

Trent Russell Northen

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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	Post-Doc.	2006-8	Mass Spectrometry
UC Berkeley Haas School of Business Center for Executive Education/Berkeley Lab Leadership Development Program	Leadership	2010	Executive Education

RESEARCH and PROFESSIONAL EXPERIENCE:

2020-	Deputy Division Director, Environmental Genomics & Systems Biology
2020-	Board of Directors, <i>AgLantis</i> 501c-3
2018-	Scientific Advisor, BrightSeed
2018-2019	Scientific Advisory Board, QLife Labs
2017-	Senior Scientist, Berkeley Lab
2016-2017	DOE Oppenheimer Science and Energy Leadership, Berkeley Lab representative
2015-2016	Interim Division Director, Environmental Genomics & Systems Biology
2014-Present	Metabolomics Lead Scientist, Joint Genome Institute
2014-2016	Founder and Scientific Advisory Board Member, MassInsight
2014-2017	Scientific Advisory Board Member, Radiant
2013-2015	Metabolomics Society Organizing Committee
2012-Present	Director of Array-based Assays, Joint Bioenergy Institute, Berkeley Lab
2012-Present	Adjunct Faculty, School of Life Sciences, Arizona State University
2012-Present	Member, West Coast Metabolomics Institute
2012-2013	Founder and Scientific Advisory Board Member, Nextval
2011-Present	Member, Synthetic Biology Institute, University of California 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
2008-2011	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 R&D, The Clorox Company

HONORS:

- R&D100 Award finalist for EcoFAB (2019)
- Berkeley Lab Director's Award for Exceptional Service Achievement (2016)
- DOE Early Career Award (2014)
- R&D100 Award finalist for HT-NIMS (2013)
- Presidential Early Career Award in Science and Engineering (Awarded by Obama in 2010)
- JBEI Industry Relationship Excellence Award (2012)
- LBNL SPOT Awards (2009, 2012, 2016)
- 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 organizer 2020 AAAS annual meeting
- 2020 ISME session organizer
- 2020 SIMB organizing committee and session organizer
- Berkeley Microbiome Initiative Steering Committee (2017-)
- LBNL Strategic Communications Recruitment Committee (2017)
- LBNL Government Affairs Recruitment Committee (2016)
- Chair of the EGSB Staffing Committee (2016-)
- Co-organizer of the UC Davis LBNL Microbiome Workshop (2016)
- Environmental Strategy Mentor: Berkeley Lab Biosciences Strategic Plan (2015-)
- Organizer and Co-Chair, EcoFAB 2016
- Session Chair 12th Biennial Conference of Science and Management on the Colorado Plateau
- Session Chair 2015 Genomes to Secondary Metabolites (G2SM) Workshop
- Organizing Committee for the 2015 Metabolomics Society International Conference
- Berkeley Lab Health Strategy Lead: Berkeley Lab Biosciences Strategic Plan

MEMBERSHIPS

- American Society of Mass Spectrometry (ASMS)
- American Association for the Advancement of Science (AAAS)
- American Society for Microbiology (ASM)
- Metabolomics Society

OUTREACH:

- **Elementary School Science Outreach** (2011-present), Buena Vista Elementary School, Walnut Creek CA). I spend a day once a year speaking to over 500 K-5 students about STEM education.
- **UC Merced: 1st Advanced Training Course on Systems Biology, Cancer Metabolism, and Metabolic Flux Analysis** (2016). <http://systemsbiology.ucmerced.edu>

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), 7(3):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; Siuzdak, Gary. Clathrate Nanostructures for Mass Spectrometry. *Nature* (2007), 449(7165):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. PMID: 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(8):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(2):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(24):4691 - 4697. DOI: 10.1002/adma.200800567
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(5):547-552 (COVER). DOI: 10.1016/j.mib.2009.07.004

12. Reindl, Wolfgang; **Northen, Trent R.** Rapid Screening of Fatty Acids Using Nanostructure-Initiator Mass Spectrometry. *Analytical Chemistry* (2010), 82(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 Cyanobacteria: 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(1):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), Sept, 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), Oct, 1(5):1-5. PMID: PMPC2962434. DOI: 10.1128/mBio.00246-10
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), March, 3(4):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), July, 4(8):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), Sep, 7(2):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* (2011), June, 30(48):4765-4779. DOI: 10.1038/onc.2011.196
24. 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. DOI: 10.3233/SPE-2011-0534. COVER
25. 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; 26(6):611-5. DOI: 10.1002/rcm.6134
26. 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. *Metabolomics* (2012), July, 8(4):1-13. DOI: 10.1007/s11306-011-0344-x
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), April, 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), Oct, 178(6):551-5. DOI: 10.1667/RR2990.1
31. Kamennaya, N; Ajo-franklin, C; **Northen, Trent R**; Jansson, C. Cyanobacteria as Biocatalysts for Carbonate Mineralization. *Minerals* (2012), 2(4):338-364. DOI: [10.3390/min2040338](https://doi.org/10.3390/min2040338)
32. 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. *MBio* (2013), Feb, 4(2):e00484-12. PMCID: PMC3604775. DOI: 10.1128/mBio.00484-12

