

## Ming C. Hammond – Curriculum Vitae

### ACADEMIC APPOINTMENTS

Associate Professor University of Utah, Department of Chemistry, 2018-*current*

Assistant Professor University of California, Berkeley, Department of Chemistry and  
Department of Molecular & Cell Biology, 2009-2018

### OTHER AFFILIATIONS

Faculty Scientist, Biological Systems Engineering Division, Lawrence Berkeley National  
Laboratory (LBNL), 2011 – *current*

Faculty Affiliate, Henry Eyring Center for Cell and Genome Science (CCGS), 2018-*current*

Faculty Affiliate, California Institute for Quantitative Biosciences (QB3), 2009-2018

Faculty Affiliate, Synthetic Biology Institute (SBI), 2011-2018

Founding Co-PI, NIGMS Center for RNA Systems Biology (CRSB), 2012-2017

### EDUCATION AND TRAINING

California Institute of Technology, B.S. with Honors in Chemistry, 2000

University of California, Berkeley, HHMI Predoctoral Fellow, Ph.D., Chemistry, 2005

Yale University, BWF CASI Postdoctoral Fellow, Molecular Biology, 2005-2009

### HONORS AND AWARDS

Women in Science Award, Chau Hoi Shuen Foundation, 2016

New Innovator Award, National Institutes of Health, 2011

Regents' Junior Faculty Fellowship, UC Berkeley, 2011

Chevron Chair of Chemistry, 2010-2013

Thieme Chemistry Journal Award, 2010

Burroughs Wellcome Fund Career Award at the Scientific Interface, 2008-2015

Howard Hughes Medical Institute Predoctoral Fellowship, 2000-2005

National Science Foundation Graduate Fellowship, 2000 (declined)

Richard P. Schuster Memorial Prize in Chemistry, Caltech, 2000

Carnation Merit Award - full merit scholarship, Caltech, 1999-2000

Arie J. Haagen-Smit Memorial Award - Chemistry department award, Caltech, 1999

Beckman Scholar Fellowship, 1998-1999

Caltech Prize Award - full merit scholarship, 1998-1999

### PUBLICATIONS (corresponding authors are in bold)

36. Hallberg, Z. F.\*, Chan, C. H.\*, Wright, T. A., Kranzusch, P. J., Doxzen, K. W., Park, J. J.,  
**Bond, D. R., Hammond, M. C.** "Evolution of a cyclic dinucleotide signaling enzyme that  
specifically controls extracellular metal respiration" (2019) *In revision*.  
[www.biorxiv.org/content/10.1101/495150v1](http://www.biorxiv.org/content/10.1101/495150v1)

35. Villa, J. \*, Su, Y. \*, **Contreras, L. M., Hammond, M. C.** "Synthetic biology of small RNAs and  
riboswitches" in *Regulating with RNA in Bacteria and Archaea*, Ed. Gisela Storz, Ed. Kai  
Papenfert, ASM Press, 2019, 527-545. (*Invited Book Chapter*)

35. Dippel, A. B., Anderson, W. A., Evans, R. S., Deutsch, S., **Hammond, M. C.** "Luminescent  
biosensors for detection of second messenger cyclic di-GMP" *ACS Chem Biol* (2018) 13,  
1872-1879. (*Invited Paper*)

**Related Highlights:** "Sensors" special issue in honor of Roger Tsien; *Nat Chem Biol*  
research highlight; *JGI* science highlight

34. Truong, J., Hsieh, Y. F., Jia, G., **Hammond, M. C.** "Circular permutation strategies for  
engineering RNA-based fluorescent biosensors", *Methods* (2018) 143, 102-109. (*Invited  
Paper*)

