

John P. McCutcheon
Investigator, Howard Hughes Medical Institute
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Education:

2006 Ph.D., Computational Biology, Washington University in St. Louis
2000 M.S., Human Genetics, University of Utah
1996 B.S., Biochemistry, University of Wisconsin–Madison

Academic appointments:

2022-present Investigator, Howard Hughes Medical Institute
2020-present Associate Director, Biodesign Center for Mechanisms of Evolution, Arizona State University
2020-present Professor, School of Life Sciences, Arizona State University
2018 Visiting Associate, Division of Biology and Biological Engineering, California Institute of Technology
2016-2020 Associate Professor, Division of Biological Sciences, University of Montana
2010-2016 Assistant Professor, Division of Biological Sciences, University of Montana

Honors and fellowships:

2021 Fellow, American Academy of Microbiology
2020 Fellow, American Association for the Advancement of Science
2019 Presidential Early Career Award for Scientists and Engineers (PECASE)
2014-2017 Fellow, Canadian Institute for Advanced Research (CIFAR), Integrated Microbial Biodiversity Program
2012-2014 Associate Member, Canadian Institute for Advanced Research (CIFAR), Integrated Microbial Biodiversity Program
2006-2010 Postdoctoral Excellence in Research and Teaching (PERT) Fellowship, NIH Division of Minority Opportunities in Research, University of Arizona
1996 Mary Shrine Peterson Undergraduate Research Award, Department of Biochemistry, University of Wisconsin

Professional service:

2024 External Reviewer, Virginia Tech Biological Sciences Department
2023 Co-organizer, EMBO | EMBL Symposium, *The cellular mechanics of symbiosis*, 8-11 March 2023, Heidelberg, Germany
2023-2024 Reviewing Editor, *eLife*
2021-2023 Treasurer, Society for Molecular Biology & Evolution
2020-2025 External Advisory Board, University of Illinois NSF Biology Integration Institute on the Genomics and Eco-evolution of Multi-scale Symbioses
2018-present Advisory Board, *Current Biology*
2018-2021 External Advisory Committee, University of Hawaii NIH Center for Biomedical Research Excellence on Environmental Microbiomes and Human Health
2015-2016 Chair, Division R of the American Society for Microbiology
2014 Co-organizer, National Academy of Sciences Sackler Colloquium *Symbiosis Becoming Permanent*, 15-17 October 2014, Irvine, California

2014-2015 Chair-Elect, Division R of the American Society for Microbiology
2014, 2015 Top Reviewer for *Molecular Ecology*
2013-2018 Associate Editor, *Genome Biology and Evolution*

NSF panelist for Division of Environmental Biology and Integrative Organismal Systems, multiple years

NIH panelist for the Genome Variation and Evolution study section (2015)

Ad hoc grant reviewer for: National Science Foundation, The Royal Society, Natural Science and Engineering Research Council of Canada, Netherlands Organisation for Scientific Research, Royal Society of New Zealand, Israel Science Foundation, M. J. Murdock Charitable Trust, among others.

Reviewer for articles submitted to: *Cell*, *Current Biology*, *eLife*, *Environmental Microbiology*, *Genome Biology and Evolution*, *ISME J*, *Molecular Biology and Evolution*, *Molecular Ecology*, *Molecular Microbiology*, *Nature*, *Nature Microbiology*, *Nature Reviews Genetics*, *Nucleic Acids Research*, *PLoS Genetics*, *Proceedings of the National Academy of Sciences USA*, *Science*, *Trends in Ecology and Evolution*, *Trends in Genetics*, among others.

