

Aaron David Goldman

email: agoldman@oberlin.edu

tel: +1 (440) 775-8749

EDUCATION AND TRAINING

Ph.D. in Microbiology, University of Washington, 2010, *Dissertation: "Characterizing the earliest living systems through comparative bioinformatics"*

Graduate Certificate in Astrobiology, University of Washington, 2010

B.A. in Biology with a minor in Astronomy, Swarthmore College, 2003

POSITIONS HELD

2026 – present	Robert W. & Eleanor H. Biggs Professor of Biology– Oberlin College
2025 – 2026	Professor of Biology – Oberlin College
2019 – 2025	Associate Professor of Biology – Oberlin College
2019 – 2020	Visiting Scientist – NASA Ames Research Center
2013 – 2019	Assistant Professor of Biology – Oberlin College
2017	Visiting Scholar – Stanford University
2010 – 2013	Postdoctoral Fellow – Princeton University

GRANTS AND FELLOWSHIPS

Co-PI, NASA Interdisciplinary Consortia for Astrobiology Research 80NSSC19M0069, total: \$9,059,049, sub-award: \$211,649, Reconciling Prebiotic Paradigms: Mapping Planetary Reality onto Experimental Strategies, 2019-2025.

Co-PI, NASA/NSF Joint Ideas Lab 16-IDEAS16-0001, total: \$997,620, sub-award: \$209,435, Becoming biotic: Recapitulating ancient cofactor-mediated metabolic pathways on the early Earth, 2017-2023.

Co-PI, NSF Major Research Instruments Grant 1427949, \$486,256, Acquisition of a high-performance computing cluster to enhance undergraduate research and education across the sciences at Oberlin College.

Oppenheim Symposium Series, \$25,000 to organize the Oppenheim Symposium on Ancient Life from Computational Perspectives, Oberlin College, May 2015.

NASA Postdoctoral Program Fellowship, July 2011 – June 2013.

Co-PI, NASA Astrobiology Conference and Workshop Fund, \$25,000 to organize the 2013 Princeton Workshop on the Origin of Life.

Whitely Fellowship Award, Department of Microbiology, University of Washington, Sep 2009 – Mar 2010.

NSF IGERT Fellowship, Astrobiology Program, University of Washington, June 2007 – Sep 2009, Mar 2010 – Sep 2010.

Co-PI, NASA Astrobiology Institute Directors Discretionary Fund, \$25,000 to organize the 2009 Astrobiology Graduate Student Conference, University of Washington.

OTHER AWARDS

Zuckerland Prize for top article of the year in *J Mol Evol*, 2020

Finalist, Origin of Life Challenge (Harry Lonsdale Award), 2012

Elected Speaker, Gordon Research Seminar on the Origin of Life, 2010 and 2012

International Society for the Study of the Origin of Life Travel Award, 2011

Chang – Kalbach Award for Excellence in Astrobiology Research, 2010

Recognition for Mentorship, Siemens-Westinghouse, 2010

NSF Graduate Research Fellowship, Honorable Mention, Apr 2007

MANUSCRIPTS UNDER REVIEW

* undergraduate students whom I mentored; † indicates that I am corresponding author

Phipps I*, **Goldman AD**[†] (in revision) The Microbial Ecology of Planetary Protection. *J Mol Evol*

Kailing F*, Taub E*, **Goldman AD**[†] (in review) Evolution of Replication Fidelity in the Absence of Natural Selection. *Scientific Reports*

Weber JM, Dzurilla KM, Velling SJ, **Goldman AD**, LaRowe DE, Henderson BL, Celestian A, Barge LM (in review) Mineral-mediated electron transfer between iron-sulfides and quinones under prebiotic geological conditions. *Proc Natl Acad Sci USA*

JOURNAL ARTICLES

* undergraduate students whom I mentored; † indicates that I am corresponding author

Goldman AD[†], Fournier GP, Kaçar B (2026) Universal Paralogs Provide a Window into Evolution before the Last Universal Common Ancestor. *Cell Genomics*. 6(3):3101140

Nikfarjam Z, Thota I*, Nikfarjam A, Kailing F*, **Goldman AD**[†] (2026) A new LUCApedia database for data-driven re-search on early evolutionary history. *Bioinf Adv*. 6(1):vbaf309.

