BETÜL KAÇAR

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Current Position

Assistant Professor, University of Wisconsin-Madison, WI

Education

Ph.D.	Emory University	Biomolecular Chemistry, 2010
B.Sc.	Marmara University	Chemistry, 2004

Awards

NASA Interdisciplinary Consortia for Astrobiology Research Program Award, 2020
Scialog Fellow, RCSA and the Heising-Simons Foundation, 2020
University of Arizona Foundation, Inaugural Early Faculty Research Award, 2019
NASA Early Career Faculty Award, NASA Science Mission Directorate, 2019
VWR Excellence in Research Award, 2015
NASA Postdoctoral Fellowship Award, 2012 – 2015
NASA Astrobiology Early Career Collaboration Award, 2011
HHMI Curriculum Development Fellowship, Emory University, Atlanta, GA, 2008
American Society for Biology and Molecular Biology, Graduate Student Award, 2006
National Science Foundation PRISM Graduate Teaching Award, Atlanta, GA, 2006, 2007

Honors and Scholarships

Lead, NASA Research Coordination Network, From Early Cells to Multicellularity, 2021
Rising Star Lecture, Harvard-Ulker Center for Metabolism and Life Symposium, 2021
UN Women, Commission on the Status of Women Delegate, CSW65, 2021
UN Women Generation Equality Scholar Europe & Central Asia, 2020
UNICEF and UNFPA, Day of the Girl Children Delegate, 2020
National Academy of Sciences, Science Exchange Program, Selected Participant, 2017
NASA-National Science Foundation Joint Origins of Life Ideas Lab, Selected Participant, 2017
The Library of Congress, NASA Astrobiology Program Lecturer, 2017
Harvard Origins of Life Initiative, Member
Science Club for Girls, Way Cool Scientist
NASA Astrobiology Institute, Scholarship, 2010
NASA Astrobiology Graduate Student Research Focus Group Proposal, 1st place, 2010
HHMI Summer Undergraduate Research Scholarship, Emory University, Atlanta, GA

Research Interests

Translation Machinery – origin and evolution
RuBisCO – evolution and impact on the carbon isotope fractionation across eons
Nitrogenases – evolution of metal dependence across geologic time
Origins of Life – emergence of the Last Universal Common Ancestor, abiotic-biotic transition
Astrobiology – ancient biosignatures and implications on exoplanetary habitability

Research Experience and Appointments

University of Wisconsin-Madison,
Assistant Professor, Department of Bacteriology (2021 – present)

National Aeronautics and Space Administration (NASA),
Director, Interdisciplinary Research Consortia for Astrobiology Research (2021 – present)
Co-Lead, Research Coordination Network Early Cell to Multicellularity (2021 – present)
Astrobiology Institute Co-Investigator, Reliving the Past Node, CAN7 (2016 – 2020)
Postdoctoral Fellow, Astrobiology Program (2012 – 2015)

University of Arizona,
Assistant Professor, Department of Molecular and Cellular Biology (2018 – 2021)
Assistant Professor, Department of Astronomy and Steward Observatory
Adjunct Faculty, Lunar and Planetary Laboratory, Planetary Sciences
Adjunct Faculty, Graduate Interdisciplinary Program, Genetics Division
Member, Bio5 Institute

Tokyo Institute of Technology,
Associate Principal Investigator (Adjunct), Earth-Life Science Institute (2016 – present)
Global Science Coordinator, Earth-Life Science Origins Network (2015 – 2018)

Harvard University,
Research Associate, Edwards Lab (2015 – 2017)
Project Leader, Department of Organismic and Evolutionary Biology & Origins Initiative

Blue Marble Space Research Institute,
Senior Research Associate (2020 – present)
Research Associate (2011 – 2020)

Visiting Research Associate,
Uppsala University, Hughes & Andersson Labs (as a part of NASA Postdoctoral Program) (2015)
Michigan State University, Lenski Lab (as a part of NASA Collaboration Award) (2012)

Postdoctoral Associate, School of Biology (2011-2012)
Georgia Institute of Technology, School of Biology

Graduate Student, Department of Chemistry (2004 – 2010)
Emory University. Thesis research: Emory Medical School, Department of Biochemistry

HHMI Summer Undergraduate Research Scholar, (2003)
Emory University, School of Medicine, SURE Program, Atlanta, GA

Research Funding (since 2012, at UA since 2017, BK is PI unless otherwise noted, **Total raised: ~9.5M**)

NASA, Interdisciplinary Consortia for Astrobiology Research (ICAR)
"What life wants? Exploring the natural selection of elements" (2021 – 2026, $6,035,714)

Human Frontier Science Program (HFSP), Young Investigator Grant, RGY0072/2021
"How life got moving: reconstructing and re-evolving the bacterial flagellar motor, piece-by-piece" (2021 – 2024, $1,395,000, BK: Co-I, PI: Matt Baker, UNSW)

John Templeton Foundation, Science of Purpose, 61926

"Machina ex machina: Agency in the earliest translation machinery" (2022 – 2025, $888,430)

NASA Astrobiology Institute, Reliving the Past Node, CAN7
"How did early metabolic networks evolve" (2020, $10,000)