Invited talks, conference presentations, etc. (only 2010 to present are listed):

2025 Washington University in St. Louis; Brown University; MRC Laboratory of Molecular Biology, Cambridge, UK; University of North Carolina at Chapel Hill

2024 Stanford University; Harvard University; University of Wisconsin-Madison; Oregon State University; American Academy of Microbiology Colloquium on Early Microbial Life, Washington, DC; California Institute of Technology

2023 Max Planck Institute for Biology, Tübingen, Germany; University of Illinois Urbana-Champaign; University of Idaho; Maynard and Suzanne Goldman Endowed Lectureship, Marine Biological Laboratory, Woods Hole, MA; University of Arizona

2022 University of Pittsburgh; University of Colorado Boulder; Microbial Diversity course, Woods Hole, MA (online remote); Company of Biologists workshop on Bridging Comparative Genomics and Cell Biology, East Sussex, UK

2021 American Association for the Advancement of Science annual meeting (online remote); University of Maryland (online remote); University of Alberta, Canada (online remote); Cold Spring Harbor Laboratory Meeting on Cellular Dynamics & Models (online remote); ERATO Evolving Symbiosis Project International Seminar Series, National Institute of Advanced Industrial Science and Technology, Japan (online remote); Keynote address, Turkish Ecology and Evolutionary Biology Symposium (online remote); University of Iowa (online remote); University of Melbourne, Australia (online remote)

2020 Arizona State University; University of Texas at Austin; Cornell University; Max Planck Institute for Evolutionary Biology, Plön, Germany (online remote); University of Pennsylvania (online remote); Integrative Organismal Systems (IOS) CAREER Awardee Meeting, National Science Foundation (online remote); American Society for Cell Biology/EMBO (virtual) annual meeting

2019 University of Utah; Keynote address, Joint Genome Institute Symposium on New Lineages of Life, San Francisco, CA; University of North Carolina; University of Connecticut; Max Planck Institute for Chemical Ecology, Jena, Germany; MRC Laboratory of Molecular Biology, Cambridge, UK; Keynote address, Gordon Research Seminar on Animal-Microbe Symbiosis, Dover, VT; International Geobiology Course, California Institute of Technology; NIH NIAID Rocky Mountain Laboratories Symposium on the Bacterial Cell Envelope, Hamilton, MT; University of British Columbia; University of California San Francisco; Dalhousie University (student invited, online remote)

2018 INRA-CBGP, Montpellier, France; Institut de Ciències del Mar, CSIC, Barcelona, Spain; Instituto Gulbenkian de Ciência, Lisbon, Portugal; University of Exeter, UK; University of Groningen Research School of Ecology and Evolution, Frontiers in Microbial Ecology Graduate Course, Schiermonnikoog, Netherlands; HHMI/Janelia conference on New Opportunities to Study Origins of the Eukaryotic Cell, Ashburn, VA; Society for Molecular Biology and Evolution satellite meeting on Molecular Evolution and the Cell, Deer Valley, UT; University of Georgia; University of Arizona; University of Washington

2017 Biology Centre of the Czech Academy of Sciences, České Budějovice, Czech Republic; Keynote address, Montana State Science Fair, Missoula, MT; Symposium of the Microbial Diversity course, Woods Hole, MA; EMBO Workshop on comparative genomics of eukaryotic microbes, Sant Feliu de Guíxols, Spain; MRC Laboratory of Molecular Biology, Cambridge, UK; Johannes Gutenberg University Mainz, Germany; University of Edinburgh, UK

2016 Universidad de Chile; Stanford University; Ohio State University; Montana State University; Institut de Biología Evolutiva, Barcelona, Spain; Genomics Days at the Université de Lausanne, Switzerland; California Institute of Technology; Colorado State University; Washington University in St. Louis (student invited); Oxford University, England

2015 National Institutes of Health Rocky Mountain Laboratories; University of Missouri; Washington University in St. Louis; Uppsala University, Sweden; Entomological Society of America Pacific Branch Annual Meeting; Duke University; American Society for Microbiology Annual Meeting; Gordon Research Conference on Animal-Microbe Symbioses

2014 Montana State University; Ohio State University; University of Washington; California Institute of Technology; Utah State University; National Academy of Sciences Sackler Colloquium *Symbiosis Becoming Permanent*; Reed College

2013 University of Utah; Georgia Institute of Technology; University of Miami; Drexel University; Canadian Institute For Advanced Research (CIFAR) Annual Meeting, Whistler, Canada; Society for Molecular Biology and Evolution Annual Meeting, Chicago, Illinois; The 12th International Colloquium on Endocytobiology and Symbiosis, Halifax, Canada; Indiana University; University of Illinois at Urbana-Champaign