Fer E, Yao T, McGrath KM, **Goldman AD**, Kaçar B (2025) The origins and evolution of translation factors. *Trends Genet* 41(7):590-600

Goldman AD[†], Fournier GP (2024) The very early evolution of biological complexity. *Trends in Genetics*. 40(11):912-913

Kailing F*, Lieberman J*, Wang J*, Turner JL*, and **Goldman AD**[†] (2024) Evolution of Cellular Organization Along the First Branches of the Tree of Life. *J Mol Evol*. 92:618–623

Goldman AD[†], Becerra A (2024) A New View of the Last Universal Common Ancestor. *J Mol Evol*. 92:659–661

Goldman AD[†], Weber JM, LaRowe DE, Barge LM (2023) Electron transport chains as a window into the earliest stages of evolution. *Proc. Natl. Acad. Sci. USA*, 120(34):e2210924120

Cuevas-Zuviria B, Adam ZR, **Goldman AD**, Kaçar B (2023) Informatic capabilities of translation and its implications for the origins of life. *J Mol Evol*, 91(5):567-569

Goldman AD[†] (2023) How did life become cellular? *Proceed R Soc B*. 290(1992), 20222327

Goldman AD[†], Kaçar B (2023) Very early evolution from the perspective of microbial ecology. *Env Microbiol*, 25(1):5-10

Krishnamurthy R, **Goldman AD**, Liberles DA, Rogers KL, Tor Y (2022) Nucleobases in meteorites to nucleobases in RNA and DNA? *J Mol Evol*, 90(5):328-331

Crapitto AJ*, Campbell A*, Harris AJ, **Goldman AD**[†] (2022) A Consensus View of the Proteome of the Last Universal Common Ancestor. *Ecol Evol*, 12:e8930.

Gagler DC, Karas B, Kempes C, **Goldman AD**, Kim H, Walker SI (2022) Scaling laws in enzyme function reveal a new kind of biochemical universality. *Proc. Natl. Acad. Sci. USA*, 119(9):e2106655119.

Weber JM, Henderson BL, LaRowe DE, **Goldman AD**, Perl SM, Billings K, Barge LM (2022) Testing abiotic reduction of NAD⁺ directly mediated by iron-sulfur minerals. *Astrobiology*, 22:25-34.

Harris AJ, **Goldman AD**[†] (2021) The very early evolution of protein translocation across membranes. *PLoS Comp Biol*, 17(3): e1008623

Goldman AD[†], Kaçar B (2021) Cofactors are remnants of life's origin and early evolution. *J Mol Evol*, 89:127–133.

Goldman AD, Liberles DA (2021) The Journal of Molecular Evolution Turns 50. *J Mol Evol*, 89:119–121

Takagi YA*, Nguyen DH*, Wexler TB, **Goldman AD**[†] (2020) The Coevolution of cellularity and metabolism following the origin of life *J Mol Evol*, 88:598–617

Harris AJ, **Goldman AD**[†] (2020) The complex phylogenetic relationships of a 4mC/6mA DNA methyltransferase in prokaryotes. *Mol Phylogenet Evol*, 15:106837.

