Freddy Bunbury

Research Scientist at the University of Chicago investigating microbial thermotolerance and metabolite exchange. My work focuses on developing genome-informed, trait-based frameworks to predict microbiome responses to environmental change.

Chicago, IL, USA
+1-650-334-6891
freddy.bunbury@gmail.com
https://freddybunbury1.github.io/

Research Vision

I study how microbial traits and interactions determine ecological performance under environmental change, with a focus on warming and metabolite exchange. My current programme centres on two linked questions: how photosynthetic microbes evolve and acclimate to high temperatures, and how bacteria synthesise, share, and compete for essential metabolites such as vitamin B12. Across these systems, I aim to develop predictive, genome-informed trait frameworks that connect genes to physiology, community assembly, and ecosystem function.

Academic Appointments

08/2023 – Curr. Chicago, IL, USA
Research Scientist, University of Chicago (Department of Ecology and Evolution)
Lead an externally funded research programme on cyanobacterial thermotolerance with co-PI Claire Donnat, alongside an independent programme on metabolite exchange hosted within the Kuehn lab. Combine cultivation, high-throughput phenotyping, genomics, and modelling. Created a diverse, arrayed, genome-sequenced library of > 300 bacterial isolates; quantified vitamin synthesis, release, and uptake traits; developed models of microbial vitamin sharing; and led development of genome-to-trait prediction pipelines. Mentor a postdoctoral researcher, research assistant, and undergraduates.

09/2019 – 07/2023 Stanford, CA, USA
Postdoctoral Fellow, Carnegie Institution for Science (Bhaya & Grossman labs)
Studied the genetics, motility, and biofilm formation of thermophilic bacteria from Yellowstone hot springs. As the first hire on an international NSF–BBSRC grant, coordinated collaborations between Carnegie, Chicago, and Cambridge; developed experimental infrastructure and protocols; onboarded team members; and contributed to publications, grant writing, mentoring, and outreach.

Education

2015–2019 **PhD in Algal Microbiology, University of Cambridge**, Cambridge, UK. Advised by Prof. Alison Smith. Thesis: *A metE mutant of Chlamydomonas reinhardtii provides new perspectives on the evolution of vitamin B12 auxotrophy*.

2014–2015 **MRes in Microbiology, University of Cambridge**, Cambridge, UK. Research projects on algal–bacterial vitamin exchange and malaria parasite protein purification.

2011–2014 **BA in Natural Sciences, University of Cambridge**, Cambridge, UK.

Research Funding and Independence

2025–2028 **MMORCC: Evolution and Mechanisms of Thermotolerance in Cyanobacteria**. Principal Investigator. Joint NSF (2520677) + Allen Family Philanthropies (02507-18152), $2 \times$ **$358,830** = **$717,660**.

2025–2026 **Numerical PDEs for Modeling Cellular Biophysics**. Co-Investigator. NITMB internal project. **$75,000**.

2022–2025 **Photosynthesis at High Temperatures: Genetic and Phenotypic Underpinnings of Thermotolerance in Cyanobacteria**. JGI New Investigator CSP, ID 509352. **$312,517** estimated in-kind value.

2021–2022 **Diel Dynamics and Physical Interactions of Phototrophic Isolates from a Hot Spring Microbial Mat**. Coauthor. EMSL Exploratory, ID 60171. **$80,468** estimated in-kind value.

Publications

In prep — [18] **Bunbury F**, Janas T, Ghosh S, Scorza K, Mullen P, Donnat C et al. *Bacterial vitamin sharing emerges from a balance between release and uptake*.

bioRxiv — [17] Schmitt MS, Lee KK, **Bunbury F**, Landsittel JA, Vitelli V, Kuehn S. *Learning functional groups in complex microbiomes*. 2026

PNAS — [16] **Bunbury F**, Rivas C, Calatrava V, Malkovskiy AV, Joubert L-M, Parvate AD, et al. *Cyanobacteria and Chloroflexota cooperate to structure light-responsive biofilms*. 2025

Plant Physiology — [15] Sayer AP, Llavero-Pasquina M, Geisler K, Holzer A, **Bunbury F**, Mendoza-Ochoa GI, et al. *Conserved cobalamin acquisition protein 1 is essential for vitamin B12 uptake in both Chlamydomonas and Phaeodactylum*. 2024