33. Baran, R; Bowen, B. P.; Price, M. N.; Arkin, A. P.; Deutschbauer, A. M.; **Northen, T. R.** Metabolic footprinting of mutant libraries to map metabolite utilization to genotype. *ACS Chem Biol* (2013) 8(1) 189-99 DOI: 10.1021/cb300477w
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), April, 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 β -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), April, 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), 288(24):17460-71. DOI: 10.1074/jbc.M113.468405
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(11):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; Gugger, 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; Aschenbrener, 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 β -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; Auer, Manfred. The Lethal Cargo of *Myxococcus xanthus* Outer Membrane Vesicles. *Frontiers in Microbiology* (2014), 5, 474, 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), 31C: 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. Kurczy, 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
53. Miquel, Sylvie; Leclerc, Marion; Martin, Rebeca; Chain, Florian; Lenoir, Marion; Raguideau, Sébastien; Hudault, Sylvie; Bridonneau, Chantal; **Northen, Trent R**; Bowen, Benjamin; Bermúdez-Humarán, Luis G; Sokol, Harry; Thomas, Muriel;

Langella, Philippe. Identification of Metabolic Signatures Linked to Anti-Inflammatory Effects of *Faecalibacterium Prausnitzii*. *mBio* (2015), 6 (2). DOI: 10.1128/mBio.00300-15

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), 6:277. DOI: 10.3389/fmicb.2015.00277
55. Silva, L; **Northen, Trent R**. Exometabolomics and MSI: Deconstructing How Cells Interact to Transform Their Small Molecule Environment. *Current Opinion in Biotechnology* (2015), 34, 209-216. DOI: 10.1016/j.copbio.2015.03.015
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, 1-9. 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
58. Baran, R; Brodie, EL; Mayberry-Lewis, J; Hummel, E; Nunes Da Rocha, U; Chakraborty, R; Bowen, BP; Karaoz, U; Cadillo-Quiroz, H; Garcia-Pichel, F; **Northen, Trent R**. Exometabolite Niche Partitioning Among Sympatric Soil Bacteria. *Nature Communications* (2015), 6 (6): 8289. DOI: 10.1038/ncomms9289
59. Bowen, B; Yao, Y; Sun, T; Wang, T; Ruebel, O; **Northen, Trent**. Analysis of Metabolomics Datasets with High-Performance Computing and Metabolite Atlases. *Metabolites* (2015), Jul 20;5(3):431-42. PMID: 26287255 PMCID: PMC4588804. DOI: 10.3390/metabo5030431
60. Swenson, T; Nico, P; Bowen, B; **Northen, Trent R**. Competitive Adsorption of Microbial Metabolites to an Iron Oxide Mineral. *Soil Biology and Biochemistry* (2015), 90. DOI: 10.1016/j.soilbio.2015.07.022
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141. Lenz, R., Louie, K., Sondreli, K., Galanie, S., Chen, J.G., Muchero, W., Bowen, B., Northen, T. and Leboldus, J., Metabolic patterns in *Septoria* canker resistant and susceptible *Populus trichocarpa* genotypes 24 hours post-inoculation. *Phytopathology.* <https://doi.org/10.1094/PHYTO-02-21-0053-R>
142. Pham M, K Deng, TR Northen, SW Singer, PD Adams, BA Simmons, KL Sale Experimental and theoretical insights into the effects of pH on catalysis of bond-cleavage by the lignin peroxidase isozyme H8 from *Phanerochaete chrysosporium*. *Biotechnology for biofuels* 14 (1), 1-11
143. Y Ding, TR Northen, A Khalil, A Huffaker, EA Schmelz. Getting back to the grass roots: harnessing specialized metabolites for improved crop stress resilience. *Current Opinion in Biotechnology* 70, 174-186
144. Ing N, Deng K, Chen Y, Aulitto M, Gin JW, Pham TL, Petzold CJ, Singer SW, Bowen B, Sale KL, Simmons BA., Singh AK, Adams PD, Northen TR. A multiplexed nanostructure-initiator mass spectrometry (NIMS) assay for simultaneously detecting glycosyl hydrolase and lignin modifying enzyme activities. *Scientific reports.* 2021 Jun 3;11(1):1-9.
145. Brisson V. Phosphate Availability Modulates Root Exudate Composition and Rhizosphere Microbial Community in a Teosinte and a Modern Maize Cultivar. *Phytobiomes* (accepted)
146. Candice Swift, Katherine Louie, Benjamin Bowen, Casey Hooker, Kevin Solomon, Vasanth Singan, Chris Daum, Christa Pennacchio, Kerrie Barry, Shuttha Shutthanandan, James Evans, Igor Grigoriev, Trent Northen, and

Michelle O'Malley. Co-cultivation of anaerobic fungi with rumen bacteria establishes an antagonistic relationship. mBIO

