Rachel J. Dutton, PhD

Assistant Professor
Section of Molecular Biology, Division of Biological Sciences
UC San Diego, La Jolla, CA
rachel.j.dutton@gmail.com

EDUCATION

Harvard Medical School — degree awarded: November 2010
Department of Microbiology and Molecular Genetics
Ph.D., Biological and Biomedical Sciences
Thesis Advisor: Dr. Jon Beckwith

University of California, San Diego — degree awarded: June 2002
Bachelor of Science, *cum laude*, Molecular Biology, with Distinction in Biology
GPA 3.75, Major GPA 3.92
Honors Thesis Advisor: Dr. Kit Pogliano

PROFESSIONAL POSITIONS

Assistant Professor, UCSD, Division of Biological Sciences, Section of Molecular Biology July 2015- present
My lab uses cheese as an experimentally tractable microbial community to understand the molecular mechanisms of species interactions across scales of biological organization, especially during pair-wise interactions, community assembly, and invasion. I aim to be a leader in the study of microbial communities, an exemplary mentor and educator, and an advocate of and participant in outreach efforts to the public and underrepresented groups in science.

Bauer Fellow, FAS Center for Systems Biology, Harvard University 2010-2015
As a Bauer Fellow, I led an independent research group focused on the development of a model system for the study of microbial communities based on cheese. We demonstrated that rind communities exhibit complex yet reproducible behaviors *in situ*, successfully cultured representatives of all major microbial groups, and developed a system for studying these behaviors *in vitro* (Wolfe *et al*, *Cell*, 2014). We identified extensive species interactions, reproducible patterns of community assembly, and biotic and abiotic factors shaping community composition. During this time, I directly supervised 3 postdoctoral fellows, 1 graduate student (visiting), 7 undergraduates, and 3 high school students.

RESEARCH

Graduate student, Department of Microbiology and Molecular Genetics, Harvard Medical School 2004-2010
Thesis: Vitamin K epoxide reductase homologues provide an alternative pathway for bacterial disulfide bond formation.
Disulfide bonds are key to the stability of secreted proteins. The Beckwith lab has performed extensive genetic analysis of disulfide bond formation in *Escherichia coli*. My interest in microbial diversity led me to analyze the collection of microbial genomes available at the time (> 400) in order to more completely characterize the presence of disulfide bond formation pathways across bacterial species. I identified an alternative pathway for disulfide bond formation in these bacteria, which was predicted to utilize a homolog of the warfarin (Coumadin)-sensitive blood coagulation enzyme from humans, vitamin K epoxide reductase (VKOR) (Dutton *et al*, 2008). My genetic characterization of this enzyme revealed that the *Mycobacterium tuberculosis* homolog was essential for growth of the pathogen, that the bacterial enzyme was sensitive to the human blood thinner warfarin, and that mycobacterial growth could be inhibited by warfarin and other anti-coagulants (Dutton *et al*, 2010). This work led to many new projects and collaborations, including the first crystal structure of a VKOR homolog (Li *et al*, 2010) and the development of a high-throughput screen for new antimicrobials based on inhibition of disulfide bond formation (Landeta *et al*, 2015).

Student, Microbial Diversity course, Marine Biological Laboratories, Woods Hole, MA Summer 2007
The MBL Microbial Diversity course was my first exposure to techniques involved in the study of microbial ecology. In additional to learning basic theory and experimental methods, I conducted an independent project investigating chemotaxis of species from marine sediment to potential carbon sources.

Staff Research Assistant, Department of Chemistry and Biochemistry, UCLA 2002-2004
Advisor: Dr. James Gober
My research involved the genetic and biochemical analysis of cell cycle-regulated assembly of the *Caulobacter crescentus* flagellum. I characterized protein-protein interactions that regulated the temporal activity of a bacterial transcription factor- the sigma-54 activator, FlbD.

Undergraduate Research Assistant, McNair Scholar, Division of Biology, UCSD 1999-2002
Honors Thesis: The diffusion barrier model: Evidence that SpoIIIE forms a diffusion barrier that contributes to compartmentalization of σ^F and σ^E during sporulation in *Bacillus subtilis.*
In Kit Pogliano's lab, my research involved genetic and cell biological methods to study the maintenance of compartmentalized sigma factor activity during the early stages of sporulation in *Bacillus subtilis*. As a first-generation college student from a low-income background, I was awarded a Ronald E. McNair Scholarship, which provided support for my research and preparation for graduate school.