Microbiol. Resour. Announc.	[14] Shelton AN, Yu FB, **Bunbury F**, Yan J, Rivas C, Grossman A, et al. *Draft genome of Chloroflexus sp. MS-CIW-1.*	2024
bioRxiv	[13] Kim RG, Huang W, Findinier J, **Bunbury F**, Redekop P, Shrestha R, et al. *Chloroplast methyltransferase homolog RMT2 is involved in photosystem I biogenesis.*	2024
Curr. Opin. Syst. Biol.	[12] **Bunbury F**, Shelton AN, Bhaya D. *Shedding light on spatial structure and dynamics in phototrophic biofilms.*	2023
Environ. Microbiol.	[11] **Bunbury F**, Deery E, Sayer AP, Bhardwaj V, Harrison EL, Warren MJ, et al. *Exploring the onset of B12-based mutualisms.*	2022
AEM	[10] **Bunbury F**, Rivas C, Calatrava V, Shelton AN, Grossman A, Bhaya D. *Differential phototactic behavior of cyanobacterial isolates.*	2022
JMIR Public Health Surveill.	[9] Donnat C, **Bunbury F**, Kreindler J, Liu D, Filippidis FT, Esko T, et al. *Predicting COVID-19 transmission to inform mass events.*	2021
PLoS One	[8] Laeverenz Schlogelhofer H, Peaudecerf FJ, **Bunbury F**, Whitehouse MJ, Foster RA, Smith AG, et al. *Combining SIMS and modelling to reveal nutrient kinetics.*	2021
mBio	[7] Menon SN, Varuni P, **Bunbury F**, Bhaya D, Menon GI. *Phototaxis in Cyanobacteria.*	2021
Plant Physiology	[6] **Bunbury F**, Helliwell KE, Mehrshahi P, Davey MP, Salmon DL, Holzer A, et al. *Responses of a newly evolved auxotroph to B12 deprivation.*	2020
PMLR	[5] Donnat C, Miolane N, **Bunbury F**, Kreindler J. *A Bayesian hierarchical network for medical diagnosis.*	2020
New Phytologist	[4] Davey MP, Norman L, Sterk P, Huete-Ortega M, **Bunbury F**, Loh BKW, et al. *Snow algae communities in Antarctica.*	2019
PhD Thesis	[3] **Bunbury F**. *A metE mutant of Chlamydomonas reinhardtii provides new perspectives on the evolution of vitamin B12 auxotrophy.*	2019
Phys. Rev. E	[2] Peaudecerf FJ, **Bunbury F**, Bhardwaj V, Bees MA, Smith AG, Goldstein RE, et al. *Microbial mutualism at a distance.*	2018
New Phytologist	[1] Helliwell KE, Pandhal J, Cooper MB, Longworth J, Kudahl UJ, Russo DA, et al. *Quantitative proteomics of a B12-dependent alga.*	2018

Research in preparation: *genetic determinants of cyanobacterial thermophily (first author); molecular mechanisms of cyanobacterial heat stress survival (senior author); algal vitamin B_{12} uptake and remodelling (co-author); benchmarking microbial GWAS methods (co-author).*

Leadership, Mentoring, Outreach and EDI

Leadership	Lead an NSF–Allen-funded research project with co-PI Claire Donnat on the mechanisms and evolution of cyanobacterial thermotolerance. Established a bacterial strain resource now used across the Kuehn lab. At Carnegie, helped coordinate an international NSF–BBSRC collaboration, including onboarding new members and developing shared infrastructure and protocols.
Mentoring	Primary advisor for Maria Hernandez-Limon (postdoctoral researcher, 2026–present) and Thomas Janas (research assistant, 2025–present) on cyanobacterial thermotolerance. Mentored Alicia Sanoyca (Carnegie Summer Internship, 2022) and Ronan Esperanza (Stanford BioBUDS, 2020). Supervised (tutored) first-year undergraduates in Plant Physiology at Cambridge (2016–2018).
Outreach & EDI	Designed Chicago South Side Science Festival demonstrations (2024–2025); contributed to outreach at the California Academy of Sciences (2023), Carnegie Academy for Science Education middle-school engagement (2022), and Stanford BioBUDS mentoring (2020).

Professional Service and Selected Talks

Professional Service

Manuscript review	Nature Microbiology (2026, 2025); ISME (2025, 2024); New Phytologist (2025); Photochemistry and Photobiology (2025, 2023).
Grant review	National Science Foundation – Collaborative research proposal (2025).
Organising	Advanced Seminars in Microbiology, Stanford (2022–2023).

Selected Talks

Imperial (2026)	**Silwood seminar series invited speaker (upcoming).** *Bacterial vitamin sharing emerges from a balance between release and uptake.*
Denver (2026)	**American Physical Society invited session speaker.** *Bacterial metabolite sharing emerges from a balance between release and uptake.*
Los Angeles (2025)	**American Society for Microbiology contributed talk.** *Cyanobacteria and Chloroflexota cooperate to structure light-responsive biofilms.*
Chicago (2024)	**NITMB ecological dynamics workshop contributed talk.** *Cooperative motility shapes microbial mat structure.*
Minneapolis (2023)	**University of Minnesota invited seminar speaker.** *Microbial motility in Yellowstone hot spring mats.*
Liverpool (2022)	**International Symposium on Photosynthetic Prokaryotes contributed talk.** *Cooperative motility shapes biofilm structure in hot spring mats.*