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33. Villa, J. \*, Su, Y. \*, **Contreras, L. M., Hammond, M. C.** "Synthetic biology of small RNAs and riboswitches" *Microbiol Spectr* (2018) 6, doi: 10.1128/microbiolspec.RWR-0007-2017. (Invited Review)
32. Yeo, J., Dippel, A. B., Wang, X. C., **Hammond, M. C.** "In Vivo Biochemistry: Single-cell dynamics of cyclic di-GMP in *E. coli* in response to zinc overload" *Biochemistry* (2018) 57, 108-116. (Invited Paper)  
**Related Highlights:** "Future of Biochemistry" special issue
31. Yeo, J., Wang, X. C., **Hammond, M. C.** "Live flow cytometry analysis of c-di-GMP levels in single cell populations" *Methods Mol Biol* (2017) 1657, 111-130. (Invited Book Chapter)
30. Hallberg, Z. F., Su, Y., Kitto, R., **Hammond, M. C.** "Engineering and in vivo applications of riboswitches" *Annual Rev Biochem* (2017) 86, 515-539.
29. Bose, D. \*, Su, Y. \*, Marcus, A., Raulet, D. H., **Hammond, M. C.** "An RNA-based fluorescent biosensor for high-throughput analysis of the cGAS-cGAMP-STING pathway" *Cell Chem Biol* (2016) 23, 1539-1549.
28. Wang, X. C., Wilson, S. C., **Hammond, M. C.** "Next-generation RNA-based fluorescent biosensors enable anaerobic detection of cyclic di-GMP" *Nucleic Acids Res* (2016) 44, e139.
27. Su, Y., Hickey, S. F., Keyser, S. G. L., **Hammond, M. C.** "In vitro and in vivo enzyme activity screening via RNA-based fluorescent biosensors for S-adenosyl-L-homocysteine (SAH)" *J Am Chem Soc* (2016) 138, 7040-7047.
26. Hallberg, Z. F., Wang, X. C., Wright, T. A., Nan, B., Ad, O., Yeo, J., **Hammond, M. C.** "Hybrid promiscuous (Hypr) GGDEF enzymes produce cyclic AMP-GMP (3', 3'-cGAMP)" *Proc Natl Acad Sci* (2016) 113, 1790-1795.  
**Related Highlights:** Faculty of 1000 recommended article
25. Muller, R. Y., Hammond, M. C., Rio, D. C., **Lee, Y. J.** "An efficient method for electroporation of small interfering RNAs (siRNAs) into ENCODE Project Tier 1 GM12878 and K562 cell lines" *J Biomol Techniques* (2015) 26, 142-149.
24. Gonzalez, T. L., Liang, Y., Nguyen, B., Staskawicz, B. J., Loque, D., **Hammond, M. C.** "Tight regulation of plant immune responses by combining promoter and suicide exon elements" *Nucleic Acids Res* (2015) 43, 7152-7161.
23. Kellenberger, C. A., Sales-Lee, J., Pan, Y., Gassaway, M. M., Herr, A. E., **Hammond, M. C.** "A minimalist biosensor: quantitation of cyclic di-GMP using the conformational change of a riboswitch aptamer" *RNA Biol* (2015) 12, 1189-1197.
22. Kellenberger, C. A. \*, Chen, C. \*, Whiteley, A. T., Portnoy, D. A., **Hammond, M. C.** "RNA-based fluorescent biosensors for live cell imaging of second messenger cyclic di-AMP" *J Am Chem Soc* (2015) 137, 6432-6435.
21. Ren, A., Wang, X. C., Kellenberger, C. A., Rajashankar, J. R., Jones, R., **Hammond, M. C., Patel, D. J.** "Structural basis for molecular discrimination by a 3', 3'-cGAMP sensing riboswitch" *Cell Reports* (2015) 11, 1-12.
20. Kellenberger, C. A. \*, Wilson, S. C. \*, Hickey, S. F., Gonzalez, T. L., Su, Y., Hallberg, Z. F., Brewer, T. F., Iavarone, A. T., Carlson, H. K., Hsieh, Y. F., **Hammond, M. C.** "GEMM-I riboswitches from *Geobacter* sense the bacterial second messenger c-AMP-GMP" *Proc Natl Acad Sci* (2015) 112, 5383-5388.  
**Related Highlights:** 2015 Signaling Breakthroughs of the Year, *Science Signaling*
19. Kellenberger, C. A., Hallberg, Z. F., **Hammond, M. C.** "Live cell imaging using riboswitch-Spinach tRNA fusions as metabolite-sensing fluorescent biosensors" *Methods Mol Biol* (2015) 1316, 87-103. (Invited Book Chapter)
18. Kellenberger, C. A., **Hammond, M. C.** "In vitro analysis of riboswitch-Spinach aptamer fusions as metabolite-sensing fluorescent biosensors" *Methods Enz* (2015) 550, 147-172. (Invited Book Chapter)