2012 Portland State University; Canadian Institute For Advanced Research (CIFAR) Annual Meeting, Quebec, Canada; University of Arizona

2011 Society for General Microbiology Spring Conference, Harrogate, England; Emory University; Vanderbilt University; University of British Columbia

2010 University of Arizona NSF-IGERT Program in Comparative Genomics Symposium; Montana State University; Kansas State University; University of Montana; University of California, Riverside; Entomological Society of America Annual Meeting

Teaching:

2024, 2025	Instructor, <i>Biology of Microorganisms</i> , MIC 220, Arizona State University
2021	Instructor, <i>Biology of Microorganisms</i> , MIC 220, Arizona State University
2020	Instructor, <i>SEA-PHAGES</i> , BIO 498, Arizona State University
2019, 2020	Instructor, <i>Diversity of Life</i> , BIOB 170, University of Montana
2013-2015	Instructor, <i>Programming for Biology</i> , BIOB 487, University of Montana
2012-2019	Instructor, <i>Genomics</i> , BIOB 486, University of Montana
2011, 2012	Instructor, <i>Microbial Div., Ecol., Evol.</i> , BIOM 415, University of Montana
2011	Instructor, <i>Microbial Genomics</i> , University of Montana
2008	Instructor, <i>Microbiology</i> , Pima Community College, Tucson, AZ

Postdoctoral trainees

2023-	Justus Nwachukwu
2023-	Dalton Leprich
2022-	Adam Carte (joint with Norbert Perrimon at Harvard Medical School)
2021-	Jessica Warren (HHMI Hanna H. Gray Fellow)
2021-2022	Zerrin Üzüm Last known position: Lab Manager, Imaging Core at ASU
2017-2022	Maria Kupper Last known position: Scientist, Azena Life Sciences
2016-2020	DeAnna Bublitz Last known position: Scientific Review Officer, NIH
2015-2017	Stephanie Ray Weldon (NASA Postdoctoral Program Fellow) Last known position: Sr. Research Program Manager, Ragon Institute of MGH, MIT and Harvard
2014-2018	Piotr Łukasik Last known position: Assistant Professor, Jagiellonian University
2012-2017	Toby Spribille Last known position: Associate Professor, University of Alberta
2011-2013	Amada Brown Last known position: Associate Professor, Texas Tech University

Graduate Students

2025-	Veronica Muller (Evolution PhD program, Arizona State University)
2024-	Utsav Tatu (Biology PhD program, Arizona State University)
2021-2024 MS, 2024	Stephanie Temnyk <i>And only four remain: functionally characterizing the peptidoglycan-related genes in flowering plants</i> Last known position: Molecular Biologist, Corteva Agriscience
2021-	Noah Spencer (NSF Graduate Research Fellow, Evolution PhD program, Arizona State University)
2021-2022 MS, 2022	Amanda Abdelsamad <i>How endosymbionts evade the endocytic pathway</i> Last known position: Medical school
2020-2025	Arkadiy Garber (Microbiology PhD program, Arizona State University)
2015-2017 MS, 2017	Tim Wheeler <i>Multilocus phylogeny of the lichen family Megasporaceae</i> Last known position: Research Scientist, University of Montana
2013-2018 PhD, 2018	Dan Vanderpool (NSF Graduate Research Fellow) <i>Evolution and reproduction in ambrosia beetle fungal symbionts</i> Last known position: Scientist, USFS Rocky Mountain Research Station

2012-2018 PhD, 2018	Matt Campbell <i>Breaking down a genome: Degenerative genome evolution in the cicada endosymbiont Hodgkinia</i> Last known position: Scientist, New England Biolabs
2012-2017 PhD, 2017	Filip Husník (joint with the University of South Bohemia) <i>Genomic and cellular integration in the tripartite nested mealybug symbiosis</i> Last known position: Assistant Professor, Okinawa Institute of Science and Technology
2010-2015 PhD, 2015	James Van Leuven <i>The evolution of nutritional co-endosymbionts in cicadas</i> Last known position: Assistant Professor, University of Idaho

