

**Jason Raymond**  
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### Research Interests

The origin and evolution of life on earth; astrobiology and the possibilities for life elsewhere in the solar system/universe; biogeochemistry and 'weird metabolism' in extreme environments; comparative + evolutionary genomics and metagenomics/metatranscriptomics; microbial ecology; statistical and mathematical analysis of complex systems

### Academic Training

2000-2003 Ph.D. Chemistry, Arizona State University (*dissertation title: Genomic Analysis of Photosynthetic Bacteria and the Natural History of Nitrogen Fixation, primary advisor: Robert E. Blankenship*)  
2000 M.S. Physics (Mathematical Physics emphasis), California State University, Los Angeles  
1994-1998 B.S. Biophysics, B.A. Chemistry (*cum laude*), Southwestern Oklahoma State University

### Academic and Professional Positions Held

2011-Present Assistant Professor, School of Earth and Space Exploration, Arizona State University  
2007-2010 Assistant Professor, Environmental Systems, and Cognitive and Information Sciences, University of California, Merced  
2004-2007 E.O. Lawrence Postdoctoral Fellow, Lawrence Livermore National Laboratory (w/ Dr. Elbert Branscomb)  
2004 Postdoctoral research associate, Dept. of Chemistry and Biochemistry, Arizona State University (w/ Dr. Robert Blankenship)

### Successful Research Funding

**2015-2018:** CoI w/ Sara Walker (PI, ASU) **NASA Exobiology and Evolutionary Biology** "Multilevel Evolution of Chemical Reaction Networks"  
**2008-2011, 2012-14:** PI **NASA Exobiology and Evolutionary Biology** "The Molecular Basis of Complexity: Using Network Analysis to Understand Evolution"  
**2012-2014:** CoI w/ Brian Hedlund (PI, UNLV) **NASA Exobiology and Evolutionary Biology** "Exploration of biological dark matter in geothermal springs"  
**2007-2009:** CoI w/ Gary Suizdak (PI, Scripps Research Institute) **DOE Genomes to Life** "Gene Annotation Validation through Metabolomics and Proteomics by Mass Spectrometry"

- 2007: DOE Laboratory Sequencing Program:** “Connecting functional versatility and microbial diversity in a hypersaline microbial mat”, Jason Raymond PI (funding for metagenome sequencing)
- 2005:** Co-I w/ Everett L. Shock (PI; Arizona State), D’Arcy Meyer-Dombard (MIT), **DOE Microbial Genome Program**, “The First Metagenomic Tests of Geochemical Predictions in Hydrothermal Ecosystems” (funding for metagenome sequencing)
- 2004:** Co-PI w/ Donald A. Bryant (PI; Penn State), DOE Microbial Genome Program “Genome sequence analysis of seven strains of Chloroflexi: filamentous anoxygenic phototrophs” (funding for genome sequencing)

### **Selected professional honors**

- National Academy of Sciences Kavli Fellow (2009)
- ISSOL/International Astrobiology Society Stanley L. Miller Award (2008)
- LLNL Biosciences Directorate Gold Publication of the Year Award (2006)
- Who’s Who in America (2006-), Who’s Who in Science and Engineering (2007-)
- Ernest O. Lawrence Fellowship at Lawrence Livermore National Laboratory (2004-2007)
- ASU Chemistry Department Outstanding Graduate Research Assistant (2004)
- Harry S. Truman Postdoctoral Fellowship (Sandia National Labs, 2004; declined)
- ASU Chemistry Department Outstanding Teaching Assistant Award (2003)
- NASA Astrobiology Institute Director’s Scholarship (2002-3)
- NASA Space Grant (Summer 2002)
- NASA Astrobiology Institute Research Assistantship (2000-1)
- Gordon Research Conference in Photosynthesis Young Investigator (2002)
- 2002 NASA Astrobiology Conference 2<sup>nd</sup> Place poster
- ASU Regents Scholarship (2000-2003)