147. Kristina E. Young 1* , Scott Ferrenberg 2 , Robin Reibold 3 , Sasha C. Reed 3 , Tami Swenson 4 , Trent Northen 4,5 , Anthony Darrouzet-Nardi 1 Vertical movement of soluble carbon and nutrients from biocrusts to subsurface mineral soils. Geoderma
148. Lauren K. Jabusch, Peter W. Kim * , Dawn Chiniquy, Zhiying Zhao, Bing Wang, Benjamin Bowen, Ashley J. Kang, Yasuo Yoshikuni, Adam M. Deutschbauer, Anup K. Singh, Trent R. Northen Microfabrication of a Chamber for High-Resolution, in-situ Imaging of the Whole Root for Plant-microbe Interactions. International Journal of Molecular Sciences. In press
149. Brisson V. Identification of effector metabolites using exometabolite profiling of diverse microalgae. mSystems (accepted)

PATENTS/PATENT APPLICATIONS:

1. **Northen, Trent R.** (Oakland, CA); Flagler, Robert W. (Pleasanton, CA); Ball, Alan D. (Somerville, MA); Schnakenberg, George H. F. III. (Cambridge, MA). Water Filter (2000). US Patent US D435,084
2. Flagler, Robert W. (Pleasanton, CA); **Northen, Trent R.** (Oakland, CA); Ball, Alan D. (Somerville, MA); Schnakenberg, George H. F. III. (Cambridge, MA). Water Filter Reservoir (2001). US Patent US D437,027
3. **Northen, Trent R.** (Oakland, CA). Insecticidal Microcrystalline Dry Aerosol Spray (2002). US Patent WO0223989.
4. **Northen, Trent R.** (Tempe, AZ); Woodbury, Neal Walter (Tempe, AZ). Microarray of Three-Dimensional Heteropolymer Microstructures and Method Therefor (2005). Full patent application PCT/US05/15764; U.S. provisional applications 60/569,370, 60/608,774, and 60/623,181 (2004)
5. **Northen, Trent R.** (Tempe, AZ); Greving, Matthew (Phoenix, AZ); Woodbury, Neal Walter (Tempe, AZ). 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). Full patent application No. 01231.0039P1
6. **Northen, Trent R.** (San Diego, CA); Nordström, Anders (La Jolla, CA); Siuzdak, Gary (La Jolla, CA). Nanostructure-Initiator Mass Spectrometry (2007). Application No. 11/852,863
7. Greving; Matthew P; Woodbury, Neal; **Northen, Trent R.** Porous Acrylate Copolymer Films and Uses Therefor 2008. US Patent 12/018,398
8. Leclerc, Marion; Bowen, Benjamin P.; **Northen, Trent R.** Provisional patent application: "NIMS Biometrics." Application No. 61/540,794 (2011)
9. **Northen, Trent R;** Reindl, Wolfgang E; Deng, Kai; Singh, Seema; Singh, Anup K. Multiplexed Screening of Enzyme Activities Using Nanostructure-initiator Mass Spectrometry. US Patent 13/363,695
10. **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. Application No. 14/651546
11. Leclerc, Marion; Bowen, Benjamin; **Northen, Trent R.** Nanostructure-Initiator Mass Spectrometry Biometrics. Application Nos. 13/631,687 & 61/540,794 & US Patent No. 9125596 &

12. Louie, Katherine; Bowen, Benjamin; **Northen, Trent R.** Use of Lipid Particles in Medical Diagnostics. Application Nos. 14/761587 & PCT/US2014/012790
13. **Northen, Trent R.**; Gao, Jian. The Application of Black Silicon for Nanostructured-Initiator Mass Spectrometry. Application No. 62/238589 and 62/286084
14. **Northen, Trent R.**; Deng, Kai. Determination of Ligninases Activities by Nano-structure Initiator Mass Spectrometry. Application No. 62/328,603
15. **Northen, Trent R.**; Reindl, Wolfgang; Deng, Kai; Singh, Seema; Singh, Anup. Colloid-based Multiplexed Screening for Glycoside Hydrolase Activities in Microbial Communities Using Nanostructure-Initiator Mass Spectrometry. Application No. 61/438,586
16. **Northen, Trent R.**; Bowen, Ben; Louie, Katherine; Hellerstein, Marc. Metabolic Flux Measurement, Imaging and Microscopy. Application Nos. 12830717.0 & 2014-529925 & 61/532,522 & 14/343,334 & PCT/US2012/054329
17. Duncombe, Todd; **Northen Trent**; Deng, Kai; Sing, Anup. Lanthanide-chelator combinatorial barcoding. US 62/344,803
18. De Raad, Markus; **Northen, Trent.** ARGO—method for determination of gene function. LBNL.071PR)
19. **Northen, Trent**; Heinemann Joshua. Detecting compounds in microfluidic droplets using mass spectrometry. US 62/347002. Heinemann, Joshua; **Northen, Trent.** Detecting compounds in microfluidic droplets using mass spectrometry. PCT/US2017/036192. Issued in 2019 as USPTO 10672601.
20. Gao, Jian; **Northen, Trent:** PCT/US2016/055536. Detection of analytes using porous mass spectrometry surface. Issued in 2019 USPTO 10600629
21. Erbilgin, Onur; **Northen, Trent**; Bowen, B. Methods for determination of gene function. 15/663,528
22. Gao, Jian; **Northen, Trent** Ecosystems for determining plant-microbial interactions. 62/490,548. Gao, Jian;
23. Andeer, Peter; **Northen; Trent.** ECOSYSTEM FOR DETERMINING PLANT-MICROBE INTERACTIONS. U.S. Patent Application No.: 15/963,887
24. Duncome, Todd; **Northen Trent.** Self-Assembled Nanoparticle Film for Nanostructure-Initiator Mass Spectrometry (NIMS). 62/448,947
25. Deng Kai, **Northen Trent.** Determination of Ligninase Activities by Nano-structure Initiator Mass Spectrometry. 15/499,769
26. Heller, Jens; Jabusch, Lauren; Kim, Peter; Northen, **Trent R.**; Glass, N. Louise DEVICES FOR STUDYING PLANT-FUNGUS INTERACTIONS AND FOR IMAGING PLANT ROOTS. 62/857,604
27. Ha, Noel; **Northen, Trent.** PICOLITER DROPLET SAMPLE PROCESSING AND DEPOSITION FOR MASS SPECTROMETRY. U.S. Provisional Patent Application No. 62/911,165. Filed: October 4, 2019
28. Andeer, P., Northen, T., Cornmesser, L. 2019-066-02 - draft patent application - ECOSYSTEM DEVICE FOR DETERMINING PLANT-MICROBE INTERACTIONS