NASA, Early Career Collaboration Award
"Exploration of the evolution of the bacterial translation machinery", Fellow: Katie McGrath (UA), Collaborator: S. Sanyal (Uppsala) (2020, $5,000)

University of Arizona Foundation Small Grants Program
"Astrobiology and metabolic origins: Resurrection of ancient nitrogen fixation" (2020, $19,538)

NASA, Science Mission Directorate, Early Career Faculty Award, 80NSSC19K1617
"Reconstruction and functional analysis of Precambrian nitrogenase" (2019 – 2022, $100,000)

John Templeton Foundation, Big Questions in Life Sciences, 61239
"Molecular insights into historical constraints on evolution II" (2018 – 2019, $357,843)

NASA, Astrobiology Program, NPP Fellowship
"The deep history of nitrogenases: Connecting the geochemical record of nitrogen fixation to isotopic signatures", Fellow: Amanda Garcia (UA) (2018 – 2020, $126,000)

National Science Foundation, Emerging Frontiers, 1724090
"Biochemical, genetic, metabolic, and isotopic constraints on an ancient thiobiosphere" (2017 – 2021, $353,276)

NASA, Exobiology Program, H006201406
"Understanding translation through experimental evolution" (2017 – 2020, $183,933 to BK, (co-I), $1,200,000 total, PI: Mike Travisano, UMinnesota)

Harvard Origins Initiative, Faculty Small Grants Program
"Reconstructing ancient enzymes to decipher life's geologic record" (2016, $8,000)

Tokyo Institute of Technology, Earth-Life Science Institute, Seed Funding
"Towards reconstructing ancient Rubisco enzymes in the laboratory" (2016, $10,000)

John Templeton Foundation, Big Questions in Life Sciences, 58562
"Molecular insights into historical constraints on evolution I" (2015 – 2017, $452,014)

NASA, Astrobiology Institute "Research Aid", Junior Researcher Award,
"Experimental evolution of engineered E. coli bacteria" (2014, $15,000)

NASA, Exobiology and Evolutionary Biology Program, NNX13AI08G (BK is the Science-PI)
"Combining experimental evolution and resurrected ancestral genes to study historical contingency and determinism" (2013 – 2016, $482,000)

NASA, Postdoctoral Program, NASA Astrobiology Institute
"The role of chance and necessity in evolution: An experimental model system to discover life's solutions" (2012 – 2015, $210,000)

Publications (*denotes corresponding)

Forthcoming

1. Kedzior M., Garcia A.K., Taton A., Li M., Adam, Z.R., Young J., **Kacar B**[*]. Molecular foundations of Precambrian uniformitarianism (under review) *BioRxiv* MS ID#:446354, (*under review)*
2. Garcia A.K., Kedzior M., Taton A., Li M., Young J., **Kacar B**[*]. Effects of CO_2 and RuBisCO concentration on carbon isotope fraction in cyanobacteria *BioRxiv* MS ID#: 440233 (*under review)*
3. Garcia A.K., Kolaczowski B., **Kacar B**[*]. Reconstruction of nitrogenase predecessors suggests origin from maturase-like enzymes *BioRxiv* MS ID#:451390 (*under review)*