### **Selected invited talks/lectures**

- Conference on Complex Systems 2015 (Session: Origin of Life: A Problem for Complexity Science) September/October 2015
- ASU School of Earth and Space Exploration Colloquium Series September 9, 2015  
“The Solar Supercharge: Using Systems Biology to Reconstruct how the Invention of Photosynthesis Transformed the Biosphere”
- NASA Astrobiology Science Conference 2015 (Session: Phototrophic Life and Earth’s Redox Evolution)
- Makarere University and Kyambogo University (Kampala, Uganda) invited lecturer (April-May 2013; Fall 2013)
- ILASOL Israel Society for Astrobiology 26<sup>th</sup> Annual Meeting invited co-keynote speaker (2012)
- University of Otago (Dunedin, New Zealand) invited symposium speaker (2012)
- National Academy of Sciences 12<sup>th</sup> Annual Kavli Symposium invited speaker (2009)
- UIUC Institute for Genomic Biology Fellows Symposium keynote speaker (2009)
- 16<sup>th</sup> International Congress on Nitrogen Fixation invited speaker (2009)
- Astrobiology Science Conference plenary speaker (2008)

American Geophysical Union Fall meeting invited speaker (2007)  
Young Investigator Plenary Lecture, International Photosynthesis Congress,  
Montreal (2004)

**Professional and University Service** (Semester; developed new courses in red)

**Teaching Experience:** Habitable Worlds (S13, S15, F15), **Environmental Systems Biology (F12, F14)**, Introductory Geology (F11, S12, F13, S14), Microbiology (F09, F10), Introductory Biology (S08, S09, S10), Biophysical Chemistry (F02, F03)

**Professional Service:** Geobiology editorial board member (2014-present); BMC Evolutionary Biology associate editor (2007-present); Frontiers in Microbiological Chemistry associate editor (2011-present)

**Affiliations and University Service at Arizona State University (Spring 2011-present): Faculty Affiliate** in four programs: Chemistry and Biochemistry, Complex Adaptive Systems, Evolutionary Biology, and Microbiology  
**Committee service** including: Faculty Selection Committee member, Undergraduate Recruiting Sub-Committee member, Computing Committee member

**Program Affiliations while at University of California, Merced (Fall 2007-Fall 2010):** Faculty, Environmental Systems Graduate Group; Faculty, Quantitative & Systems Biology Program; Affiliate Faculty, Cognitive & Information Sciences; Member, Sierra Nevada Research Institute

**University Service while at UC Merced:** Quantitative and Systems Biology Executive Committee member and treasurer (2008-2013), School of Natural Sciences Curriculum Committee (2008-2010), Quantitative and Systems Biology Website Committee (2008-2010)

**Postdoctoral Fellows Supervised:** Dr. Wesley Swingley, Dr. Jordan Okie

**Graduate Students Supervised:** Eric Alsop (PhD, Summer 2014), Matthew Kellom (anticipated PhD Spring 2015), Heinz Falenski (2012)

**Graduate Student Committee membership:** SESE: Prajtkha Mane (chair), Steven Glaser, Audrey Horne, Samuelle Rochelle, Harrison Smith, Angel Garcia Jr. (chair), Kelsey Young; Ronna Mallios (UC Merced PhD 2010), Eric Lau (UC Merced MS 2010)

**Professional society membership:** Sigma Pi Sigma (Physics honor society), American Association for the Advancement of Science, American Geophysical Union

**Publications** (student/postdoc coauthors in red)

43. **Kellom, M.** and Raymond, J. (2015) Using dendritic heat maps to simultaneously display genotype divergence with phenotype divergence. *PLoS ONE*, in revision.
42. **Alsop, E.B.** and Raymond, J. (2015) Estimating Microbial Diversity and Abundances in Natural Communities: Reconciling Metagenomics and Environmental 16S Sequencing, *Advances in Bioinformatics*, in review.
41. Raymond, J. and **Alsop, E.** (2015) Microbial evolution in extreme environments:

- microbial migration, genomic highways, and geochemical barriers in hydrothermal ecosystems, *Environmental Systems Research*, 4: 14, doi 10.1186/s40068-015-0038-x.
40. Bailey, A.C., Kellom, M., Poret-Peterson, A.T., Noonan, K., Hartnett, H.E., Raymond, J. (2014) Draft Genome of *Massilia consociata* BSC265, Isolated from Biological Soil Crust of Moab, Utah. *Genome Ann*, 2(6), e01199-14.
  39. Bailey, A.C., Kellom, M., Poret-Peterson, A.T., Noonan, K., Hartnett, H.E., Raymond, J. (2014) Draft Genome of *Microvirgo* sp. BSC39, Isolated from Biological Soil Crust of Moab, Utah. *Genome Ann*, 2(6), e01197-14.
  38. Bailey, A.C., Kellom, M., Poret-Peterson, A.T., Noonan, K., Hartnett, H.E., Raymond, J. (2014) Draft Genome of *Bacillus subtilis* BSC154, Isolated from Biological Soil Crust of Moab, Utah. *Genome Ann*, 2(6), e01198-14.
  37. Raymond, J. and Kellom, M. (2014) Microbial Diversity Meets Environmental Dynamics: Metagenome Analyses of Natural Communities, *Microbial Evolution under Extreme Conditions*, in review.
  36. Alsop, E.B., Boyd, E.S., Raymond, J. (2014) Merging Metagenomics and Geochemistry Reveals Environmental Controls on Biological Diversity and Evolution. *BMC Ecology*, 14:16, doi:10.1186.
  35. Alsop, E.B. and Raymond, J. (2013) Resolving Prokaryotic Taxonomy without rRNA: Longer Oligonucleotide Word Lengths Improve Genome and Metagenome Taxonomic Classification. *PLoS One*, 8(7):e67337.
  34. Dodsworth, J.A., Blainey, P.C., Murugapiran, S.K., Swingley, W.D., Ross, C.A., Glavina, T., Tringe, S.G., Raymond, J., Quake, S.R., and Hedlund, B.P. (2013) Single-cell genomics and metagenomics suggests a fermentative, saccharolytic lifestyle for members of the OP9 lineage. *Nature Communications*, 4:1854, doi: 10.1038/ncomms2884.
  33. Swingley, W.D., Meyer-Dombard, D.R., Alsop, E.B., Falenski, H.D., Havig, J.R., Shock, E.L., Raymond, J. (2012) Coordinating environmental genomics and geochemistry reveals metabolic transitions in a hot spring ecosystem. *PLoS One*, 7(6):e38108.
  32. Meyer-Dombard, D.R., Swingley, W., Raymond, J., Shock, E.L., Summons, R.E. (2011) Hydrothermal ecotones and streamer biofilm communities in the Lower Geyser Basin, Yellowstone National Park. *Environmental Microbiology*, 8:2216-31.
  31. Havig, J.R., Raymond, J., Meyer-Dombard, D.R., Zolotova, N., Shock, E.L. (2011) Merging isotopes and community genomics in a siliceous sinter-depositing hot spring. *Journal of Geophysical Research*, 116:G01005.
  30. Raymond, J. (2009) The Role of Horizontal Gene Transfer in Photosynthesis, Oxygen Production, and Oxygen Tolerance. In: *Horizontal Gene Transfer: Genomes in Flux*, M.B. Gogarten, J.P. Gogarten, and L.C. Olendzenski eds., pp. 323-338.
  29. Wu, D., Raymond, J., Wu, M., Chatterji, S., Ren, Q., Graham, J.E., Bryant, D.A., Robb, F., Colman, A., Tallon, L.J., Badger, J.H., Madupu, R., Ward, N.L., Eisen, J.A. (2009) Complete Genome Sequence of the Aerobic CO-Oxidizing Thermophile Thermomicrobium roseum. *PLoS One*, 4:e4207.
  28. Swingley, W.D., Blankenship, R.E., and Raymond, J. (2009) Evolutionary Relationships Among Purple Photosynthetic Bacteria and the Origin of Proteobacterial Photosynthetic Systems. In: *The Purple Phototrophic Bacteria*, C.N. Hunter, F. Daldal, M.C. Thurnauer and J.T. Beatty eds., pp. 17-29.
  27. Raymond, J. (2008) Coloring in the tree of life. *Trends in Microbiology*, 16:41-43.
  26. Raymond, J. and Swingley, W.D. (2008) Phototroph Genomics: Ten Years On. *Photosynthesis Research*, 97:5-19.
  25. Northen, T.R., Lee, J.C., Hoang, L., Raymond, J., Hwang, D.R., Yannone, S.M., Wong, C.H., and Siuzdak, G. (2008) A nanostructure-initiator mass spectrometry-based enzyme