BOOKS:

Trent R. Northen. 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 R. 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

Lubbe, Andrea and **Trent R. Northen**. Exometabolomics for Linking Soil Carbon Dynamics to Microbial Communities. Microbial Metabolomics: Applications in Clinical, Environmental, and Industrial Microbiology. Nature/Springer Press. Editors: Enzo Palombo, David Beale, and Konstaninos Kouremenos (2016)

Tami L. Swenson and **Trent R. Northen**. Untargeted Soil Metabolomics Methods. Microbial Metabolomics: Methods and Protocols. Methods in Molecular Biology, Springer Press. Editor Edward Baidoo (2019)

Zheyun Zhang, Jian Gao, Tami Swenson, Yasuo Yoshikuni, **Trent R. Northen**. Advancing our understanding of the chemistry of soil microbiomes. National Academy (2017).

Markus De Raad, **Trent Northen**, Benjamin Bowen. Analysis and interpretation of mass spectrometry imaging datasets, CAC Vol 82: Data Analysis for Omic Sciences: Methods and Applications. Elsevier press. Editors: Joaquim Jaumot, Romà Tauler, and Carmen Bedia (2018)

Pett-Ridge J, Shi S, Estera-Molina K, Nuccio E, Yuan M, Rijkers R, Swenson T, Zhalnina K, Northen T, Zhou J, Firestone MK. Rhizosphere carbon turnover from cradle to grave: the role of microbe–plant interactions. In Rhizosphere biology: interactions between microbes and plants 2021 (pp. 51-73). Springer, Singapore.

Katherine Louie, Suzie Kosina, Yuntao Hu, Hiroshi Otani, Markus de Raad, Andrea Kuftin, Nigel Mouncey, Benjamin Bowen and Trent Northen. Mass spectrometry for natural product discovery, Comprehensive Natural Products III: Chemistry and Biology. eBook ISBN: 9780081026915; Paperback ISBN: 9780081026908 Elsevier, Published Date: 22nd July 2020

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.

WORKSHOP REPORTS:

2016 EcoFAB workshop Report
2017 EcoFAB Summit Report
2018 Breaking the Bottleneck of Genomes
2021 EcoPOD workshop report

ORGANIZING COMMITTEES AND SESSION MODERATION:

- Organized a 2021 World Microbe Forum mini-conference

- Organized a 2020 conference with Jennifer Pett-Ridge for all BER-BSSD funded SFAs with 100 attendees
- Co-organizing ISME session at 2020 meeting
- Co-organizing AAAS session for 2020 meeting
- Co-organizing SIMB session for 2020 meeting
- Co-organized and hosted a Metabolomics Association of North America BootCamp on metabolomics data analysis. JGI. April 30th -May 1st 2019.
- 2018 DOE Breaking the Bottleneck of Genomes, Breakout Leader: Understanding Gene Functions Across Taxa. Bethesda MD, November 1-2, 2018.
- ASM Session co-chair: Architecture of Microbial Communities and Host microbe Interactions. Atlanta GA. June 11th 2018.
- 2018 EcoPOD workshop moderator June 12th 2018
- 2018 ASMS Session chair: Microorganisms and the Microbiome, San Diego CA. June 6th 2018
- 2018 Synbio-metabolomics workshop, JGI user meeting, San Francisco CA, March 14th 2018.
- 2018 AAAS Session Organizer: Advancing Health and Environmental Science Through Standardized Laboratory Microbial Ecosystems. Austin Texas, Feb. 17th 2018.
- 2017 Microbial and Plant Systems Modulated by Secondary Metabolites Conference. Organizing committee and session chair. Walnut Creek CA.
- 2017 EcoFAB Summit Chair, Washington DC
- 2017 JGI Metabolomics Workshop Organizer, Walnut Creek, CA
- 2016 EcoFAB workshop chair, Walnut Creek, CA
- 2015 Genomes to Secondary Metabolites (G2SM) workshop, Session Chair. Walnut creek, CA.
- 2015 metabolomics society international conference organizing committee. San Mateo, CA.
- 2015 Session Chair 13th Biennial Conference on the Colorado Plateau. Flagstaff, AZ