- Maltais TR, VanderVelde D, LaRowe DE, **Goldman AD**, Barge LM (2020) Reactivity of Metabolic Intermediates and Cofactor Stability under Model Early Earth Conditions. *Orig Life Evol Bios*. doi: 10.1007/s11084-019-09590-9
- Liberles DA, Chang B, Geiler-Samerotte K, **Goldman AD**, and 6 others (2020) Emerging Frontiers in the Study of Molecular Evolution. *J Mol Evol*. 88:211-226.
- Harris AJ, **Goldman AD**[†] (2018) Phylogenetic Reconstruction Shows Independent Evolutionary Origins of Mitochondrial Transcription Factors from an Ancient Family of RNA Methyltransferase Proteins. *J Mol Evol*. 86:277-282.
- Goldman AD**[†], Landweber LF (2016) What is a Genome? *PLoS Genetics*. 12:e1006181.
- Goldman AD**[†], Beatty JT*, Landweber LF (2016) The TIM Barrel Architecture Facilitated the Early Evolution of Protein-Mediated Metabolism. *J Mol Evol*. 82:17-26. ** Cover Article
- Domagal-Goldman SD, Wright KE, Adamala K, Arina de la Rubia L, Bond J, Dartnell LR, **Goldman AD**, Lynch K, Naud M-E, Paulino-Lima IG, and 29 others (2016) The Astrobiology Primer v2.0. *Astrobiology*. 16: 561-653.
- Chen X, Bracht JR, **Goldman AD**, Landweber LF and others (2014) The architecture of a scrambled genome reveals massive levels of genomic rearrangement during development. *Cell*. 158:1187-98.
- Goldman AD**, Stein EM*, Bracht JR, Landweber LF (2014) Programmed Genome Processing in Ciliates. In N Jonoska and M Saito (Ed.), Discrete and Topological Modeling in Molecular Biology. Berlin, Germany: Springer.
- Goldman AD**[†], Bernhard TM*, Dolzhenko E, Landweber LF (2013) LUCApedia: a database for the study of ancient life. *Nucleic Acids Research*, 41:D1079-82.
- Vogt A, **Goldman AD**, Mochizuki K, Landweber LF (2013) Transposon Domestication versus Mutualism in Ciliate Genome Rearrangements. *PLoS Genets*, 9:e1003659.
- Swart EC, Bracht JR, Magrini V, Minx P, Chen X, Zhou Y, Khurana JS, **Goldman AD**, Landweber LF and others (2013) The *Oxytricha trifallax* Macronuclear Genome: A Complex Eukaryotic Genome with 16,000 Tiny Chromosomes. *PLoS Biology*, 11:e1001473.
- Bracht JR, Fang W, **Goldman AD**, Dolzhenko E, Stein EM*, Landweber LF (2013) Genomes on the edge: programmed genome instability in ciliates. *Cell*, 52:406.
- Stüeken EE, Anderson RE, Bowman JS, Brazelton WJ, Colangelo-Lillis J, **Goldman AD**, Som SM, Baross JA (2013) Did life originate from a global chemical reactor?. *Geobiology*, 11:101-26.
- Goldman AD**[†], Landweber LF (2012) *Oxytricha* as a modern analog of ancient genome evolution. *Trends Genet*, 28:382-388. ** Cover Article
- Goldman AD**[†], Baross JA, Samudrala R (2012) The enzymatic and metabolic capabilities of life forms during the origin of life. *PLoS One*, 7:e39912.
- Goldman AD**[†], Horst JA, Hung L-H, Samudrala R (2012) Evolution of the Protein Repertoire. Systems Biology, R Meyers, Editor. (pp. 207-237). Weinheim, Germany: Wiley-VCH.
- Goldman AD**[†], Samudrala R, Baross JA (2010). The evolution and functional repertoire of translation proteins following the origin of life. *Biol Dir*, 5:15.
- Borlee BR, **Goldman AD**, Murakami K, Samudrala R, Wozniak DJ, Parsek MR (2010). *Pseudomonas aeruginosa* uses a cyclic-di-GMP-regulated adhesin to reinforce the biofilm extracellular matrix. *Mol Microbiol*, 75:827-842. ** Cover Article
- Goldman AD**[†], Leigh JA, Samudrala R (2009) Comprehensive computational analysis of Hmd enzymes and paralogs in methanogenic Archaea. *BMC Evol Biol*, 9:199.

OTHER PUBLICATIONS

* undergraduate students whom I mentored; † indicates that I am corresponding author

- Goldman AD**, Fournier G, Gogarten JP, Petrov AS, Rothschild L, Segrè D, Smith E, Williams L (2021) Understanding the Early Major Transitions in Evolutionary History Part 1: Stages in the Emergence of Complex Life. *Bulletin of the American Astronomical Society*, 53: 247.
- Fournier G, Gogarten JP, **Goldman AD**, Petrov AS, Rothschild L, Segrè D, Smith E, Williams L

(2021) Understanding the Early Major Transitions in Evolutionary History Part 2: Ancient Evolution of Biological Systems and the Biosphere. *Bulletin of the American Astronomical Society*, 53: 253.

Achenbach L, Barnes R, Baross J, Boston P, Boyd E, Cable M, Chen I, Ciesla F, Des Marais D, Domagal-Goldman S, **Goldman A**, and 17 others (2015) Astrobiology Strategy (Lindsay Hays, Ed.). NASA Astrobiology Program.

Goldman AD (2014) Astrobiology: an overview. In VM Kolb (Ed.) Astrobiology: An Evolutionary Approach. Boca Raton, FL: CRC Press.

Goldman AD (2014) Ancient Life in the Information Age. *The Scientist*. March issue, pp. 28-29.

INVITED TALKS

An ancient link between the the origins of trnalstion and cellular organization. Fondation des Treilles, Tourtour, France, November 2026 (anticipated).

The Origin and Early Evolution of Cellularity. University of Arizona Department of Biology, September 2026 (anticipated).

From the Origin of Life to LUCA. NASA Decadal Astrobiology Research and Exploration Strategy. Online, March, 2026.

The Origin and Early Evolution of Cellularity. Metal Utilization and Selection Across Eons consortium meeting. Online, March, 2026.