- activity assay. *Proceedings of the National Academy of Sciences*, 105:3678-83.
24. Sattley, W.M., Madigan, M.T., Swingley, W.D., Cheung, P.C., Clocksin, K.M., Conrad, A.L., Dejesa, L.C., Honchak, B.M., Jung, D.O., Karbach, L.E., Kurgdoglu, A., Lahiri, S., Mastrian, S.D., Page, L.E., Taylor, H.L., Wang, Z.T., Raymond, J., Chen, M., Blankenship, R.E., Touchman, J.W. (2008) The genome of *Heliobacterium modesticaldum*, a phototrophic representative of the Firmicutes containing the simplest photosynthetic apparatus. *Journal of Bacteriology*, 190:4687-96.
  23. Swingley W.D., Chen M., Cheung P.C., Conrad A.L., Dejesa L.C., Hao J., Honchak B.M., Karbach L.E., Kurdoglu A., Lahiri S, Mastrian S.D., Miyashita H., Page L.E., Ramakrishna P., Satoh S., Sattley W.M., Shimada Y., Taylor H.L., Tomo T., Tsuchiya T., Wang Z.T., Raymond J., Mimuro M., Blankenship R.E. and Touchman J.W. (2008) Niche adaptation and genome expansion in the chlorophyll d-producing cyanobacterium *Acaryochloris marina*. *Proceedings of the National Academy of Sciences*, 105: 2005-10.
  22. Swingley, W.D., Blankenship, R.E. and Raymond, J., (2008) Integrating Markov clustering and molecular phylogenetics to reconstruct the cyanobacterial species tree from conserved protein families. *Molecular Biology and Evolution*, 25:643-54.
  21. Swingley, W.D., Blankenship, R.E., and Raymond, J. (2008) Insights into cyanobacterial evolution from comparative genomics. In: *The Cyanobacteria: Molecular Biology, Genomics and Evolution*, A. Herrero and E. Flores eds., pp. 21-44.
  20. Raymond, J. and Blankenship, R.E. (2008) The Origin of the Oxygen Evolving Complex. *Coordination Chemistry Reviews*, 252: 377-383.
  19. Staples, C.R., Lahiri, S., Raymond, J., Von Herbulis, L., Mukhopadhyay, B., and Blankenship, R.E. (2007) The Expression and Association of Group IV Nitrogenase NifD and NifH hHomologs in the Non-Nitrogen Fixing Archaeon *Methanocaldococcus jannaschii*. *Journal of Bacteriology*, 189, 7392-8.
  18. Blankenship, R.E., Raymond, J., Staples, C., and Mukhopadhyay, B. (2007) Evolution of functional diversity in nitrogenase homologs. *Biological Nitrogen Fixation: Towards Poverty Alleviation through Sustainable Agriculture*, 42: 305-306.
  17. Blankenship, R.E., Sadekar, S., and Raymond, J. (2007) The Evolutionary Transition from Anoxygenic to Oxygenic Photosynthesis. In: Falkowski, P.G. and Knoll, A.H. (Eds.) *Evolution of Primary Producers in the Sea*, Elsevier, Amsterdam, pp. 22-37.
  16. Raymond, J. and Segré, D. (2006) The effect of oxygen on biochemical networks and the evolution of complex life. *Science*, 311, 1724-5.
  15. Mix, L.J., Armstrong, J., Mandell, A., Moiser, A., Raymond, J., Raymond, S., Steward, F., von Braun, K., and Zhaxybayeva, O. (2006) The Astrobiology Primer: An Outline of General Knowledge. *Astrobiology*, 6, 735-813.
  14. Sadekar, S., Raymond, J., and Blankenship, R.E. (2006) Conservation of Distantly Related Membrane Proteins: Photosynthetic Reaction Centers Share a Common Structural Core. *Molecular Biology and Evolution*, 23, 2001-7.
  13. Raymond, J. (2006) Oxygen and the evolution of complex life. *McGraw-Hill Encyclopedia of Science and Technology*. NY: McGraw-Hill.
  12. Raymond, J. and Blankenship, R.E. (2006) How did the Photosystem I Reaction Center Evolve? In: *Photosystem I: The Plastocyanin:Ferredoxin Oxidoreductase*. John H. Golbeck, Ed., Springer, Dordrecht, 669-682.
  11. Raymond, J. (2005) The Evolution of Biological Carbon and Nitrogen Cycling—a Genomic Perspective. *Reviews in Mineralogy & Geochemistry*, 59, 211-31.
  10. Raymond, J. and Blankenship, R.E. (2004) Biosynthetic Pathways, Gene Replacement and the Antiquity of Life. *Geobiology*, 2, 1472-4.
  9. Raymond, J., Siefert, J.L., Staples, C.R., and Blankenship, R.E. (2004) The Natural History of Nitrogen Fixation. *Molecular Biology and Evolution*, 21, 541-54.