Funding:

2023-2028	Co-PI, <i>Engine of Innovation: How compartmentalization drives evolution of novelty and efficiency across scales</i> NASA Interdisciplinary Consortia for Astrobiology Research (ICAR) Program
2016-2022	PI, <i>How does a bacterium become part of its host cell?</i> Gordon and Betty Moore Foundation
2016-2022	PI, <i>CAREER: Evolution of genomic complexity in the endosymbionts of cicadas.</i> NSF Integrative Organismal Systems
2015-2016	Co-PI, <i>The ecological genomics of symbiotic complexity in cicadas.</i> National Geographic Explorer Travel Grant
2014-2019	Co-PI, <i>Experimental evolution of major transitions in the history of life.</i> NASA Astrobiology Institute
2013-2016	PI, <i>Functional transitions in an insect-bacteria symbiosis.</i> NSF Integrative Organismal Systems
2014-2016	Co-PI, <i>Establishing a genomics core at the University of Montana.</i> M.J. Murdock Charitable Trust
2011-2014	Co-PI, <i>The adaptive potential of an introduced symbiosis: Megacopta cribraria and its bacteria.</i> USDA Agriculture and Food Research Initiative

Publications:

62. Warren JM, Prasad KSVK, Mendez AM, Temnyk S, McCutcheon JP. 2025. Expression of four mitochondrial tRNAs from only two loci. *bioRxiv*, doi.org/10.1101/2025.11.12.688142.
61. Friar L, Keepers K, Garber AI, McCutcheon JP, Wing B, Kane N. 2025. Selection maintains photosynthesis in a symbiotic cyanobacterium despite redundancy with its fern host. *Mol Biol Evol* 42:1-15.
60. Mongue AJ, Woodman T, Marshall HS, Garber A, Franco JC, McCutcheon JP, Ross R. (2025) Paternal genome elimination creates contrasting evolutionary trajectories in male and female citrus mealybugs. *Mol Ecol*, 34:e17826..
59. McCutcheon JP, Garber A, Spencer N, Warren JM. (2024) How do bacterial endosymbionts work with so few genes? *PLOS Biol* 22:e3002577.
58. Garber AI, Molina AGF, Vea I, Mongue AJ, Ross L, McCutcheon JP. (2024) Retention of an endosymbiont for the production of a single molecule. *Genome Biol Evol* 16:evae075.

57. Spencer N, Łukasik P, Meyer M, Veloso C, McCutcheon JP. (2023) No transcriptional compensation for extreme gene dosage imbalance in fragmented bacterial endosymbionts of cicadas. *Genome Biol Evol* 15:evad100.

56. Syberg-Olsen MJ, Garber AI, Keeling PJ, McCutcheon JP, Husnik F. (2022) Pseudofinder: detection of pseudogenes in prokaryotic genomes. *Mol Biol Evol* 39:msac153.

55. Resl P, Bujold AR, Tagirdzhanova G, Meidl P, Rallo SF, Kono M, Fernández-Brime S, Guðmundsson H, Andrésson OS, Muggia L, Mayrhofer H, McCutcheon JP, Wedin M, Werth S, Willis LS, Spribille T. (2022) Large differences in carbohydrate degradation and transport potential in the genomes of lichen fungal symbionts. *Nat Commun* 13:2634.

54. McCutcheon JP. (2021) The genomics and cell biology of host-beneficial intracellular infections. *Annu Rev Cell Dev Biol* 37:115–42.

53. Tagirdzhanova G, McCutcheon JP, Spribille T. (2021) Lichen fungi do not depend on the alga for ATP production: a comment on Pogoda et al. (2018). *Mol Ecol* 30:4155-4159.

52. Garber AI, Kupper M, Laetsch DR, Weldon SR, Ladinsky MS, Bjorkman PJ, McCutcheon JP. (2021) The evolution of interdependence in a four-way mealybug symbiosis. *Genome Biol Evol* 13:evab123.

