheng, Xiaoliang; Keasling, Jay D. Rapid Discovery and Optimization of Enzyme Solutions Using Tagged Biomass and Mass Spectrometry. U.S. Patent Application Ser. No: 61/736,409 PCT/US2013/074495
12. Louie, Katherine B, Bowen, Benjamin P, **Northen, Trent R.** NIMS Lipid Particle Medical Diagnostics". U.S. Patent Application Ser. No: 61/756,401

## **BOOKS:**

**Northen, Trent, R.** The small molecule dimension: mass spectrometry based metabolomics, enzyme assays, and imaging. Handbook of Molecular Microbial Ecology: Metagenomics and Complementary Approaches. Wiley Press. Frans J. de Bruijn Editor

Katherine Louie and **Trent Northen**. Mass Spectrometry in Metabolomics. Daniel Raftery (Ed). Metabolic Imaging Using Nanostructure-Initiator Mass Spectrometry (NIMS). (2014) [Methods in Molecular Biology](#) Volume 1198, 2014, pp 313-329



### **TEXTBOOKS:**

**Northen, Trent, R.** Harnessing Microbial Metabolism for Biofuels and Biomaterials. Fundamentals of Materials for Energy and Environmental Sustainability. Cambridge Press. David Ginley & David Cahen Editors.

### **SYNERGISTIC ACTIVITIES:**

Director of Biotechnology of the DOE ENIGMA SFA with broad exposure to state of the art technologies for studying microbial metabolism.

Director of High Throughput Chip Based assays with a focus on screening microbial metabolism and enzymatic activities.

Reviewer for Analytical Chemistry, Nature Methods, Nature Chemical Biology, Angewandte chemie, Journal of American Society for Mass Spectrometry (JASMS), Rapid communications in mass spectrometry, Analytical methods, Molecular Biosystems, Physical Chemistry Chemical Physics, and etc. Serve on ad hoc review for DOE, NIH, and DoD.

### **SELECTED INVITED LECTURES:**

1. **Northen T**, "Surface Based Approaches to Mass Spectrometry", Short Course on Mass Spectrometry, The Scripps Research Institute, La Jolla CA January 2008.
2. **Northen T**, "High Throughput Mass Spectrometry Based Metabolomic and Enzymatic Assays for Functional Genomics" Genomes 2008, Institut Pasteur, April 8-11 2008 Paris, France.
3. **Northen T**, "Nanostructure-Initiator Mass Spectrometry for Metabolomics and Enzyme Activity Profiling, Plenary Lecture, American Society for Mass Spectrometry Annual Meeting, June 1-6<sup>th</sup>, Denver CO. 2008
4. **Northen T**, "Gene Maps-MS: Gene Annotation Validation Through Metabolomics and Proteomics by Mass Spectrometry", 16<sup>th</sup> Annual Microbial Genomics Meeting at Lake Arrowhead, CA, Sept 14-18<sup>th</sup> 2008
5. **Northen T**, "High Throughput Metabolomics and Proteomics by Mass Spectrometry", Annual DOE GTL program meeting, Washington D.C., Feb 8-11<sup>th</sup> 2009
6. **Northen T**, "In situ metabolomic imaging mass spectrometry", Annual DOE low-dose program meeting, Washington D.C., April 5-8<sup>th</sup> 2009
7. **Northen T** "Functional Genomics Using Mass Spectrometry Based Metabolomics", JGI, Walnut Creek August 27<sup>th</sup> 2009.
8. **Northen T** "GeneMap-MS: Applications to Cellular Dynamics and Protein Annotation", SRI, Stanford, CA. Sept. 9<sup>th</sup> 2009.
9. **Northen T** "Mass Spectrometry Based Metabolomics Approaches to Studying Cyanobacterial Metabolism", LSD/Genomics Divisional Seminar Berkeley CA, Oct 6<sup>th</sup> 2009.
10. **Northen T** "Glyco-Chips: High Throughput Mass Spectrometry Based Enzyme Assays", Plenary Seminar, Annual DOE Genome Sciences Program Meeting, Washington D.C. Feb. 7<sup>th</sup>, 2010.