The Origin and Early Evolution of Cellularity. University of San Francisco Department of Biology. San Francisco, CA, March, 2026.

The Origin and Early Evolution of Cellularity, Keynote Speaker: Quantitative Biology Retreat, University of Notre Dame, October, 2024

Evolution of Cellular Organization Along the First Branches of the Tree of Life, Astrobiology Science Conference, Providence, RI, 2024.

The Origin of Cellularity: Historical and Theoretical Perspectives, Planetary Science Seminar Series, NASA Jet Propulsion Laboratory, 2022.

The Origin of Cellularity: Historical and Theoretical Perspectives, Blue Marble Space Institute of Science, 2022.

Ascent of the Proteome in Ancient Life, Akron University, December 2018

The Origin and Early Evolution of the Protein Repertoire, Stanford University, February 2017.

Ascent of the Proteome in Ancient Life, John Carroll University, March 2017

The Origin and Early Evolution of the Protein Repertoire, Princeton University, February 2016.

Ascent of the Proteome in Ancient Life, NASA Ames Research Center, January 2016.

Early evolution of the protein repertoire, Stanford University, January 2016.

AstroBIOlogy. Princeton Center for Theological Inquiry. September, 2015.

Ascent of the Proteome in Ancient Life. Massachusetts Institute of Technology. January, 2015.

Ascent of the proteome in ancient life. Occidental College, December 2014.

Evolution of Protein Families in the Last Universal Common Ancestor, Princeton University, April, 2014.

Reconstructing The Ancient Proteome And Its Emergence From An RNA World, Bard College, December, 2013.

The ancient proteome: from the RNA World to the Last Universal Common Ancestor, Stanford University, October 2013.

Early evolution of the protein repertoire, NASA workshop on Thermodynamics Disequilibrium and Evolution, Tempe, Arizona. May 2012.

Ascent of the proteome in ancient life. Universidad Nacional Autónoma de México, December 2012.

Ascent of the proteome in ancient life. Oberlin College. December 2012.

Emergence and expansion of the ancient protein repertoire. American Chemical Society local seminar, Princeton, New Jersey. October 2012.

Ascent of the proteome in ancient life. Johns Hopkins University, October 2012.

Ascent of the proteome in ancient life. NASA workshop on Thermodynamics Disequilibrium and Evolution, Granada, Spain. October 2012.

What is life?. Princeton University, September 2012.

Metabolism and evolution. Astrobiology Graduate Conference, Pasadena, California, August 2012.

Origin of the protein repertoire. MRC Laboratory of Molecular Biology, Cambridge, UK June 2012.

A systems biology approach to the origin of life and early metabolism. Discrete and Topological Models in Molecular Biology, USF, Florida March 2012.

Things we think we know about the origin of life. Princeton University, February 2012.

A systems biology approach to the origin of life and early metabolism. Lewis-Sigler Institute for Integrative Genomics, Princeton, New Jersey, December 2011.

What is life?. Princeton University, September 2011.

What is life and how did it begin?. Swarthmore College, April 2011.

Characterizing the earliest living systems through comparative bioinformatics. Universidad Nacional Autónoma de México, February 2011.

CONTRIBUTED TALKS

Replication Fidelity and Random Drift at the Origin of Life. Astrobiology Science Conference, Virtual and Atlanta, GA, May 2022.

Coevolution of Cellularity and Metabolism in Digital Life Simulations. Astrobiology Science Conference, Seattle, WA, April 2019.

The functional repertoire of RNA and its relationship to the early proteome. Astrobiology Science Conference, June, 2015.

Relating ancient cellular life to the RNA world and prebiotic chemistry through the LUCApedia database. Origins2014, Nara, Japan, July 2014.

Relating ancient cellular life to the RNA world and prebiotic chemistry through the LUCApedia database. Society for Molecular Biology and Evolution, San Juan, Puerto Rico, June 2014.

A machine learning, systems-biological approach to the metabolism of the last universal ancestor. Astrobiology Science Conference, Atlanta, April 2012.

The TIM Barrel fold as a driver of early protein-mediated metabolism. Astrobiology Science Conference, Atlanta, Georgia, April 2012.

Oxytricha as a model for early genetic systems. Gordon Research Conference on the Origin of Life, Galveston, TX, January 2012.

Viruses aren't life, but neither are you. Origins 2011, International Society for the Study of the Origin of Life, Montpellier, France, July 2011.

The TIM Barrel fold, early life forms, and the nature of biological complexity. Astrobiology Graduate Student Conference, Bozeman, Montana, June 2011.