Peer-reviewed

4. Kedzior M. and **Kacar B**[*]. Quantification of RuBisCO expression and photosynthetic oxygen evolution in cyanobacteria (*in press*, *Bio-Protocols)*
5. Garcia A.K., Fer E., Sephus C.M., **Kacar B**[*]. An integrated method to reconstruct ancient proteins (*accepted*, Methods in Mol Bio)
6. De Tarafder A., Parajuli N.S., Majumdar S., **Kacar B**, Sanyal S. 2021. Kinetic Analysis Suggests Evolution of Ribosome Specificity in Modern Elongation Factor-Tus from 'Generalist' Ancestors. Mol Biol Evo, msab114, https://doi.org/10.1093/molbev/msab114
7. Garcia A.K., Cavanaugh C.M., **Kacar B**[*]. 2021. The curious consistency of carbon biosignatures over billions of years of Earth-life co-evolution. ISME J, doi:10.1038/s41396-021-00971-5)
8. Carruthers B., Garcia A.K., Rivier A., **Kacar B**[*]. 2021. Automated laboratory growth assessment and maintenance of *Azotobacter vinelandii*. Current Protocols, e57. doi:10.1002/cpz1.57
9. Goldman A.D.[*], **Kacar B**[*]. 2021. Protein cofactors are remnants of life's origin and early evolution. J Mol Evol. 1-7.
10. Adam Z.R., Fahrenbach A., Jacobson S., **Kacar B**., Zubarev D. 2021. Radiolysis generates a complex organosynthetic chemical network. Scientific Reports, 11, 1743.
11. **Kacar B**. 2021. Living on thin ice: Ancient microbes, climate change and life in the universe. (in press, The Quarterly Review of Biology) *(Book Review)*
12. Venkataram S., Monasky R., Hajizadeh S., Kryazhimskiy S[*], **Kacar B**[*]. 2020. Evolutionary stalling in the optimization of the translation machinery. Proc Nat Acad Sci, 117(31):18582-18590
13. **Kacar B**[*]., Garcia A.K., Anbar A.D. 2020. Evolutionary history of bioessential elements can guide search for life in the universe. ChemBioChem, (21):1-7
14. Garcia A.K., McShea H., Kolaczowski B., **Kacar B**[*]. 2020. Reconstructed ancient nitrogenases suggest Mo-specific ancestry. Geobiology, 20;00:1-18
15. Liberles D., Chang D., Geiler-Samerotte K., Goldman A., Hey J., **Kacar B**., Meyer M., Murphy W., Posada D., Storfer A. 2020. Emerging frontiers in the study of molecular evolution, J Mol Evol, 20:1-16
16. Garcia A.K., **Kaçar B**[*]. 2019. How to resurrect ancestral proteins as proxies for ancient biogeochemistry. Free Rad Biol Med, 140:260-269
17. Adam Z.R., **Kacar B**., Som S.S., Lynch K., Walther-Antonio M., Wilford K. 2019. Metazoan origins as microbial host volumes in Neoproterozoic oligotrophic seas. PeerJ 6:e27173v1
18. Adam Z.R., Fahrenbach A., **Kacar B**., Aono M. 2018. Prebiotic geochemical automata at the intersection of radiolytic chemistry, physical complexity and systems biology. Complexity (18)e9376183
19. Bains W., Cronin L., DasSarma S., Danielache S… **Kaçar B**., & others. 2018. Exoplanet Biosignatures: Future Directions. Astrobiology 18(6):779-824
20. **Kacar B**[*], Garmendia E[+], Tuncbag N, Andersson D.I., Hughes D. 2017. Replacement of an essential gene with its ancient and modern homologs. mBio 8(4)e01276-17
21. **Kacar B**[*]., Guy L, Smith E, Baross J. 2017. Resurrecting ancient biosignatures in modern bacteria. Phil Trans A Roy Soc 375(2109)
22. **Kacar B**[*], Hanson-Smith V, Adam Z.R., Boekelheide N. 2017. Reconstruction and dynamic modeling of ancestral Rubisco proteins. Geobiology 15(5):628-640
23. **Kacar B**[*], Ge X., Sanyal S, Gaucher E.A. 2017. Experimental evolution of *Escherichia coli* harboring an ancient translation protein. J Mol Evol 81:1-16 *(Journal Cover Article*, *most downloaded paper of 2018 and 2019)*
24. **Kacar B**[*], Gaucher E.A. 2013. Experimental evolution of protein-protein interaction networks.

Biochem J 453(3), 311-319

25. **Kaçar B**[*], Gaucher E.A. 2012. Towards the recapitulation of ancient history in the laboratory. Artificial Life (13)11-18
26. **Kacar B**., Boyd E.S., Dolci W.W., Dodson E., Boldt M., Pilcher C.B. 2011. Workshop without walls: Broadening science access around the world, PLoS Biology 9(8):e1001118
27. Aldeco M[+]., **Kacar B**, Edmondson D.E. 2011. Catalytic and inhibitor binding properties of zebrafish Monoamine Oxidase (zMAO): Comparisons with human MAO A and MAO B. Comp Biochem 159(2):78-83
28. **Kacar B**., Edmondson D.E. 2010. Expression of zebrafish (*Danio rerio*) Monoamine Oxidase (MAO) in *Pichia pastoris*: Purification and comparison with human MAO A and MAO B. Protein Exp Purif. 70(2):290-297

White Papers

29. **Kacar B**., Anbar A., Garcia A.K., Seefeldt L.C., Konhauser K. 2020. "Synthesizing abiotic and biotic systems for the search and detection of life in the Universe". *NASA and NASEM, Planetary Science and Astrobiology Decadal Survey 2023-2032* https://doi.org/10.3847/25c2cfeb.8073c38a
30. Hand K.P., Phillips C.B., Chyba C.F., Toner B., Katija K., Orphan V., Huber J., … Fike D., Baross J.A., Gogarten J.P., **Kaçar B**., & others (2020) "On the Past, Present, and Future Role of Biology in NASA's Exploration of our Solar System. Biology and Solar System". Exploration *NASA and NASEM, Planetary Science and Astrobiology Decadal Survey 2023-2032*
31. Mainzer A., Abell P, Barbee B, Bottke B, Britt, Brozović M, …, **Kacar B**. & others. 2020. "The future of planetary defense in the era of advanced surveys". *NASA and NASEM, Planetary Science and Astrobiology Decadal Survey 2023-2032*
32. Domagal-Goldman S., Kiang N.Y., Parenteau N., Catling D.C., DasSarma S… **Kacar B**. & others. 2017. "Life Beyond the Solar System: Remotely Detectable Biosignatures". arXiv:1801.06714*, NASA white paper submitted to the National Academy of Sciences*

Book Chapters/Primers

33. **Kacar B**. 2017. Rolling the dice twice: Evolving reconstructed ancient proteins in extant organisms. in Chance in Evolution pp 265-276, C. Pence and G. Ramsay, eds, University of Chicago Press
34. **Kacar B**. 2016. What is LUCA? What does the tree of life tell us about how life has evolved? Astrobiology Primer 2.0 S. Domagal-Goldman and Wright K, eds, Astrobiology 16(8):561-653