INTERVIEWS/ HIGHLIGHTS:

- AIChE Feature October 2020
<https://www.aiche.org/resources/publications/cep/2020/october/unraveling-plant-and-soil-microbiomes>
- Finding Genius Podcast: Living Earth: Studying the Microbial Community in Soil with Trent Northen <https://www.findinggeniuspodcast.com/podcasts/living-earth-studying-the-microbial-community-in-soil-with-trent-northen/>
- Interview Nature 24 SEPTEMBER 2019 “Microbial chemistry gains fresh focus-- The tools of chemical biology, genomics and data mining can yield insights into the metabolites of the microbiome.”
- Interview Nature Methods Engineers embrace microbiome messiness, Nature Methods volume 16, pages581–584 (2019)
- EcoFAB work featured in the Economist (Feb 20th 2020 edition).

- Nature JUNE 2019 A sticky solution could speed up drug discovery
- Tools of science interview
- Nimzyme feature in C&E News
- Trends in plant science review “Feed Your Friends: Do Plant Exudates Shape the Root Microbiome?” selected as one of the top reviews of 2017
- Highlight Nature Methods: The secret of NIMS. NATURE METHODS | VOL.4 NO.12 | DECEMBER 200724
- Highlight—Small scale hits the big time. 24 October 2007 | Nature | doi:10.1038/news.2007.193

INVITED REVIEWER: DOE ad hoc reviewer, DOD ad hoc reviewer, NSF ad hoc reviewer; Reviewer: Nature, Nature Methods, Nature Chemical Biology, Nature Microbiology, Nature Plants, Nature Communications, PNAS, Analytical chemistry, ISME, Metabolites, Marine Drugs, ChemBioChem. Angewante Chemie, PLOS One, Journal of the American Society for Mass Spectrometry, Rapid Communications in Mass Spectrometry, Molecular Biosystems and many more.

SELECTED INVITED LECTURES:

1. **Northen T.** “Surface Based Approaches to Mass Spectrometry.” Short Course on Mass Spectrometry, The Scripps Research Institute, La Jolla, CA. Jan 2008.
2. **Northen T.** “High Throughput Mass Spectrometry Based Metabolomic and Enzymatic Assays for Functional Genomics.” Genomes 2008, Institut Pasteur, Paris, France. April 8-11th 2008.
3. **Northen T.** “Nanostructure-Initiator Mass Spectrometry for Metabolomics and Enzyme Activity Profiling.” Plenary Lecture, American Society for Mass Spectrometry Annual Meeting, Denver, CO. June 1-6th 2008.
4. **Northen T.** “Gene Maps-MS: Gene Annotation Validation Through Metabolomics and Proteomics by Mass Spectrometry.” 16th Annual Microbial Genomics Meeting at Lake Arrowhead, CA. Sept 14-18th 2008.
5. **Northen T.** “High Throughput Metabolomics and Proteomics by Mass Spectrometry.” Annual DOE GTL Program Meeting, Washington D.C. Feb 8-11th 2009.
6. **Northen T.** “In Situ Metabolomic Imaging Mass Spectrometry.” Annual DOE Low-Dose Program Meeting, Washington D.C. April 5-8th 2009.
7. **Northen T.** “Functional Genomics Using Mass Spectrometry Based Metabolomics.” Joint Genome Institute, Walnut Creek, CA. Aug 27th 2009.
8. **Northen T.** “GeneMap-MS: Applications to Cellular Dynamics and Protein Annotation.” SRI, Stanford, CA. Sept 9th 2009.
9. **Northen T.** “Mass Spectrometry Based Metabolomics Approaches to Studying Cyanobacterial Metabolism.” LSD/Genomics Divisional Seminar, Berkeley, CA. Oct 6th 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 7th 2010.