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17. Pan, Y., Duncombe, T. A., Kellenberger, C. A., Hammond, M. C., **Herr, A. E.** "High-throughput electrophoretic mobility shift assays for quantitative analysis of molecular binding reactions" *Anal Chem* (2014) 86, 10357-10364.
16. Wilson, S. C., Cohen, D. T., **Hammond, M. C.** "A neutral pH thermal hydrolysis method for quantification of structured RNAs" *RNA* (2014) 20, 1153-1160.
15. Hickey, S. F., **Hammond, M. C.** "Structure-guided design of fluorescent S-adenosyl-methionine analogs for a high-throughput screen to target SAM-I riboswitch RNAs" *Chem Biol* (2014) 21, 345-356.
14. Sadhu, M. J., Guan, Q., Sales-Lee, J., Iavarone, A. T., Hammond, M. C., Cande, W. Z., **Rine, J.** "Nutritional control of epigenetic processes in yeast and human cells" *Genetics* (2013) 195, 831-844.
13. Diner, E. J., Burdette, D. L., Wilson, S. C., Monroe, K. M., Kellenberger, C. A., Hyodo, M., Hayakawa, Y., **Hammond, M. C., Vance, R. E.** "The innate immune DNA sensor cGAS produces a noncanonical cyclic dinucleotide that activates human STING" *Cell Rep* (2013) 3, 1355-1361.
12. Leppek, K., Schott, J., Reitter, S., Poetz, F., Hammond, M. C., **Stoecklin, G.** "Roquin promotes constitutive mRNA decay via a conserved class of stem-loop recognition motifs" *Cell* (2013) 153, 869-881.
11. Kellenberger, C. A., Wilson, S. C., Sales-Lee, J., **Hammond, M. C.** "RNA-based fluorescent biosensors for live cell imaging of second messengers cyclic di-GMP and cyclic AMP-GMP" *J Am Chem Soc* (2013) 135, 4906-4909.
10. Karns, K., Vogan, J. M., Qin, Q., Hickey, S. F., Wilson, S. C., **Hammond, M. C., Herr, A. E.** "Microfluidic screening of electrophoretic mobility shifts elucidates riboswitch binding function" *J Am Chem Soc* (2013) 135, 3136-3143.
9. Hickey, S. F., Sridhar, M., Westermann, A. J., Qin, Q., Vijayendra, P., Liou, G., **Hammond, M. C.** "Transgene regulation in plants by alternative splicing of a suicide exon" *Nucleic Acids Res* (2012), 40, 4701-10.  
**Related Highlights:** Featured Article (top 5%), *Nucleic Acids Res*
8. **Hammond, M. C.** "A tale of two riboswitches" *Nat Chem Biol* (2011), 7, 342-343.  
*(Commentary)*
7. Meyer, M. M., Hammond, M. C., Salinas, Y., Roth, A., Sudarsan, N., **Breaker, R. R.** "Challenges of ligand identification for riboswitch candidates" *RNA Biol* (2011), 8, 5-10.
6. Block, K. F., Hammond, M. C., **Breaker, R.R.** "Evidence for widespread gene control function by the *ydaO* riboswitch candidate" *J Bacteriol* (2010), 192, 3983-3989.
5. Hammond, M. C., Wachter, A., **Breaker, R. R.** "A plant 5S rRNA mimic regulates alternative splicing of transcription factor IIIA pre-mRNAs" *Nat Struct and Mol Biol* (2009), 16, 541-549.
4. Weinberg, Z., Regulski, E. E., Hammond, M. C., Barrick, J. E., Yao, Z., Ruzzo, W. L., **Breaker, R. R.** "The aptamer core of SAM-IV riboswitches mimics the ligand-binding site of SAM-I riboswitches" *RNA* (2008), 14, 822-828.
3. Hammond, M. C., **Bartlett, P. A.** "Synthesis of amino acid-derived cyclic acyl amidines for use in beta-strand peptidomimetics" *J Org Chem* (2007), 72, 3104-3107.
2. Hammond, M. C., Harris, B. Z.; Lim, W. A., **Bartlett, P. A.** "Beta-strand peptidomimetics as potent PDZ ligands" *Chem Biol* (2006), 13, 1247-1251.
1. Sudarsan, N.\*, Hammond, M. C.\*, Block, K. F., Welz, R., Barrick, J. E., Roth, A., **Breaker, R. R.** "Tandem riboswitch architectures exhibit complex gene control functions" *Science* (2006), 314, 300-304. **\*co-first authors**