<u>Keynote and Plenary Lectures</u> (all invited)

1. BEACON Center Annual Congress, Michigan State University, August 2021 (upcoming)
2. UArizona Biological, Engineering, and Chemical Research Annual Symposium, April 2021 "Reconstructing the biology of ancient Earth"
3. Biophysical Society Annual Meeting, Origin of Life Symposia, San Diego, CA, February 2020, "Ancient Proteins to Understand the Biophysical Underpinning of the Origins of Life"
4. Gordon Research Conference, Applied Microbiology, Keynote Lecture, Holyoke, MA, July 2019, "Reconstructed Enzymes as Proxies for Ancient Biogeochemical Intermediaries"
5. Evolution of Complexity Symposium, Georgia Research Center, Atlanta, GA, May 2019, "Mechanisms Driving Evolutionary Innovations"
6. Rocky Mountain Geobiology Symposium, Boulder, CO, April 2019, "Recapitulating Ancient History in the Laboratory with The Methods of Evolutionary Synthetic Biology"
7. The Library of Congress, NASA Astrobiology Program Lecture, Washington DC, August 2017 "Life As It Could Be: Astrobiology, Synthetic Biology, and the Future of Life"
8. U.S. State Department, Community Development Lecture, Brčko, Bosnia and Herzegovina, July 2017 "How did we get here? Astrobiology and Life in the Universe"
9. Astrobiology Science Conference (Day 3 Opening Lecture), Phoenix, AZ, April 2017, "New Developments in the Origins of Life Field"

10. MIT, Earth and Planetary Sciences, IAP Lecture Series, 2015, "Engineering Modern Microbes with Ancestral Genes to Explore Ancient Life"
11. Oxford University St Anne's College, Science, Progress and History Lecture Series, 2014, "Evolution and Historical Explanation: Contingency, Convergence, and Teleology"
12. World Summit on Evolution, University of San Francisco de Quito, Galápagos, June 2014, "Beagle in a Flask: Experimental Evolution of Ancient Proteins"

Symposia and Conference Lectures

1. The 12th Molybdenum and Tungsten Enzymes Conference, September 2021 (invited)
2. Cornell High Energy Synchrotron Source, "Biology Under Extreme Conditions: 2030 and Beyond", July 2021 (invited)
3. Goldschmidt 2021, Virtual, July 2021, "Reconstructing ancient enzymes to understand the peculiar consistency of Precambrian carbon isotope biosignatures" (invited)
4. WIDS Women in Data Science Conference, Tucson, AZ, April 2020, "How can solving life's origins guide our search for finding life in the universe?" (invited)
5. Arizona Science Lecture 2020, "Catalyst: Life Beyond Earth", February 2020 (invited)
6. University of Connecticut, Mansfield, CT, May 2017, "Biogeochemical Dating in Deep Time using Ancient RuBisCO Sequences" (invited)
7. Harvard University, Natural Intelligence Proto-computation and Proto-life Workshop, Cambridge, MA, Dec 2016, "Decoding the coder: Lessons from the translation machinery"
8. Michigan State University, BEACON Center Annual Symposium, East Lansing, MI, July 2016 (invited), "Experimental evolution of E. coli with a perturbed translation machinery"
9. Astrobiology Science Conference, Chicago, IL, June 2015, "Biophysical underpinnings of the origins of life" (invited)
10. Carnegie Institute of Washington, "Re-conceptualizing the Origins of Life", March 2015, "Evolution of RuBisCO" (invited)
11. Geological Society of America, Denver, CO, September 2016, "Constraining the Great Oxidation Event using ancient genes".
12. ASM Symposium on Microbial Evolution, Washington DC, June 2014 (invited), "Experimental evolution of bacteria harboring an ancient gene" (invited)
13. Gordon Research Conference, Origins of Life, Galveston, TX, January 2014 (invited)
14. Gordon Research Conference, Microbial Population Biology, Andover, NH, July 2013 (invited)
15. International Conference on the Synthesis and Simulation of Living Systems, MI, June 2012, "Combining synthetic biology with experimental evolution"
16. NASA Workshop Without Walls: Rewinding the Tape of Life, April 2011 "Revisiting Gould's tape of life"
17. University of Colima, Excellence in Education Conference, Colima, Mexico, January 2008, "Problem-based learning for K12 education in a model classroom in Atlanta, Georgia"

Departmental Seminars and Colloquiums (all invited)

18. University of Toronto, Department of Astronomy and Astrophysics, November 2021
19. Penn State, Department of Biology, May 2021
20. University of California, Santa Cruz, Department of Astronomy & METX, April 2021
21. Origins Center Netherland, March 2021
22. University of Oregon, Department of Biology, February 2021
23. University of Wisconsin-Madison, Department of Bacteriology, January 2021
24. Stanford University, Earth, Energy & Environmental Sciences, November 2020
25. Montana State University, Chemistry and Biochemistry, October 2020
26. Bristol University, Geobiology and Geomicrobiology Division, October 2020
27. NASA Ames Synthetic Biology Core, September 2020
28. University of North Carolina Chapel Hill, Department of Biology, Durham, NC, October 2019
29. Harvard University, Origins Forum, Cambridge, MA, September 2019