8. Zhaxybayeva, O., Hamel, L., Raymond, J., and Gogarten, J.P. (2004) Visualization of Phylogenetic Content of Five Genomes with Dekapentagonal Maps. *Genome Biology*, **5**(3):R20.
7. Raymond J., and Blankenship, R.E. (2004) The evolutionary development of the protein complement of Photosystem II. *Biochimica et Biophysica Acta*, **1655**, 133-9. (R, IR)
6. Olson, J.M. and Raymond, J. (2003) The FMO-protein is related to PscA in the reaction center of green sulfur bacteria. *Photosynthesis Research*, **75**, 277-285.
5. Raymond, J. and Blankenship, R.E. (2003) Horizontal gene transfer in eukaryotic algal evolution. *Proceedings of the National Academy of Sciences*, **100**, 7419-7420.
4. Raymond, J., Zhaxybayeva, O., Gogarten, J.P., and Blankenship, R.E. (2003) Evolution of photosynthetic prokaryotes: a maximum likelihood mapping approach. *Philosophical Transactions of the Royal Society of London B*, **358**, 223-230.
3. Raymond, J., Zhaxybayeva, O., Gogarten, J.P., and Blankenship, R.E. (2002) Whole genome analysis of photosynthetic prokaryotes, *Science*, **298**, 1616-1620.
2. Blankenship, R.E., Raymond, J., Lince, M., Larkum, A.W.D., Jermiin, L.S., Lockhart, P.J., Zhaxybayeva, O., and Gogarten, J.P. (2001) Evolution of photosynthetic antennas and reaction centers. *Proceedings of the 12<sup>th</sup> International Congress of Photosynthesis*, CSIRO Publishing, Collingwood, Victoria, Australia.
1. Raymond, J. and Olson, J.M. (2001) Is FMO protein related to PscA in the reaction center of green sulfur bacteria? *Proceedings of the 12<sup>th</sup> International Congress of Photosynthesis*, CSIRO Publishing, Collingwood, Victoria, Australia.