The rapid development of early protein biosynthesis. Astrobiology Science Conference, League City, TX, April 2010.

The shortcomings of a phenomenological semantic system in origin of life research. Astrobiology Science Conference, League City, TX, April 2010.

The rapid evolution of translation proteins during the origin of life. Gordon Research Conference on the Origin of Life, Galveston, TX, January 2010.

An enhanced semantic system for the origin of life. Astrobiology Graduate Student Conference, Seattle, WA, July 2009.

CHAired CONFERENCE SESSIONS

Evolution Before LUCA: Reconstructing the Earliest Cellular Lineages. Astrobiology Science Conference, Madison, WI, May 2026

Thinking Beyond LUCA: Stem Life and Primordial Diversity. ABSciCon, Virtual and Atlanta, GA, May 2022.

Life's Dark Ages: Molecular evolution between the origin of life and the LUCA, Astrobiology

Science Conference, Seattle, WA, April 2019.
 Major transitions in organismal individuality: From compartments, to protocells, to cells, Astrobiology Science Conference, Seattle, WA, April 2019.
 Cellularity, multicellularity, and endosymbiosis: Major transitions and their impacts on the biosphere, Astrobiology Science Conference, Mesa, AZ, April 2017.
 The origin and evolution of early life, Society for Molecular Biology and Evolution, San Juan, Puerto Rico, June 2014.
 Metabolism and evolution. ABGradCon, Pasadena, California, August 2012.
 Extremeomics: The biology and metabolism of weird life. ABSciCon, Atlanta, Georgia, April 2012.
 Origin and evolution of genetic systems. ABSciCon, League City, TX, April 2010.

POPULAR MEDIA

IFL Science. *Genetic Hints Reveal The Roots Of The Tree Of Life Before The Last Universal Common Ancestor*. Stephen Luntz, 2026
 Popular Mechanic. *All Life on Earth Has One Common Ancestor. Scientists Think These Genes Predate It*. Darren Orf, 2026.
 Washington Post. Simple chemistry helps explain the origin of life, new study suggests. Kasha Patel, August 2025
 Washington Post. *How did life on Earth begin? The chemical puzzle just became clearer*. Kasha Patel, February 2024
 All About Space. *Unravelling the Mystery of Life*. David Crookes, Oct 2023.
 Popular Mechanic. *New Study May Very Well Solve the #1 Mystery of Life's Origins*. Darren Orf, 2023.
 The Debrief. *Origin Of Life Mystery May Finally Be On The Brink Of A Solution Thanks To Electron Transport Chains*. Christopher Plain, 2023.
 + 24 additional articles in 2023 according to Altmetrics
 Cosmos Magazine. *Would extraterrestrial life even be life as we know it?*. Richard Lovett, 2022.
 SciTechDaily. *New Astrobiology Research Predicts Alien Life "As We Don't Know It"*. 2022.
 Quanta Magazine. *Biologists Invoke the Past in Modern Bacteria*. Emily Singer, June 2015.

RECENT COMMUNITY SERVICE ACTIVITIES

Senior Editor, Journal of Molecular Evolution, 2019 – present.
 Associate Editor, BMC Evolution and Ecology, 2024-present.
 Ad hoc reviewer for 23 journals: Astrobiology, Biosystems, BMC Evolutionary Biology, ChemBiochem, Current Biology, eLife, Extremophiles, The FEBS Journal, International Microbiology, Journal of Molecular Evolution, Molecular Biology and Evolution, Molecular Phylogenetics and Evolution, Nature Communications, Nature Ecology and Evolution, Origins of Life and Evolution of Biospheres, Philosophical Transactions of the Royal Society A, Philosophical Transactions of the Royal Society B, PLoS One, PLoS Biology, Proceedings of the National Academy of Science U S A, Proceedings of the Royal Society B, Protein Science, Science Advances, Scientific Reports.
 Panelist NSF BIO/DBI Programs, 2024
 Panel Leader, NASA ISFM Midway Review, 2023
 Panel Leader, NASA FINESST Program Proposal Review, 2022
 Associate Editor, Journal of Molecular Evolution, 2014 – 2019.
 Panelist, NASA Exobiology Grant Proposal Review, 2019.
 Editorial Board, Astrobiology Primer 2nd Edition, August 2010 – 2016.
 Organizer, Oppenheim Symposium on Ancient Life from Computational Perspectives, Oberlin College, 2015.
 Panel Leader, NASA Exobiology Grant Proposal Review, 2015.
 Co-chair of Organizing Committee, Origin of Life Workshop, Princeton Center for Theoretical Science, January 2013.