30. Arizona State University, BEYOND Center, Phoenix, AZ, March 2019
31. University of Washington, Astrobiology Colloquium, November 2018
32. Princeton University, Department of Earth Sciences, October 2017
33. University of Arizona, Department of Molecular and Cellular Biology, February 2017
34. Harvard Medical School, Department of Genetics, December 2016
35. NASA Executive Council Annual Meeting, Flathead Lake, MT, September 2016
36. Harvard University Origins Initiative Chalk Talk, May 2016
37. McGill University Space Institute, Montreal, Canada, April 2016
38. Dalhousie University, Biochemistry and Molecular Biology, Nova Scotia, March 2016,
39. Uppsala University, Department of Microbiology, Uppsala, Sweden, September 2015
40. Tokyo Institute of Technology, ELSI Origins Lecture, Tokyo, Japan, May 2015
41. Tokyo Institute of Technology, Synthetic Biology Core Unit, Tokyo, Japan, May 2015
42. The Smithsonian Institution Human Origins Hall, Washington, DC, March 2014
43. University of New Hampshire, Biology Department, Durham, NH, March 2015
44. Oberlin College, Department of Biology, Oberlin, OH, March 2014
45. California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA, November 2013
46. Tokyo Institute of Technology, ELSI Earth-Life Science Institute, Tokyo, Japan, September 2013
47. The Smithsonian Institution, Washington, DC, February 2011

Community and Public Outreach Talks (all invited)

48. TED Talk, A Case for Optimism, Monterey, CA, June 2021
49. United Nations CSW65, March 2021
50. Global Relations Forum, March 2021
51. Carnegie Museum of Natural History, March 2021
52. Planetary Society Annual PlanetFest: To Mars and Back Again, Panelist, February 2021
53. Lifelong Learning in Retirement at the Highlands in Arizona, LLRH, October 2020
54. UNICEF, UN Women, UNFPA: International Day of the Girl Child, Panelist, October 2020
55. SAGANet Online: Talk to an Astrobiologist, May 2020
56. UA Lifelong Learning Center, Astronomy and Geology Lecture Series, March 2020
57. Women in Science Lecture Series, Tucson Science Café, Tucson, AZ, November 2018
58. Flandreau Planetarium, Exoplanets Community Lecture Series Speaker, 2018
59. National Academy of Sciences, The Science Exchange, Manhattan, NY, December 2017
60. Cambridge Science Festival, Science Club for Girls, Cambridge, MA, April 2017
61. Somerville Public Library Community Lecture, Somerville, MA, April 2017
62. NOVA Science Café, Boston, MA, April 2016
63. Atlanta Science Tavern, Atlanta, GA, February 2011

Invited Workshops

Max Planck Institute for Evolutionary Biology Plön, Microbial Population Biology, June 2022
Signatures of Life in the Universe II, Research Corporation for Science Advancement, March 2022
NASA Standards of Evidence for Life Detection joint NExSS/NfoLD workshop, July 2021
Signatures of Life in the Universe I, Research Corporation for Science Advancement, June 2021
Santa Fe Institute, Origins of life: The possible and the actual, February 2021
NASA Executive Council Meeting, Atlanta, GA, January 2020
John Templeton Foundation, Trends in Evolution Workshop, Biosphere 2, Tucson, AZ, April 2019
Origins of Life Workshop, Santa Fe Institute, November 2018
NASA Agnostic Life Workshop, Washington DC, March 2017
NSF-NASA Ideas Lab "Origins of Life", Bethesda, MD, September 2016
NASA-NEXSS for Exoplanet System Science "Exoplanet Biosignatures", Seattle, WA, June 2016
NSF NESCENT, "Experimental Evolution", Durham, NC, March 2015
ASU-BEYOND "Thermodynamics, Entropy and Life" Workshop, Phoenix, AZ, September 2014
NSF NESCENT, "Astrobiology, Synthetic Biology, Evolution", Durham, NC, November 2011

Teaching Experience

University of Arizona: "*Astrobiology and the Molecular History of Life"* (MCB 445/545) (Spring 2021, 16-students); "*Molecular Biology and Evolution of Star Trek*" (MCB 184A) (Fall 2019, Spring 2021, 20-students); "*Science Communication and Science Writing*" (MCB 575) (Fall 2018 with R. Gutenkunst, Fall 2018 with N. Horton) (15-students). Harvard University: OEB 258 "*Chance versus Determinism: Is Evolution Predictable?*" (Graduate seminar co-facilitator, Lead: J. Losos) (Fall 2016).