11. **Northen T** "Mass spectrometric based metabolomics and tissue imaging for characterization of breast tissues." UCSF, Integrated Cancer Center, San Francisco CA. Feb 24, 2010.
12. **Northen T.** "Integrated mass spectrometry based metabolomic profiling, imaging, and high throughput assays". Bay Area Mass Spectrometry, San Francisco, CA. April 15<sup>th</sup>, 2010.
13. **Northen T.** "Metabolite profiling and imaging", Plenary Seminar, Annual DOE Low-Dose Meeting, Washington D.C. April. 14<sup>th</sup>, 2010
14. **Northen T.** "Resolving the spatial structure of metabolites and activities within the biological matrix". Institute of Systems Biology, Seattle, WA. May 21<sup>th</sup>, 2010.
15. **Northen T.** "Mass spectrometry tools for optimizing, assembling, and discovering new parts". Synthetic biology institute, Berkeley, CA. June 22<sup>th</sup>, 2010.
16. **Northen T.** "Mass spectrometry based metabolomics and imaging". Computational biology training and workshop, Berkeley, CA. Aug 12<sup>th</sup>, 2010.
17. **Northen T.** "Mass spectrometry based metabolomics and imaging". University of California Davis, Davis, CA. September 14<sup>th</sup>, 2010.
18. **Northen T.** "Identifying drug resistant breast cancer using Metabolomics and nanotechnology". Annual meeting of California Breast Cancer Program, Oakland, CA. September 25<sup>th</sup>, 2010.
19. **Northen T.** "Imaging and characterization of small molecules from tissues and crude cell lysates". Annual coSMos meeting, Portland, OR. September 28<sup>th</sup>, 2010.
20. **Northen T.** "Resolving the spatial distribution of metabolites and activities within the biological matrix". University of California Berkeley Bioengineering departmental seminar. Berkeley, CA. October 20<sup>th</sup>, 2010.
21. **Northen T.** "High throughput multiplexed GlycoChip enzymatic assays for biofuel development". Annual meeting of the American Institute of Chemical Engineers (AIChE). Salt Lake City, UT. November 12<sup>th</sup>, 2010.
22. **Northen T.** "Spatio-Temporal metabolic turnover to detect drug resistant breast cancers". Buck Institute, Novato, CA. February 4<sup>th</sup>, 2011.
23. **Northen T.** "Accelerating functional genomics using metabolomics". JGI. Walnut Creek, CA. May 14<sup>th</sup>, 2011.
24. **Northen T.** "Mass spectrometry for optimizing, assembling, and discovering new parts". Synthetic Biology SB5.0, Stanford, CA. June 15<sup>th</sup>, 2011.
25. **Northen T.** "Accelerating functional genomics using metabolomics", Synthetic Genomics Invited Lecture, San Diego CA, August 25<sup>th</sup> 2011.
26. **Northen T.** "Improving functional annotations and supporting synthetic biology using MS based metabolite profiling and screening". Amyris Invited Lecture, Emeryville CA, Sept 19<sup>th</sup> 2011.
27. **Northen T.** "Resolving community and metabolic dynamics and carbon flux in Colorado Plateau biological soil crusts" Northern Arizona University, Flagstaff AZ, October 25<sup>th</sup>, 2011.
28. **Northen T.** "Mass spectrometry based metabolite profiling and imaging". Pacific Northwest National Laboratory Frontiers Lecture, PNNL, Richland, WA. November 4<sup>th</sup>, 2011.