11. **Northern T.** "Mass Spectrometric Based Metabolomics and Tissue Imaging for Characterization of Breast Tissues." UCSF, Integrated Cancer Center, San Francisco, CA. Feb 24th 2010.
12. **Northern T.** "Integrated Mass Spectrometry Based Metabolomic Profiling, Imaging, and High Throughput Assays." Bay Area Mass Spectrometry, San Francisco, CA. April 15th 2010.
13. **Northern T.** "Metabolite Profiling and Imaging." Plenary Seminar, Annual DOE Low-Dose Meeting, Washington D.C. April 14th 2010.
14. **Northern T.** "Resolving the Spatial Structure of Metabolites and Activities within the Biological Matrix." Institute of Systems Biology, Seattle, WA. May 21th 2010.
15. **Northern T.** "Mass Spectrometry Tools for Optimizing, Assembling, and Discovering New Parts." Synthetic Biology Institute, Berkeley, CA. June 22th, 2010.
16. **Northern T.** "Mass Spectrometry Based Metabolomics and Imaging." Computational Biology Training and Workshop, Berkeley, CA. Aug 12th 2010.
17. **Northern T.** "Mass Spectrometry Based Metabolomics and Imaging." University of California Davis, Davis, CA. Sept 14th 2010.
18. **Northern T.** "Identifying Drug Resistant Breast Cancer Using Metabolomics and Nanotechnology." Annual meeting of California Breast Cancer Program, Oakland, CA. September 25th 2010.
19. **Northern T.** "Imaging and Characterization of Small Molecules from Tissues and Crude Cell Lysates." Annual CoSMos Meeting, Portland, OR. September 28th 2010.
20. **Northern T.** "Resolving the Spatial Distribution of Metabolites and Activities within the Biological Matrix." University of California Berkeley Bioengineering Departmental Seminar, Berkeley, CA. October 20th 2010.
21. **Northern 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 12th 2010.
22. **Northern T.** "Spatio-Temporal Metabolic Turnover to Detect Drug Resistant Breast Cancers." Buck Institute, Novato, CA. February 4th 2011.
23. **Northern T.** "Accelerating Functional Genomics Using Metabolomics." Joint Genome Institute, Walnut Creek, CA. May 14th 2011.
24. **Northern T.** "Mass Spectrometry for Optimizing, Assembling, and Discovering New Parts." Synthetic Biology SB5.0, Stanford, CA. June 15th 2011.
25. **Northern T.** "Accelerating Functional Genomics Using Metabolomics." Synthetic Genomics Invited Lecture, San Diego, CA. August 25th 2011.
26. **Northern T.** "Improving Functional Annotations and Supporting Synthetic Biology Using MS Based Metabolite Profiling and Screening." Amyris Invited Lecture, Emeryville, CA. Sept 19th 2011.
27. **Northern T.** "Resolving Community and Metabolic Dynamics and Carbon Flux in Colorado Plateau Biological Soil Crusts." Northern Arizona University, Flagstaff, AZ. October 25th 2011.
28. **Northern T.** "Mass Spectrometry Based Metabolite Profiling and Imaging." Pacific Northwest National Laboratory Frontiers Lecture, PNNL, Richland, WA. November 4th 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, OR. March 9th 2012.
32. **Northen T.** "Metabolic Dynamics of Colorado Plateau Biological Soil Crusts." Canyonlands Symposium, Moab, UT. March 13th 2012.
33. **Northen T.** "Mass Spectrometry Based Metabolite Profiling and Imaging." Life Sciences Division, SRI International, Menlo Park, CA. April 27th 2012.
34. **Northen T.** "Carbon Cycling and Metabolic Dynamics of Biological Soil Crusts." LBNL CC2.0 Seminar, Berkeley, CA. August 16th 2012.
35. **Northen T.** "Mass Spectrometry Based Metabolite Profiling and Imaging." USDA, Albany, CA. September 5th 2012.
36. **Northen T.** "ENIGMA: Dissecting Microbial Metabolism in Communities." Biannual Microbial Genomics Conference, Lake Arrowhead, CA. September 19th 2012.
37. **Northen T.** "ENIGMA: Decoding Microbial Metabolism Using Metabolite Profiling." CSUMB, Monterey, CA. October 10th 2012.
38. **Northen T.** "Accelerating Functional Genomics." Chemical Engineering Departmental Seminar, Caltech, Pasadena, CA. Oct 25^h 2012.
39. **Northen T.** "Imaging Lipid Turnover in Tumors." UCSF Breast Oncology Program Scientific Retreat, San Francisco, CA. January 25^h 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 10th 2014.
46. **Northen T.** "Deconstructing Carbon Cycling in Soils Using Metabolomics." Montana State University, Bozeman, MT. April 21st 2014.
47. **Northen T.** "Soil Metabolomics Approach to Investigate Dissolved Organic Matter Recalcitrance Against Soil Bacteria." Goldschmidt, Sacramento, CA. June 10th 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 11th 2014.