Guest Lecturer: Carleton College: "*Origin and Early Evolution of Life*" (Spring 2021); Massachusetts Institute of Technology: *"The Phylogenomic Planetary Record"* (12.178/478, Fall 2020); University of California Berkeley: "*Introduction to Astrobiology*" (ASTRON9, Summer 2020); University of Arizona: "*Introduction to Biology*" (MCB 181R, Fall 2018), "*Seminar in Bioinformatics*" (ECOL 268B, Spring 2019), "*Life in the Universe*" (ASTR 202, Fall 2018), "*Recent Advances in Genetics*" (GENE 670, Fall 2018), "*Science in the News*" (JOUR 772/572, Spring 2020); Georgia Institute of Technology: "*Prokaryotic Molecular Genetics*" (Fall 2013, BIOL 4608/6608), "*Molecular Evolution*" (BIOS 4225, Spring 2014), "*Evolutionary Biology*" (BIOS 3600, Fall 2014), "*Origins of Complex Life*" (BIOS 4550, Fall 2014).

Contributor: Bard College: "*Advanced Evolution*" (BIO 315L, Fall 2017), Undergraduate-level laboratory, experimentally evolution and analyses of the *E. coli* strains harboring a phylogenetically inferred gene, generated in my laboratory (co-developed with G. Perron).

Other Teaching: Santa Fe Institute MOOC *"Origins of Life and Phylogenetic Thinking"*. Origins of Life Lecture Series supported by the National Science Foundation. Recorded: April 2019, Released: November 2019.

Education and Outreach Proceedings

- Som S.M., Walker S.I., Miller E., Anbar M., **Kacar B**., Forrester JH. 2014. Evaluating virtual STEM mentoring programs: The SAGANet experience. American Geophysical Union, ID: ED31B-3439
- **Kacar B**., Som S.M., DeMarines J., Illangkoon H. 2013. Mentoring elementary school students through virtual media: SAGANet Mentorship Program. Impact and Effectiveness of Developmental Relationships. UNM Mentoring Institute Press.

Popular Science Articles

- **Kacar B**. 2021. Extinction isn't an end: Mining ancient innovation for future solutions. Andreessen Horowitz Future, a16z.
- **Kacar B**. 2020. What if we are alone in the Universe? Ought we to do something about it? Aeon Essays.
- **Kacar B**., Womack, Y. 2018. Future shaped by pasts that could have been. Journal of Design and Science 10.21428, MIT Press
- **Kacar B**. 2013. Teaching evolution in Turkey: SAGAN Education Platform. Astrobiology Magazine.

Advising

Postdoctoral advising: **Bruno Cuevas** (2021-present), **Azul Pinochet-Barross** (2021-present), **Amanda Garcia** (2018-present, recipient of a NASA Postdoctoral Fellowship); **Mateuzs Kedzior** (2020-2021, Scripps Research Covid-19 Team, La Jolla, CA).

Lab Techs/Research Scientists: **Evrim Fer** (Molecular Biology, 2019-2020); **Ross Monasky** (Microbiology, 2017-2019), Harvard University: **Brett Enos** (Microbiology, 2016).

Doctoral students: **Evrim Fer** (Ph.D. student, MDTP, 2021-present); **Katie McGrath** (Ph.D. student, Molecular and Cellular Biology, NIH Training Grant & NASA Scholarship recipient, 2019-present).

Master's students: **Cathryn Sephus** (Accelerated master's program, MCB, Galileo Scholar, Arizona Space Undergrad Fellow, Blue Marble Space YSP, 2018-2021); **Alex Rivier** (Accelerated master's program, MCB, Fall 2019-present).

Doctoral and master's committees: **Matt Miller** (Molecular and Cellular Biology, 2018-present), **Jared Sivinski** (Biochemistry, 2020-present), **Bradley Stuart** (Molecular and Cellular Biology, 2020, Master's), **Savannah Weaver** (Microbiology, 2020-present), **Jacob Copple** (Molecular and Cellular Biology, 2020-present).

Students mentored as a part of the NASA astrobiology center: **Andrew Wheeler** (Ph.D. student, Genetics, 2020-present).

Examiner at Other Universities: Ph.D. Thesis Examiner: **Alannah Rickerby** (University of Auckland, Biology, New Zealand, 2021); **Sophie Wendel** (DTU Novo Nordisk, Synthetic Biology, Denmark, 2016).

Current undergraduate students/independent study: **Brooke Carruthers** (Honors) (MCB, 2019-present, Galileo Scholar, Blue Marble Space YSP) Previous undergraduate students/ independent study: University of Arizona: **Emily Peñaherrera** (MCB, 2018-2021, Blue Marble Space YSP), **Gizem Ozturk** (MCB, Spring-Fall 2021); **Carissa Bond** (CHEM/PHYS, Spring 2021), **Alyks Odell** (2020-2021), **Sofia Jacobson** (Honors) (2018-2019). Harvard University: **Hanon Mcshea** (Senior Thesis 2017-2018, Ph.D. Student, Stanford University), **Ryan Ward** (Senior Thesis 2017-2018, Fulbright Scholar, École Normale Supérieure), **Alex Pleşa** (Senior Thesis 2016-2017, Ph.D. Student, Harvard Medical School), **Anna Donovan** (Senior Thesis 2016-2018, Associate Manager, Evolved by Nature).