29. **Northen T.** "Stable Isotopes, metabolic profiling and imaging". UC Berkeley Department of Nutritional Sciences and Toxicology, Berkeley CA, Nov 9th 2011.
30. **Northen T.** "Secrets of the Soil". Berkeley Science Theatre, Berkeley CA, Nov 7th 2011.
31. **Northen T.** "Characterization of alterations in lipid expression in breast cancer cell lines and tumors", OHSU, Portland Oregon, March 9<sup>th</sup> 2012
32. **Northen T.** "Metabolic dynamics of Colorado Plateau Biological Soil Crusts", Canyonlands Symposium, Moab, UT. March 13<sup>th</sup> 2012
33. **Northen T.** "Mass spectrometry based metabolite profiling and imaging". Life Sciences Division, SRI International, Menlo Park CA. April 27<sup>th</sup>, 2012.
34. **Northen T.** "Carbon Cycling and Metabolic Dynamics of Biological Soil Crusts". LBNL CC2.0 seminar, Berkeley CA. August 16<sup>th</sup>, 2012.
35. **Northen T.** "Mass spectrometry based metabolite profiling and imaging". USDA, Albany, CA. September 5<sup>th</sup>, 2012.
36. **Northen T.** "ENIGMA: dissecting microbial metabolism in communities". Biannual Microbial Genomics Conference, Lake Arrowhead, CA, September 19<sup>th</sup>, 2012.
37. **Northen T.** "ENIGMA: decoding microbial metabolism using metabolite profiling". CSUMB, Monterey CA, October 10<sup>th</sup>, 2012.
38. **Northen T.** "Accelerating functional genomics". Chemical Engineering Departmental Seminar, Caltech, Pasadena, CA. Oct 25<sup>h</sup>, 2012.
39. **Northen T.** "Imaging Lipid Turnover in Tumors". UCSF Breast Oncology Program Scientific Retreat, San Francisco, CA. January 25<sup>h</sup>, 2013.
40. **Northen T.** "Imaging Metabolic Dynamics in Breast Tumors". UC Davis, Davis, CA. May 8th, 2013.
41. **Northen T.** "Profiling and Imaging Metabolic Dynamics Using Mass Spectrometry". Molecular Foundry Seminar Series, Berkeley Ca, May 28th, 2013.
42. **Northen T.** "Modeling metabolic dynamics in colorado plateau biological soil crusts to predict the impacts of climate change". Northern Arizona University, Flagstaff AZ, September 18th, 2013.
43. **Northen T.** "High Throughput Metabolite Profiling". Superfund meeting, Berkeley CA, September 20th, 2013.
44. **Northen T.** "Metabolic Dark Matter: Mass spectrometry explorations of bacterial metabolism". Oregon State University, January 22nd, 2014.
45. **Northen T.** "Systems Approaches for Understanding Soil Metabolite Based Foodwebs". DOE Genomic Sciences Contractors Meeting, Bethesda MA, Feb 10<sup>th</sup> 2014.
46. **Northen T.** "Deconstructing Carbon Cycling in Soils Using Metabolomics". Montana State University, Bozeman MT. April 21<sup>st</sup>, 2014.
47. **Northen T.** "Soil Metabolomics Approach to Investigate Dissolved Organic Matter Recalcitrance Against Soil Bacteria". Goldschmidt, Sacramento CA. June 10<sup>th</sup>, 2014.
48. **Northen T.** "The x, y, z and t's of Mass Spectrometry Imaging". West Coast Metabolomics Center Metabolomics Summer Course, Davis Ca. Sept 11<sup>th</sup>, 2014.
49. **Northen T.** "Accelerating Functional Genomics Using Mass Spectrometry". Missouri S&T, Rolle Mo. Oct 13<sup>th</sup>, 2014.

50. **Northen T.** “Determination of Soil Dissolved Organic Matter Composition and Bacterial Cycling Using Soil Metabolomics”. Soil Science Society of America, Long Beach CA. Nov 5<sup>th</sup>, 2014.
51. **Northen T.** “Exometabolomic Analysis of Dissolved Organic Matter Composition and Bacterial Cycling”, Lawrence Livermore National Lab, Department Seminar, Livermore CA. Dec 4<sup>th</sup> 2014.
52. **Northen T.** “Investigation of Biological Soil Crust Metabolic Webs using Exometabolomics Analysis”, AGU, San Francisco, CA. Dec 15<sup>th</sup> 2014.
53. **Northen T.** “**Understanding microbial carbon cycling in soils using novel metabolomics approaches**”. DOE Genomic Sciences Contractors Meeting, Bethesda MA, Feb 25<sup>th</sup>, 2015
54. **Northen T.** “**Kinetic mass spectrometry imaging**”. International meeting of the Metabolomics Society, San Francisco CA, June 29<sup>th</sup>, 2015

**TRAINEES:**

Wolfgang Reindl, Evotec  
Nicholas Justice, UCB  
Curt Fisher  
Karen Andrade  
David Sonojo  
Bin Yoo  
Do Yup Lee, Kookmin University  
Nicholas Jose  
Kriti Sondhi  
Manpreet Kaur  
Daniel Hartono  
Kai Deng  
Benjamin Bowen  
Richard Baran  
Xiaoliang Cheng  
Katherine Louie  
Peter Rademacher  
Annika Mosier  
Megan Danielewicz  
Tami Swenson  
Stefan Jenkins  
Leslie Silva  
Jian Gao  
Markus De Raad  
Suzanne Kosina  
Rebecca Lau  
Andrea Lubbe  
Erika Cagampan  
Jasmine Sanghera  
Gabriella Boulton  
Peter Andeer

Josh Heinemann  
Todd Duncombe