49. **Northen T.** "Accelerating Functional Genomics Using Mass Spectrometry." Missouri S&T, Rolle, MO. Oct 13th 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 5th 2014.
51. **Northen T.** "Exometabolomic Analysis of Dissolved Organic Matter Composition and Bacterial Cycling." Lawrence Livermore National Lab, Department Seminar, Livermore, CA. Dec 4th 2014.
52. **Northen T.** "Investigation of Biological Soil Crust Metabolic Webs using Exometabolomics Analysis." AGU, San Francisco, CA. Dec 15th 2014.
53. **Northen T.** "Understanding Microbial Carbon Cycling in Soils Using Novel Metabolomics Approaches." DOE Genomic Sciences Contractors Meeting, Bethesda, MA. Feb 25th 2015.
54. **Northen T.** "Kinetic Mass Spectrometry Imaging." International Meeting of the Metabolomics Society, San Francisco, CA. June 29th 2015.
55. **Northen T.** "Rapid Screening and kinetic characterization of glycosyl hydrolase activities against native substrates." Davis CA, September 2nd, 2015.
56. **Northen T.** "Discovering Metabolic Webs in Biocrust Using Exometabolomics." 13th Biennial Conference on the Colorado Plateau, Flagstaff AZ, October 7th, 2015.
57. **Northen T.** "Microbes to Biomes." Monsanto Biologicals Meeting, San Diego CA, March 15nd, 2016.
58. **Northen T.** "Metabolomics for Functional Genomics." Joint Genome Institute User Meeting, Walnut Creek CA, March 22nd, 2016.
59. **Northen T.** "Deconstructing Enzyme Activities and Metabolite Exchange in Microbiomes." University of Wisconsin Biochemistry Departmental Seminar, Madison WI, April 25th, 2016.
60. **Northen T.** "Deconstructing the Connections between exogenous metabolites and microbiome structure." Carnegie Institution for Science, Department of Plant Biology Seminar, Stanford CA, June 3rd 2016.
61. **Northen T.** Plenary Lecture "Linking microbial community structure, activity and carbon cycling in Biocrust" Triennial International Biocrust Conference (Biocrust3), Moab, UT, October 2nd 2016.
62. **Northen T.** "Exometabolomics linking genomes with environments to understand how webs of microbes sustain biomes." National Academy of Sciences, Washington DC, September 20th 2016.
63. **Northen T.** Plenary Lecture "Linking microbial community structure, activity and carbon cycling in Biocrust" Triennial International Biocrust Conference (Biocrust3), Moab, UT, October 2nd 2016.
64. **Northen T.** "Discovering Metabolic Webs in Desert Biological Soil Crusts". Microbial Consortia Workshop. Santa Barbara, CA, March 17th 2017
65. **Northen T.** "Laboratory ecosystem fabrication for examination of plant-microbe interactions" Plant Microbiome Interaction Symposium. Walnut Creek, CA. April 21, 2017
66. **Northen T.** "Plant-microbe interactions driven by exometabolite preferences of rhizosphere bacteria", Plant Sciences Departmental Seminar, Davis CA, May 3rd 2017.
67. **Northen T.** "Exploring the dynamic reciprocity between environmental metabolites and microbiome structure" OSU microbiome forum, May 12th 2017

68. **Northern T.** Mechanistic examination of microbiome interactions using laboratory ecosystems. UCSB Chemical Engineering Departmental Seminar, Santa Barbara CA., Sept. 28th 2017.
69. **Northern T.** "Using metabolomics to decipher metabolic webs in microbiomes" School of Life Sciences Seminar, Arizona State University, Oct. 13th 2017.
70. **Northern T.** "High-Throughput Metabolite Analysis Using Mass Spectrometry Imaging", Stanford University Mass Spectrometry meeting, Stanford CA, Oct. 27th 2017.
71. **Northern T.** "Metabolomic investigations of microbial interactions and functional annotations", Pathway Tools Workshop, SRI, Feb 14th 2018.
72. **Northern T.** "Advancing Health and Environmental Science Through Standardized Laboratory Microbial Ecosystems", AAAS Annual Meeting, Austin Texas, February 17th 2018.
73. **Northern T.** "Feeding my friends: exometabolomic explorations of the hidden world of soil microbiomes", The Scripps Research Institute Metabolomics Symposium, La Jolla Ca. March 8th 2018.
74. **Northern T.** "Exometabolomics Linking Genomes with Environments to understand how Webs of Microbes Sustain Biomes", R. Brian Miller Symposium, Davis CA, March 15th 2018.
75. **Northern T.** "Metabolite imaging to shed light on microbial interactions in the environment", ASM Microbe, Atlanta GA, June 11th 2018.
76. **Northern T.** "Deconstructing Metabolic Webs of Microbiomes in Biological Soil Crusts", ASM Conference on Biofilms Washington DC, October 11th 2018.
77. **Northern T.** "Exometabolomic analysis reveals how soil metabolites shape soil microbiomes", Soil Microbiome Workshop UC Davis, October 16-17, 2018
78. **Northern T.** "Metabolomic investigations of microbial interactions and functional annotations", Pathway Tools Workshop, SRI, Feb 14th 2018.
79. **Northern T.** "Integration and Analysis Web of Microbes Exometabolite Data in the KBase Platform", KBase Session, 2019 Genomic Sciences Program Meeting Washington DC. February 25th 2019
80. **Northern T.** "Using fabricated ecosystems to study metabolic exchange in the rhizosphere", Switchgrass Microbiome Meeting, UC Berkeley, Berkeley CA. April 1st 2019 .
81. **Northern T.** "Using fabricated microbial ecosystems to study metabolite exchange within microbiomes", Stanford University, Stanford, CA. March 11th, 2019.
82. **Northern T.** "New strategies for assessing beneficial microbial interactions in the rhizosphere", Corteva Agriscience Webinar May 31st, 2019.
83. **Northern T.** "Metabolomic investigation of plant microbe interactions using fabricated ecosystems" Novozymes, Davis CA. June 5th, 2019
84. **Northern T.** "Exploring the chemistry of rhizosphere microbiomes using model ecosystems and metabolomics" Microbiome. Cold Spring Harbor NY, July 21st 2019.
85. **Northern T.** "Exploring the chemistry of microbiomes using laboratory communities" MERCK, Rahway, NJ July 21st, 2019
86. **Northern T.** "Deconstructing the metabolic webs of microbiomes within biological soil crusts". BER Advisory Committee Meeting. Bethesda MD, Oct . 25 2010
87. **Northern T.** "Investigation of rhizosphere interactions using ecosystem fabrication" NCSU, Raleigh NC, October 23rd, 2019
88. **Northern T.** "Feeding your friends: Do plant exudates shape the root microbiome?" NCSU, Raleigh NC, October 22nd, 2019