Visiting students: **Maddie Paoletti** (Undergraduate, Wellesley College, Blue Marble Space YSP, Summer 2021); **Roza Mizrak** (Undergraduate, Blue Marble Space YSP, Summer 2021); **Sarah Schwartz** (Ph.D. Student, MIT EAPS, Fall 2020); **Leonardo Sandrini** (Ph.D. Student, University of Milan, Fall 2019); **Azen Koç** (Undergraduate, Bilkent University, Summer 2019); **Aonuma Keito** (University of Tokyo, Summer 2020), Harvard University: **Divjot Kaur** (Undergraduate, University of Sussex, Spring 2017), **Stuart Brown** (Undergraduate, University of Sussex, Spring 2017), **Ulku Uzun** (Master's Thesis, MEME Fellow, 2017), **Gökçe Senger** (Undergraduate, Izmir Technology Institute, Summer 2015). Rotation Students: **Pearl Lam** (MCB, Spring 2018), **Andrew Wheeler** (Genetics, Fall 2021)

High school interns: **Ryan Conant** (KEYS High School Summer Intern, UA, 2019), **Bouchra Benghomari** (Science Club for Girls Intern, Harvard, 2016).

Service

University of Arizona

MCB Beckman Scholars Program *Proposal Development Participant*, 2020 & 2021
MCB Department, *Equity Committee*, Spring 2021
Astronomy Department, *Grad Admissions Committee*, 2020 – 2021
Genetics GIDP Program, *Student Progress Committee*, 2020 – present
Arizona Wonder House, *Lecturer,* 2020
ABBS Graduate Program, *Grad Admissions Committee*, 2019 – 2020
Genetics GIDP Graduate Program, *Grad Admissions Committee*, 2020
Biosciences ABBS Graduate Student Recruitment Week, *Speaker*, 2019

Astrobiology Initiative, *Steering Committee*, 2019 – present
Ecosystem Genomics Initiative, *Cluster Faculty Hiring Committee*, 2019
MCB Program, *Undergraduate Award Committee*, 2018 – present
MCB Program, *Graduate Student Award Committee*, 2018 – present
ABBS Program, *Graduate Student Award Committee*, 2018 – present
Minority Women Faculty, *Member*, 2018 – present

National Boards and Committees

American Astronomical Society, DPS Publications Subcommittee, *Member*, 2021 – present
NASA Nexus for Exoplanet System Science, NExSS, *Member*, 2020 – present
National Science Foundation RCN Origins of Life, *Steering Committee*, 2018 – 2021
Santa Fe Research Institute, Santa Fe, NM, *Member*, 2018 – present
Engineering Biology Research Consortium, *Junior Faculty Member*, 2019 – present
NASA Center for Origins of Life, COOL, *Member*, 2019 – present
NASA Origins of Life Research Focus Group, *Member*, 2012 – 2015

International Boards and Service

United Nations, Council on the Status of Women, *Delegate*, 2020, 2021
Global Relations Forum, *Member*, 2021 – present
European Union, International Women's Day, *Delegate*, 2020
Sabanci University Gender and Women's Studies Center of Excellence, *Board*, 2017 – 2019
SAGANet Astrobiology Mentorship and Outreach Network, *Executive Board*, 2016 –present

Diversity Leadership and Outreach

- Panelist and Delegate, United Nations International Day of the Girl (Europe and Central Asia), *Impact of COVID-19 and Climate Change on Girls of Color and the Future of Science*, Webinar, September 2020
- Co-Lead, The Power Hour Discussion on Gordon Research Conference on Applied and Environmental Microbiology, Summer 2019
- Delivered the first Harvard SACNAS Scientific Excellence Through Diversity Faculty Lecture, "Exploring Evolution and Distribution of Life in The Universe", January 2017
- Faculty Mentor for URM at Science Club for Girls, Harvard University, Cambridge, MA., 2016-17
- Mentor, Young Guru Academy for the Visually Impaired Syrian Refugees in Turkey (online), 2016
- Guest Teacher: *Being a Woman of Color in STEM*, Coretta Scott King Young Women's Leadership Academy, Atlanta, GA., March 2014
- Co-Founder and Director, SAGANet Online Grassroots Astrobiology Education, Mentorship and Outreach Network, 2011-2016

Symposia and Conferences (Organizer)

- AAAS Annual Meeting 2021, "Astrobiology and Origins of Life: From Chemical Networks to Living Ecosystems", Respondent and Organizer (2021) (with D. Baum)
- AbSciCon 2021, "Origins Exploration: From Stars to Cells", Local Organizing Committee (2021)
- "Machina ex Machina", Templeton Workshop, Tucson, Arizona, Organizer and Chair, (2019) (with D. Apai)
- American Society for Microbiology Microbe General Meeting, "Exobiology and Origins of Life" Plenary Session, Co-Organizer (2018) (with J. Lennon, J. Glass)
- Tokyo Institute of Technology, "Universal Biology Workshop", Co-Organizer (2017) (with C. Mariscal, P. Hut, N. Goldenfeldt, M. Voytek)
- Harvard University "Intelligence and Protocomputation" Workshop, Co-Organizer (2016) (with M. Aono, Z. Adam)
- American Society for Microbiology 2nd Conference on Experimental Microbial Evolution, Co-Organizer (2016) (with F. Rosenzweig, G. Sherlock)