### PATENTS AND PATENT APPLICATIONS

Hammond, M. C., Wright, T. A. "Methods of producing cyclic dinucleotides" US Pat Appl 62/438,126 (filed 2016)

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Hammond, M. C., Su, Y., Bose, D. "Fluorescent biosensor for 2', 3'-cGAMP" US Pat Appl 62/349,556 (filed 2016)

**Related Highlights:** Material transfer agreement to potential licensees  
Biosensor technology team endorsed for national I-CORPS program and \$50K grant

Hammond, M. C., Su, Y., Keyser, S. G. L., Hickey, S. F. "A fluorescent biosensor for high throughput screening of methyltransferase activity" US Pat Appl 62/246,953 (filed 2015)

**Related Highlights:** Material transfer agreement to potential licensees

Vance, R. E., Hammond, M. C., Burdette, D., Diner, E. J., Wilson, S. C. "Cyclic di-nucleotide induction of type I interferon" US Pat Appl 14/268,967 (filed 2014)

**Related Highlights:** Licensed, patent royalties to UC Berkeley

Hammond, M. C., Westermann, A. J., Qin, Q. "A P5SM suicide exon for regulating gene expression" U.S. Patent 13/747,395 (filed 2013)

Bartlett, P. A., Hammond, M. C. "Peptide beta-strand mimics based on pyridinones, pyrazinones, pyridazinones, and triazinones" US Pat Appl Publ (2005).

### **PROFESSIONAL ACTIVITIES**

-Peer reviewer for *Nature*, *Proceedings of the National Academy of Science*, *Journal of the American Chemical Society*, *Angewandte Chemie International Edition*, *ACS Central Science*, *Nucleic Acids Res*, *Chemical Communications*, *Nature Chemical Biology*, *ACS Chemical Biology*, *Cell Chemical Biology*, *Nature Chemistry*, *Nature Protocols*, *Biochemistry*, *RNA*, *RNA Biology*, *ACS Synthetic Biology*, *PLOS Comp Bio*, and *Scientific Reports* journals

-Grant proposal reviewer for the National Institutes of Health (Jan 2019- ad hoc, SBCA study section), National Science Foundation, Joint Genome Institute-LBNL, Houska Award (Austria), Biotechnology and Biological Sciences Research Council (BBSRC, UK)

-Session chair for "Technology innovations", 2019 Bacterial Locomotion and Signal Transduction Meeting; "Metabolism, small molecules, and signaling", 2016 Molecular Genetics of Bacteria and Phages Meeting; (co-chair) "Chemical approaches toward understanding and reprogramming RNA", Fall 2014 American Chemical Society National Meeting

### **Invited Talks and Lectures**

2020 (scheduled to date) – Sensory Transduction in Microorganisms Gordon Conference

2019 (scheduled to date) – Telluride Workshop on Aqueous Supramolecular Chemistry; Department of Pharmacy, University of Utah; "Targeting RNA with Drugs" session, American Chemical Society National Meeting; Bacterial Locomotion and Signal Transduction meeting (**session chair** on "Technology Innovations", speaker)

2018 – Center for Cell and Genome Science Symposium, University of Utah; Pfizer La Jolla; NYU-Nature Conference on Chemical Biology; Bioorganic Chemistry Gordon Conference; "Seeing is Believing" session, American Society of Microbiology; University of Minnesota; FNano – Foundations of Nanoscience Conference, Snowbird, Utah; "Discovery of Small Molecules Targeting RNA" session, American Chemical Society National Meeting

2017 – University of Michigan, Ann Arbor; University of Colorado, Boulder (**student-invited**); Joint Bioenergy Institute-LBNL; University of Utah (**Novartis Lecturer**); Biophysics of Nuclear Organization and Function, UC Berkeley (**plenary speaker**); Nucleosides, Nucleotides & Oligonucleotides Gordon Conference; Nucleic Acid Chemistry and Biology Symposium - Canadian Society for Chemistry 100<sup>th</sup> Anniversary Conference; NIH Chemistry-Biology Interface Symposium, University of Minnesota (**student-invited**); Chemical Tools for Complex Biological Systems, Janelia Research Campus; Predictive Crop Design: Genome-to-Phenome, University of Nebraska-Lincoln; RNA Nanotechnology Gordon Conference; International Conference on Biomolecular Engineering