51. Milhaven M, Hastings E, Brister D, Cevallos L, Chilukuri S, Diyya A, Garg A, Hernandez R, Kelly D, Lazo K, Le J, Maag G, Marfatia PD, Mehta R, Nejad A, Porche J, Queiroz A, Sackett D, Santos Molina P, Slade T, So M, Thakur K, Urquidez Negrete A, Wackett S, Weiss S, McCarthy L, Wheaton K, Rudner AD, McCutcheon JP, Pfeifer SP. (2021) Complete genome sequence of *Microbacterium Bacteriophage Erla*. *Microbiol Resour Announc* 10:e01354-20.

50. Simon C, Gordon ERL, Moulds MS, Cole JA, Haji D, Lemmon AR, Moriarty-Lemmon E, Kortyna M, Nazario K, Wade EJ, Meister RC, Goemans G, Chiswell SM, Pessacq P, Veloso C, McCutcheon JP, Łukasik P. (2019) Off-target capture data, endosymbiont genes and morphology reveal a relict lineage sister to all other singing cicadas. *Biol J Linnean Soc* 128:865–886.

49. Bublitz DC, Chadwick GL, Magyar JS, Sandoz KM, Brooks DM, Mesnage S, Ladinsky MS, Garber AI, Bjorkman PJ, Orphan VJ, McCutcheon JP. (2019) Peptidoglycan production by an insect-bacterial mosaic. *Cell* 179:703–712.

48. Van Leuven JT, Mao M, Bennett GM, McCutcheon JP. (2019) Cicada endosymbionts have tRNAs that are correctly processed despite having genomes that do not encode all of the tRNA processing machinery. *mBio* 10:e01950-18.

47. McCutcheon JP and Lekberg Y. (2019) Symbiosis: fungi as shrewd trade negotiators. *Curr Biol* 29:R570-R572.

46. McCutcheon JP, Boyd B, Dale C. (2019) The life of an insect endosymbiont from the cradle to the grave. *Curr Biol* 29:R485–R495.

45. Richards TA and McCutcheon JP. (2019) Coral symbiosis is a three-player game. *Nature* 568:41-2.

44. Łukasik P, Chong RA, Nazario K, Matsuura Y, Bublitz D, Campbell MA, Meyer M, Van Leuven JT, Pessacq P, Veloso C, Simon C, McCutcheon JP. (2018) One hundred mitochondrial genomes of cicadas. *J Hered* 110:247–56.

43. Campbell MA, Łukasik P, Meyer MM, Buckner M, Simon C, Veloso C, Michalik A, McCutcheon JP. (2018) Changes in endosymbiont complexity drive host-level compensatory adaptations in cicadas. *mBio* 9:e02104-18.

42. Matsuura Y, Moriyama M, Łukasik P, Vanderpool D, Tanahashi M, Meng X-Y, McCutcheon JP, Fukatsu T. (2018) Recurrent symbiont recruitment from fungal parasites in cicadas. *Proc*

Natl Acad Sci USA 115:E5970-E5979.