- Gordon Research Seminar Microbial Population Biology, Chair (elected) (with G. Perron) (2013)
- ASM Conference on Experimental Microbial Evolution, Co-Organizer (2014) (with F. Rosenzweig)
- Local Organizing Committee, AbSciCon 2012, Exploring Life: Past, Present, Near, Far (2012) (Lead: L. Williams, N. Hud)
- Organizer, NASA Workshop Without Walls: Rewinding the Tape of Life (2010) (with L. Williams, J. Peters, M. Kirven-Brooks, W. Dolci, C. Pilcher)

Reviewer Activities

Panel Chair: NASA Exobiology Program: Evolutionary Biology (2018).

Panel Member: NASA Planetary Science Division (2020); NASA Exobiology and Evolutionary Biology Review Panel II (2018, 2021); National Science Foundation CAREER Panel, National Science Foundation Molecular and Cellular Biosciences, (2017).

Ad Hoc Reviewer: Stanford Synchrotron Radiation Lightsource (SSRL) (2021); Marsden Fund Royal Society Te Apārangi (New Zealand) (2021); Agence Nationale de la Recherche (ANR-France) General Proposal Call (2021); National Science Foundation: Molecular and Cellular Biology (2017-2019), Division of Environmental Biology (2019), Genetic Mechanisms (2018, 2019), Geobiology & Low Temp. Geochemistry (2017); National Aeronautics and Space Administration: Internal Scientist Funding Model for Planetary Science Division (2020), Exobiology and Evolutionary Biology Program (2017-2018, 2020), Space Biology, NASA Earth and Space Science Fellowship (2016, 2018-2019), NASA Postdoctoral Program (Astrobiology, Space Biology, Astronomy) (2016-2019); John Templeton Foundation: Life Sciences Program Genetics (2018, 2019), Science of Purpose (2020).

Journal/Referee Activities: Astrobiology, Biology & Philosophy, BMC Biology, ChemBioChem, Current Biology, Evolution, Free Radical Biology and Medicine, Frontiers in Microbiology, Geobiology, Journal of Molecular Evolution, Life, MBio, Molecular Biology and Evolution, Nature Communications, npj Microgravity, PLOS Biology, PLOS One, Science, Science Advances, The Quarterly Review of Biology.

Editorial Boards: Journal of Molecular Evolution (Associate Editor, 2018-present), Faculty 1000 (Junior Editor, 2019-present).

Press and Media Coverage (Selected)

Interviews
Bill Nye's Great Big World of Science, November 2020
DW Deutsche Welle, October 2020
UNESCO/ UNFRA International Day of the Girl, September 2020
United Nations, UN Women Europe and Central Asia, March 2020
Arizona Public Radio, Catalysts of Change, College of Science Lecturers Conversation, February 2020
Turkish National TV and Radio, CNN Turk, NTV, Biosignatures and Life in the Universe, January 2020
Five Questions for Betul Kacar, John Templeton Foundation Highlighted Grantee, December 2019
Lunar Planetary Institute, Exploring early Earth using DNA by Marc Kaufman, September 2019
NPR Arizona, Science Friday, Topic: Origins of Life, June 2019
Fearless Women of Tucson, Arizona Daily Star, May 2019
PLoS Blogs, Looking for the origins of life using synthetic biology, by Kostas Vavitsas, October 2018
NPR Arizona, Science Friday, Topic: Synthetic Biology and Experimental Evolution, September 2017
Belmont TV, Reconstructing Evolution, Production by Yvonne Stapp, February 2016
SETI Podcast, Cells and Planets Season 2, Episode 4, Moderator: Paul Carr, August 2014
Popular Science, Splicing a 500-million-year-old gene into modern bacteria, April 2013

News Coverage related to research publications

Science Talk, “To understand the machinery of life, this scientist breaks it on purpose” Aug 2020
The Scientist, “Scientists Bring Ancient proteins back to life” by Amber Dance, July 2018
New Scientist, Resurrected gene allows travel to an Earth before oxygen, by Bob Holmes, May 2017
Quanta Magazine, Biologists Invoke the Past in Modern Bacteria, by Emily Singer, April 2015
MIT Technology Review, Biologists replay million years evolution in the lab, September 2013
BBC Focus Magazine: Ancient DNA brought back to life, September 2012
Wired, Ancient Gene Inserted in E. coli., July 2012

Documentary
PBS NOVA Science Documentary, “Into the Origins”, Production: January 2014, Self.
Currently used as a part of Montana Public School Education Curriculum.

Comic Books
NASA Astrobiology Comic Book: Origins of Life (self), Author: Aaron Gronstal, Published: June 2019
Lunar and Planetary Institute: Mars Now! For Girls (self), Published: September 2011

Professional Societies

- American Association for the Advancement of Science
- American Astronomical Society – Division of Planetary Sciences
- American Society for Microbiology
- Biophysical Society
- Engineering Biology Research Consortium
- Geobiological Society
- NASA Astrobiology and Exobiology Program