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- 2016 – University of Maryland; NIH Lambda Lunch Meeting; Tufts University; Tri-Institutional Chemical Biology Symposium (**keynote speaker**); Molecular Genetics and Phages Meeting (**session chair**, speaker); Telluride Workshop on Nucleic Acid Chemistry; American Society for Microbiology Annual Meeting; University of Minnesota; Tufts University; Joint BioEnergy Institute
- 2015 – NIH High Risk-High Reward Research Symposium; IHÉS Conference on Cellular and Molecular Biotechnology; University of Wyoming; University of California, Davis; University of California, Berkeley; Young Academic Investigators Symposium, American Chemical Society National Meeting; Kyoto University; Chinese Academy of Medical Sciences, Institute of Pathogen Biology; Peking University; Golden Jubilee Chemistry Conference, Singapore; University of California, San Francisco; Stanford University; University of Chicago; University of Texas, Austin; California Institute of Technology; Princeton University; Yale University; Massachusetts Institute of Technology; Max Planck Institute of Molecular Physiology; RWTH Aachen University; John Innes Centre; MRC Laboratory of Molecular Biology; University of Wisconsin, Madison; University of California, San Diego; Scripps Research Institute; University of Pennsylvania; HHMI-Janelia Research Campus; University of Colorado, Boulder
- 2014 – Synthetic Biology Meets Organic Synthesis Conference; University of North Carolina; Duke University; “Chemical approaches toward understanding and reprogramming RNA”, American Chemical Society National Meeting (**session co-chair**, speaker); Symposium on Host-Microbe Systems Biology, University of Oregon; University of Illinois, Urbana-Champaign (**student-invited**); ACS Chemical Biology award symposium in honor of Peter Dervan, American Chemical Society National Meeting; Boston College; Brandeis University; University of California, Berkeley; University of Southern California
- 2013 – 2006: Colorado State University; National Cancer Institute; Joint BioEnergy Institute; German Cancer Research Center, Heidelberg, Germany; Goethe University, Institute for Molecular Biosciences, Frankfurt, Germany; Leopold Franzens University, Innsbruck Austria; International Synthetic Biology Workshop: A Bio-Based Future; Santa Clara University; University of California, Berkeley; University of California, Riverside; University of Southern California; University of California, San Diego; University of California, Berkeley; Tufts University; Columbia University; Bowdoin College; RNA Chemistry Meets Biology Conference, Lund University

**Other Conference Talks:** International Symposium on Nucleotide Second Messenger Signaling in Bacteria, Berlin, Germany (2018); International Symposium on c-di-GMP Signaling in Bacteria, Berlin, Germany (2015); Fluorescent Biomolecules and Their Building Blocks Conference (2014); American Chemical Society National Meeting (2013); Challenges in Chemical Biology Conference (2013); Bioorganic Chemistry Gordon Conference (2013); International Conference of RNA Nanotechnology and Therapeutics (2013); American Society of Biochemistry and Molecular Biology Annual Meeting, “RNA: processing, transport, and regulation” symposium (2009); Nucleic Acids Gordon Conference (2008)

### **FUNDING SUPPORT**

**Completed support:** Sole Principal Investigator on \$3.14M in grants obtained through the NIH (New Innovator), DOE (Community Science Program), foundations (Burroughs Wellcome Fund), industry (Synthetic Biology Institute-Agilent Technologies), and intramural awards. Co-PI on \$9.5M P50 grant to establish the NIGMS Center for RNA Systems Biology at UC Berkeley.

**Current support:** Sole PI on NIH R01 (2017-2021), Office of Naval Research (2017-2020), and NSF-BSF (2018-2021) grants, and sponsored research with Agilent Technologies. Lead PI on NSF Collaborative grant (2 PIs; 2017-2020).