41. McCutcheon JP. (2018) Nancy A. Moran: The Winding Path of a Brilliant Scientific Life, p213-217. In Whitaker RJ, Barton HA (ed), *Women in Microbiology*. American Society for Microbiology, Washington, DC.
40. Łukasik P, Nazario K, Van Leuven JT, Campbell MA, Meyer M, Michalik A, Pessacq P, Simon C, Veloso C, McCutcheon JP. (2017) Multiple origins of interdependent endosymbiotic complexes in a genus of cicadas. *Proc Natl Acad Sci USA* 115:E226–E235.
39. Vanderpool D, Bracewell R, McCutcheon JP. (2017) Know your farmer: ancient origins and multiple independent domestications of ambrosia beetle fungal cultivars. *Mol Ecol* 27:2077–2094.
38. Husník F, McCutcheon JP. (2017) Functional horizontal gene transfer from bacteria to eukaryotes. *Nat Rev Microbiol* 16:67–79.
37. Campbell MA, Łukasik P, Simon C, McCutcheon JP. (2017) Idiosyncratic genome degradation in a bacterial endosymbiont of periodical cicadas. *Curr Biol* 27:3568–3575.
36. Keeling PJ, McCutcheon JP. (2017) Endosymbiosis: the feeling is not mutual. *J Theor Biol* 434:75–79.
35. Spribille T, McCutcheon JP. (2016) Principles of systems biology, No. 8: Inferring the microbial building blocks of the lichen symbiosis. *Cell Syst* 3:111.
34. Husník F, McCutcheon JP. (2016) Repeated replacement of an intrabacterial symbiont in the tripartite nested mealybug symbiosis. *Proc Natl Acad Sci USA* 113: E5416–E5424.
33. Spribille T, Tuovinen V, Resl P, Vanderpool D, Wolinski H, Aime MC, Schneider K, Toome-Heller M, Mayrhofer H, Thor G, Johannesson H, McCutcheon JP. (2016) Basidiomycete yeasts in the cortex of ascomycete macrolichens. *Science* 353:488–492.
32. McCutcheon JP. (2016) From microbiology to cell biology: when an intracellular bacterium becomes part of its host cell. *Curr Opin Cell Biol* 41:132–136.
31. Bennett GM, McCutcheon JP, McDonald BR, Moran NA. (2015) Lineage-specific patterns of genome deterioration in obligate symbionts of sharpshooter leafhoppers. *Genome Biol Evol* 8:296-301.
30. Keeling PJ, McCutcheon JP, Doolittle WF. (2015) Symbiosis becoming permanent: survival of the luckiest. *Proc Natl Acad Sci USA* 112:10101-10103.
29. Campbell MA, Van Leuven JT, Meister RC, Carey KM, Simon C, McCutcheon JP. (2015) Genome expansion via lineage splitting and genome reduction in the cicada endosymbiont *Hodgkinia*. *Proc Natl Acad Sci USA* 112:10192-10199.
28. Hallam SJ and McCutcheon JP. (2015) Microbes don't play solitaire: how cooperation trumps isolation in the microbial world. *Environ Microbiol Rep* 7: 26-28.
27. Bennett GM, McCutcheon JP, McDonald BR, Romanovicz D, Moran NA. (2014) Differential genome evolution between companion symbionts in an insect-bacteria symbiosis. *mBio* 5:e01697-14.
26. Van Leuven JT, Meister RC, Simon C, McCutcheon JP. (2014) Sympatric speciation in a bacterial endosymbiont results in two genomes with the functionality of one. *Cell* 158: 1270-1280.
25. McCutcheon JP and Keeling, PJ. (2014) Endosymbiosis: protein targeting further erodes the organelle/symbiont distinction. *Curr Biol* 24: R654–R655.
24. Duncan RP, Husnik F, Van Leuven JT, Gilbert D, Davalos, L, McCutcheon JP, Wilson ACC. (2013) Dynamic recruitment of amino acid transporters to the insect-symbiont interface. *Mol Ecol* 23: 1608–1623.

23. McCutcheon JP. (2013) Genome evolution: a bacterium with a Napoleon complex. *Curr Biol* 23: R657–R659.

22. Brown AMV, Nelson K, Bolender C, McCutcheon JP. (2013) Population genomics of a symbiont in the early stages of a pest invasion. *Mol Ecol* 23: 1516–1530.

21. Husnik F, Nikoh N, Koga R, Ross L, Duncan RP, Fujie M, Tanaka M, Satoh N, Bachtrog D, Wilson ACC, von Dohlen CD, Fukatsu T, McCutcheon JP. (2013) Horizontal gene transfer from diverse bacteria to an insect genome enables a tripartite nested mealybug symbiosis. *Cell* 153:1567–1578.

20. Van Leuven JT and McCutcheon JP (2012) An AT mutational bias in the tiny GC-rich endosymbiont genome of *Hodgkinia*. *Genome Biol Evol* 4: 24-27.

19. McCutcheon JP and Moran NA (2012) Extreme genome reduction in symbiotic bacteria. *Nat Rev Microbiol* 10: 13-26.

18. McCutcheon JP and von Dohlen CD (2011) An interdependent metabolic patchwork in the nested symbiosis of mealybugs. *Curr Biol* 21: 1366-72.