PUBLICATIONS

As a Bauer fellow (Harvard):
1) Wolfe BE and **Dutton RJ**. Fermented Foods as Experimentally Tractable Microbial Ecosystems. Cell. Mar 26;161(1):49-55. (2015)
2) Bokulich N, Rideout JR, Patnode K, Ellett Z, McDonald D, Wolfe BE, Maurice CF, **Dutton RJ**, Turnbaugh PJ, Knight R, Caporaso JG. Extensible framework for taxonomy-classification optimization enhances short-amplicon marker-gene-sequence assignments. *In review*.
3) Wolfe BE, Button JE, Santarelli M, **Dutton RJ**. Cheese rind communities provide tractable systems for *in situ* and *in vitro* studies of microbial diversity. Cell. July 17;158,422-33. (2014)
4) David LA, Maurice CF, Gootenberg DB, Button JE, Ling A, Biddinger SB, **Dutton RJ**, Turnbaugh PJ. Diet rapidly and reproducibly alters the human gut microbiome. Nature. Jan 23;505(7484):559-63 (2014).
5) Wolfe BE, **Dutton RJ**. Towards an ecosystems approach to cheese microbiology. Book chapter: Cheese and Microbes. ASM Press and Microbiology Spectrum (2014)
6) Hsu CC, ElNaggar MS, Peng Y, Fang J, Sanchez LM, Mascuch SJ, Møller KA, Emad EK, Pikula J, Quinn RA, Zeng Y, Wolfe BE, **Dutton RJ**, Gerwick L, Zhang L, Liu X, Månsson M, Dorrestein PC. Real-time metabolomics on living microorganisms using ambient electrospray ionization flow-probe. Analytical chemistry. 85 (15), 7014-7018 (2013)
7) Button JE and **Dutton RJ**. Quick Guide to Cheese Microbes. Current Biology. Aug 7; 22(15):587-9. (2012)
8) **Dutton RJ** and Turnbaugh PJ. Taking a metagenomic view of human nutrition. Curr Opin Clin Nutr Metab Care. Sep;15(5):448-54. (2012)

As a graduate student (Harvard Medical School):
9) Landeta C, Blazyk JL, Hatahet F, Meehan BM, Eser M, Myrick A, Bronstain L, Minami S, Arnold H, Ke N, Rubin EJ, Furie BC, Furie B, Beckwith J, **Dutton RJ**, Boyd D. Compounds targeting disulfide bond forming enzyme DsbB of Gram-negative bacteria. Nat Chem Biol. Apr;11(4):292-8. (2015)
10) Chng SS, **Dutton RJ**, Denoncin K, Vertommen D, Collet JF, Kadokura H, Beckwith J. Overexpression of the rhodanese PspE, a single cysteine-containing protein, restores disulphide bond formation to an *Escherichia coli* strain lacking DsbA. Molecular Microbiology. 85 (5), 996-1006. (2012)
11) Cho SH, Parsonage D, Thurston C, **Dutton RJ**, Poole L, Collet JF, Beckwith J. A new family of membrane electron transporters and its substrates, including a new cell-envelope peroxiredoxin, reveal a broadened reductive capacity of the oxidative bacterial cell envelope. mBio April 3; 3(2) (2012)
12) Wang X, **Dutton RJ**, Beckwith J, Boyd D. Membrane topology and mutational analysis of *Mycobacterium tuberculosis* VKOR, a protein involved in disulfide bond formation and a homologue of human vitamin K epoxide reductase. Antioxid Redox Signal. Apr 15;14(8):1413-20. (2011)
13) Li WK, Schulman S, **Dutton RJ**, Boyd D, Beckwith J, Rapoport T. Structure of a bacterial homologue of vitamin K epoxide reductase. Nature. Jan 28;463: 507-12. (2010)