### **COLLABORATIONS**

**Funded and/or published:** *Daniel R. Bond*, BioTechnology Institute, U Minnesota; *Sigal Ben-Yehuda*, Hebrew University of Jerusalem; *Samuel Deutsch*, Joint Genome Institute; *Amy E. Herr*,

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Bioengineering, UC Berkeley; *Dominique Loque*, Joint BioEnergy Institute-LBNL; *Beiyan Nan*, Biology, Texas A&M; *Dinshaw J. Patel*, Memorial Sloan-Kettering; *Daniel A. Portnoy*, Molecular & Cell Biology, UC Berkeley; *David H. Raulet*, Molecular & Cell Biology, UC Berkeley; *Jasper Rine*, Molecular & Cell Biology, UC Berkeley; *Donald C. Rio*, Molecular & Cell Biology, UC Berkeley; *Brian J. Staskawicz*, Plant & Microbial Biology, UC Berkeley; *Georg Stoecklin*, German Cancer Research Center; *Russell E. Vance*, Molecular & Cell Biology, UC Berkeley

**Other:** *Chris McKay*, NASA Ames; *Jean-Jacques Favier*, International Space University. Our plant synthetic biology experiment, the first to explore biomanufacturing using plants in space, launched on SpaceX Dragon 16 to the International Space Station on Dec 2018.

### UNIVERSITY SERVICE

**Department of Chemistry, Utah:** Chem Ed faculty search committee (2018-current); Chemistry Graduate Program admissions committee (2018-current); Biological Chemistry Graduate Program admissions committee (2018-current)

**Department of Chemistry, UC Berkeley:** Co-chair of organic chemistry seminar series (2010-2013); administrator of Andrew D. Dorsey Memorial Teaching Award (2014-2018); faculty advisor to undergraduate chemical biology majors (2010-2018); faculty advisor to chemical biology Ph.D. students (2013-current); service on first-year report committees, qualifying exam committees, master's and Ph.D. thesis committees (2009-current)

**Department of Molecular & Cell Biology, UC Berkeley:** Interviewer for MCB graduate program (2010-2017); service on qualifying exam committees and Ph.D. thesis committees (2009-current)

**Other:** Search committee for Director of Biological Systems and Engineering (BSE) division, LBNL (2015); Agilent equipment committee for Synthetic Biology Institute (2012); service on qualifying exam for Plant & Microbial Biology and Comparative Biochemistry Ph.D. programs

### TEACHING

Chemistry 3BL, Organic Chemistry Laboratory  
Chemistry C96, Introduction to Research and Study in the College of Chemistry  
Chemistry 115, Organic Chemistry – Advanced Laboratory Methods  
Chemistry 135, Chemical Biology (undergraduate lecture)  
Chemistry 114, Advanced Chemical Biology (undergraduate lecture; new/pilot course)  
Chemistry 271 / Molecular and Cell Biology 212, Chemical Biology (graduate lecture)  
Molecular and Cell Biology 290, Graduate Seminar  
Molecular and Cell Biology 293C, Ethics Discussion Section  
Chemistry 5750, Advanced Chemical Biology Laboratory

### MENTORING, SUPERVISION, OUTREACH

I have mentored and trained 20 undergraduate, 13 graduate, and 5 postdoctoral researchers in my group to date. My graduate students have obtained national fellowships (NDSEG, NSF) and other competitive research awards (UC Cancer Research Coord Comm) and have given talks at international conferences (2013 RNA Society, 2014 and 2015 JGI Annual Mtg, 2015 Nucleosides, Nucleotides, and Oligonucleotides Gordon Conference, 2015 Plant Biology, 2017 ASM Microbe). Of the four Ph.D. graduates from my lab, two performed postdoctoral training (one received an individual NRSA fellowship), one joined a biotech start-up as R&D Director, and another joined a management consultant firm. Two postdoctoral scholars obtained academic positions as assistant professors (Loyola University, New Orleans and Duy Tan University, Vietnam). **Outreach:** I have served as faculty research mentor for undergraduates in CalTeach, Amgen Scholar, and NIH Bridges to Baccalaureate summer programs; keynote speaker for Berkeley Expanding Your Horizons conference; interviewer and recruiter for NSF-Berkeley Edge program; selection committee member for Amgen Scholar program; and founder of YouSTEM.org, an NIH- and NSF-supported web resource for the general public to find information about free K-12 STEM programs in the SF Bay Area.