17. McCutcheon JP and Moran NA (2010) Functional convergence in reduced genomes of bacterial symbionts spanning 200 million years of evolution. *Genome Biol Evol* 2: 708-718.

16. Woyke T, Tighe D, Mavromatis K, Clum A, Copeland A, Schackwitz W, Lapidus A, Wu D, McCutcheon JP, McDonald BR, Moran NA, Bristow J, Cheng J. (2010) One bacterial cell, one complete genome. *PLoS ONE* 5: e10314.

15. International Aphid Genomics Consortium (2010) Genome sequence of the pea aphid *Acythosiphon pisum*. *PLoS Biol* 8: e1000313.

14. Nikoh N, McCutcheon JP, Kudo T, Miyagishima S, Moran NA, Nakabachi A. (2010) Bacterial genes in the aphid genome: absence of functional gene transfer from *Buchnera* to its host. *PLoS Genet* 6: e1000827.

13. McCutcheon JP (2010) The bacterial essence of tiny symbiont genomes. *Curr Opin Microbiol* 13: 73-8.

12. McCutcheon JP, McDonald BR, and Moran NA (2009) Convergent evolution of metabolic roles in bacterial co-symbionts of insects. *Proc Natl Acad Sci USA* 106: 15394-9.

11. McCutcheon JP, McDonald BR, and Moran NA (2009) Origin of an alternative genetic code in the extremely small and GC-rich genome of a bacterial symbiont. *PLoS Genet* 5: e1000565.

10. Moran NA, McCutcheon JP, and Nakabachi A (2008) Genomics and evolution of heritable bacterial symbionts. *Annu Rev Genet* 42: 165-90.

9. McCutcheon JP and Moran NA (2007) Parallel genomic evolution and metabolic interdependence in an ancient symbiosis. *Proc Natl Acad Sci USA* 104: 19392-7.

8. Shendure J, Porreca GJ, Reppas NB, Lin X, McCutcheon JP, Rosenbaum AM, Wang MD, Zhang K, Mitra RD, and Church GM (2005) Accurate multiplex polony sequencing of an evolved bacterial genome. *Science* 309: 1728-32.

7. McCutcheon JP and Eddy SR (2003) Computational identification of non-coding RNAs in *Saccharomyces cerevisiae* by comparative genomics. *Nucleic Acids Res* 31: 4119-28.

6. Clemons WM Jr, Broderson DE, McCutcheon JP, May JL, Carter AP, Morgan-Warren RJ, Wimberly BT, and Ramakrishnan V (2001) Crystal structure of the 30 S ribosomal subunit from *Thermus thermophilus*: purification, crystallization and structure determination. *J Mol Biol* 310:827-43.

5. Clemons WM Jr, Wimberly BT, May JL, McCutcheon JP, Capel MS, and Ramakrishnan V (1999) Structure of a bacterial 30S ribosomal subunit at 5.5 Angstrom resolution. *Nature*

400:833-40.

4. Wimberly BT, Guymon R, McCutcheon JP, White SW, and Ramakrishnan V (1999) A detailed view of a ribosomal active site: the structure of the L11-RNA complex. *Cell* 97: 491-502.
3. McCutcheon JP, Agrawal RK, Philips SM, Grassucci RA, Gerchman SE, Clemons WM Jr, Ramakrishnan V, and Frank J. (1999) Location of translational initiation factor IF3 on the small ribosomal subunit. *Proc Natl Acad Sci USA* 96: 4301-6.
2. Gamble TR, Yoo S, Vajdos FF, von Schwedler UK, Worthy lake DK, Wang H, McCutcheon JP, Sundquist WI, and Hill CP (1997) Structure of the carboxyl-terminal dimerization domain of the HIV-1 capsid protein. *Science* 278: 849-53.
1. Felden B, Himeno H, Muto A, McCutcheon JP, Atkins JF, and Gesteland RF (1997) Probing the structure of the *Escherichia coli* 10Sa RNA (tmRNA). *RNA* 3: 89-103.