89. **Northen T.** “How exudates structure the rhizosphere” Plenary Talk, 3rd Annual IIGB Symposium, Riverside CA , October 4th 2019
90. **Northen T.** “EcoFABs: Advancing microbiome science through standardized fabricated ecosystems” NSF Deconstructing Microbiomes Workshop. Alexandria Virginia, December 10th 2019
91. **Northen T.** “Development of Fabricated Ecosystems to Investigate Beneficial Microbial Interactions” AAAS Annual Meeting, February 14th 2020. Seattle, Washington.
92. **Northen T.** “Laboratory Assessment of Microbial Community Engineering Approaches within Fabricated Ecosystems” Genomic Sciences Meeting, February 25th 2020 Washington DC.
93. **Northen T.** “Exploring the chemistry of microbiomes using mass spectrometry”. UCLA MIB Departmental Seminar, March 5th 2020, Los Angeles CA.
94. **Northen T.** “Exploring the chemistry of rhizosphere microbiomes using laboratory communities”. CFAM Seminar. September 10th 2020. Arizona State University, Tempe AZ.
95. **Northen T.** “Exploring metabolic interactions within the rhizosphere using mass spectrometry”. NIST Seminar. November 23rd 2020. Gaithersburg, MD.
96. **Northen T.** “New approaches for investigating plant-microbe interactions: collaborative opportunities at LBNL Part I”. Caltech, December 8th, 2020. Pasadena CA.
97. **Northen T.** “New approaches for investigating plant-microbe interactions: collaborative opportunities at LBNL Part II”. Caltech, February 1st, 2021. Pasadena CA.
98. **Northen T.** “Fabricated Ecosystems (EcoFABs) “. Microbiome technology workshop, Keynote. March 19th, 2021. University of California Berkeley. Berkeley, CA.
99. **Northen T.** “Deconstructing the Role of Exudate Chemistry in Selecting Beneficial Rhizosphere Microbes”. qBIO seminar. April 5th 2021. University of California San Diego. La Jolla, CA.
100. **Northen T.** “New strategies for assessing beneficial microbial interactions in the rhizosphere”. Biology Department Seminar, Wake Forest University, April 19th 2021. Winston-Salem, NC.
101. **Northen T.** “Examining microbial interactions in the rhizosphere using exometabolomics”. University of Tennessee Knoxville and Oak Ridge National Laboratory Joint Seminar. April 22nd 2021. Knoxville, TN.
102. **Northen T.** “Examining microbial interactions in the rhizosphere using exometabolomics”. Autonomous Discovery in Science and Engineering Workshop April 22nd 2021. Berkeley, CA.
103. **Northen T.** “Mechanistic Ecology Enabled Through Investigation of Simplified Microbial Communities”. World Microbe Forum. June 20th 2021. Virtual

EDUCATIONAL OUTREACH:

2020 and 2021 [Berkeley Lab Director's Apprenticeship Program](#) hosted 17 Bay Area high school students for its inaugural year. The curriculum was adapted to a virtual format and focused on an introduction. Students participated in independent take-home research projects on EcoFABs with guidance from Trent Northen, Pete Andeer, Yi Wang, and Lauren Jabusch.

ALBINA KHASANOVA, DOE OFFICE OF SCIENCE GRADUATE STUDENT RESEARCH (SCGSR)
PROGRAM PROJECT

MENTORED GEM FELLOW, ZOILA THE MISSION OF THE NATIONAL GEM CONSORTIUM IS TO
ENHANCE THE VALUE OF THE NATION'S HUMAN CAPITAL BY INCREASING THE PARTICIPATION
OF UNDERREPRESENTED GROUPS (AFRICAN AMERICANS, AMERICAN INDIANS, AND HISPANIC
AMERICANS) AT THE MASTER'S AND DOCTORAL LEVELS IN ENGINEERING AND SCIENCE.