14) **Dutton RJ**, Wayman A, Wei JR, Rubin EJ, Beckwith J, Boyd D. Inhibition of bacterial disulfide bond formation by the anti-coagulant warfarin. PNAS. Jan 5;107(1):297-301. (2010)
15) Roeselers G, Newton IL, Woyke T, Auchtung TA, Dilly GF, **Dutton RJ**, Fisher MC, Fontanez KM, Lau E, Stewart FJ, Richardson PM, Barry KW, Saunders E, Detter JC, Wu D, Eisen JA, Cavanaugh CM. Complete genome sequence of *Candidatus Ruthia magnifica*. Stand Genomic Sci. Oct 27;3(2):163-73. (2010)
16) **Dutton RJ**, Boyd D, Berkmen M, Beckwith J. Bacterial species exhibit diversity in their mechanisms and capacity for disulfide bond formation. PNAS. Aug 19; 105 (33):11933-8. (2008)
17) Mac TT, Hacht AV, Hung KC, **Dutton RJ**, Boyd D, Bardwell JC, Ulmer TS. Insight into disulfide bond catalysis in *Chlamydia* from the structure and function of DsbH - a novel oxidoreductase. J Biol Chem. Jan 11; 283(2):824-32. (2008)
18) Newton ILG, Woyke T, Auchtung TJ, Dilly GF, **Dutton RJ,** Fisher MC, Fontanez KM, Lau E, Stewart FJ, Richardson PM, Barry KW, Saunders E, Detter JC, Wu D, Eisen JA, Cavanaugh CM. A window into hydrothermal vent endosymbioses: the *Calyptogena magnifica* chemoautotrophic symbiont genome. Science. Feb 16; 315 (5814):998-1000. (2007)

As a research assistant (UCLA):
19) Xu Z, **Dutton RJ**, Gober JW. Direct interaction of FliX and FlbD is required for their regulatory activity in *Caulobacter crescentus*. BMC Microbiol. May 2;11:89. (2011)
20) **Dutton RJ**, Xu Z, and Gober JW. Linking structural assembly to gene expression: A novel mechanism for regulating the activity of a sigma-54 transcription factor. Molecular Microbiology. Nov; 58(3);743-57. (2005)
21) Llewellyn M, **Dutton RJ**, Easter J, O'Donnol D, and Gober JW. The conserved flaF gene has a critical role in coupling flagellin translation and assembly in *Caulobacter crescentus*. Molecular Microbiology. Aug; 57(4);1127-42. (2005)

As an undergraduate (UCSD):
22) Liu NL, **Dutton RJ**, and Pogliano K. Evidence that the SpoIIIE DNA translocase participates in membrane fusion during cytokinesis and engulfment: a proposed role for proteinaceous channels in cytokinesis. Molecular Microbiology. Feb; 59 (4):1097-113. (2006)

MENTORING

2014-present	Kevin Bonham, postdoctoral fellow
2011-2014	Julie Button, postdoctoral fellow (currently Scientist at Seres Health)
2011-2014	Benjamin Wolfe, postdoctoral fellow (Assistant Professor at Tufts University)
2013-2014	Alex Smith, Harvard College senior thesis (co-advised with Richard Wrangham)
Spring 2012	Alyson Yee (Tufts undergraduate, currently a Fulbright Scholar)
2011	Marcela Santarelli (visiting graduate student, University of Parma, Italy)
2011- 2013	Undergraduate Summer Interns in Systems Biology. 2014: Daniel Rubin (Harvard College); 2013: Shanice Webster (Grinnell College) and Rajashree Mishra (UMBC, currently applying to graduate schools); 2012: Miriam Schiffman (Pomona, currently a Fulbright Scholar) and Juan Alvarez (UMBC); 2011: Adriann Negreros (Harvard)
2009	April Wayman, Summer Honors Undergraduate Research Program, Harvard Medical School

TEACHING

2012	**Project leader,** LS100r: Experimental research in the life sciences. I supervised a project on reconstructing microbial communities from cheese led by my two postdocs.
2010	**Teaching Fellow**, LS100r: Experimental research in the life sciences. I led a group of seven undergraduates through a research project focused on the study of cheese microbes. We cultured and identified bacteria and fungi from cheeses and tested species interactions.
2010-2013	**Invited lecturer**, Wellesley College, BISC209: Microbiology
2011	**Lecturer**, Science and Cooking: From Haute Cuisine to Soft Matter, Harvard.
2009	**Teaching Fellow,** Harvard Extension School, course: The Evolution of Microbes. Instructor: Chris Marx
2005	**Teaching Assistant,** Harvard Medical School, course: Molecular Biology- graduate level Taught weekly sections involving the critical analysis of primary literature in the field of molecular biology, held office hours, proctored and graded exams.

2001 **Teaching Assistant**, Division of Biology, UCSD, course: Bacteriology- undergraduate level
Taught weekly discussion sections, held office hours, assisted in preparation and proctoring of exams for an upper division course instructed by Drs. Kit Pogliano and Moselio Schaecter.

PROFESSIONAL DEVELOPMENT AND SERVICE

2013-2014 **Steering committee member**, American Academy of Microbiology colloquium on Cheese Microbiology

2013 **Participant,** Junior Faculty Leadership Training Course, Harvard Medical School. Workshop led by HFP Consulting to provide training in scientific leadership and management skills.

2009 **Participant** in the workshop, "Communicating Science: The Scientist as Citizen," led by New York Times science journalist Cornelia Dean.

2005-2009 **Organizing committee member**, Boston Bacterial Meeting. A two day conference, with talks and poster sessions by graduate students and postdocs. Attended by over 350 microbiologists from academic and industrial laboratories around New England.

2001-present **Member,** American Society for Microbiology

OUTREACH

Activities which promote participation of underrepresented groups in science:

2011-2014 Faculty mentor for students in the Summer Research Internship in Systems Biology at Harvard University. This program aims to provide research opportunities for students from groups underrepresented in science.

Activities which promote participation of women in science:

2014 Invited speaker for the National Symposium for the Advancement of Women in STEM

2014 Invited speaker for the Joan Wood Memorial lecture for women in science at Indiana University

Activities which promote broader participation in science (*e.g.* children, the public):

2006 Lecturer for Science in the News (SITN), Harvard Medical School. SITN is a graduate student-run organization that gives public lectures to explain scientific topics covered by the news media.

2008, 2009 Volunteer at the Harvard Holiday Science Lecture for children

2009 Organizer and Lecturer for "Multi-talented Microbes," a Harvard Microbial Sciences Initiative-sponsored outreach symposium. This symposium included lectures and interactive demonstrations that educated non-scientists about the importance of microbes in everyday life.

2009-present Instructor/Speaker "The Science of Cheese." I have given many lectures on the science of cheesemaking to broad audiences, including for the California Artisan Cheese Guild, American Cheese Society, Formaggio Kitchen, Cheese School of San Francisco, Murray's Cheese NYC.

2011, 2012 Invited speaker for the Life Sciences Education Outreach Program for high school teachers, Harvard

2012 Invited speaker for the Darwin Festival, Salem State University, MA

2012, 2013 Invited speaker for the Children's School of Science, Woods Hole, MA

2013 Invited speaker for the Experimental Cuisine Collective, NYU

2013 Invited speaker for the London Gastronomy Seminar series, London, UK

2013 Invited speaker for the World Science Festival, NYC

2014 Invited speaker for the American Society for Microbiology: "Microbes after hours" live broadcast

2015 Invited video lecture for use on the iBiology.org public website

INVITED TALKS

2015	**Fungal Genetics Conference***, Plenary lecture*, Asilomar, CA
2014	**Lake Arrowhead Conference on Microbial Genomics**
2014	**UMass Medical School**, Department of Biochemistry and Molecular Pharmacology
2014	**Indiana University***,* Joan Wood Memorial lecture and Department of Biology seminar
2013	**UT Southwestern,** Green Center for Systems Biology
2013	**New England Biolabs**
2013	**EMBO/EMBL Symposium, New Approaches and Concepts in Microbiology**
2013	**University of Vermont***,* Department of Microbiology and Molecular Genetics
2013	**Boston University,** Department of Biology, student-invited talk
2012	**Princeton University,** Lewis-Sigler Institute
2012	**Science of Artisanal Cheese conference**, Somerset, England
2012	**National Centers for Systems Biology Annual Conference,** Chicago
2012	**Cornell University***,* Department of Food Science
2011	**American Cheese Society Annual Conference,** Montreal
2011	**Harvard-Weizmann Institute Conference on Systems Biology**, Rehovot, Israel

HONORS

2014	"40 under 40," *Cell* magazine
2011	Bernard N. Fields Prize, Department of Microbiology and Molecular Genetics, Harvard Medical School.
2010-2015	Bauer Fellowship, Harvard University, FAS Center for Systems Biology
2010	Raymond W. Sarber award, American Society for Microbiology
2010	Distinction in Teaching, Harvard University
2009	Hauser Scholar Award for science communication, Harvard Medical School
2001-2002	UCSD Chancellor's Undergraduate Research Scholarship
2001	Phi Beta Kappa
2000-2001	Scholar, Ronald E. McNair Postbaccalaureate Achievement Program