

NATALIE GREFENSTETTE

Research Scientist ◊ nataliegref@gmail.com

RESEARCH INTERESTS

Astrobiology, Origins of Life, Life Detection and Agnostic Biosignatures, Emergence, Laws and Universal principles of biology

PROFESSIONAL EXPERIENCE

Blue Marble Space Institute of Science, WA, USA *April 2020 - present*
Affiliate Research Scientist

Santa Fe Institute, NM, USA *June 2019 - August 2022*
Postdoctoral fellow with Christopher Kempes
Developing theories and techniques to detect life in the universe, in the Laboratory for Agnostic Biosignatures funded by NASA.

NASA Goddard Space Flight Center, MD, USA *September 2019*
Visiting researcher

University of Michigan, MI, USA *April 2019 - May 2019*
Visiting scholar with Luis Zaman
Modelled the co-evolution of phage and bacteria in bipartite networks.

Encelo Laboratories, London, UK *December 2017 - March 2019*
CEO and Founder
Studied the use of kidney-on-a-chip organoids in the stratification of patients during drug development and in precision medicine. Developed a deep understanding of the drug development process and its pitfalls. Made strong contacts in pharmaceutical companies and wrote a white paper alongside a business plan and fundraising materials. Raised pre-seed funding for the company.

Earth Life Science Institute, Tokyo, Japan *May 2017 - June 2017*
Visiting scholar with Jim Henderson Cleaves
Studied the incorporation of amino acids in the genetic code using cheminformatics. Developed a program to analyse hypothetical earlier sets of canonical amino acids compared to potentially available non-canonical alpha amino acids.

University of New South Wales, Sydney, Australia *July 2011 - August 2011*
Undergraduate Internship with Brett Neilan and Jason Woodhouse
*Studied the bacterial diversity in the cyanobacterium *Lynbya* summer blooms in Moreton Bay (Northern Australia) using genetic identifiers.*

EDUCATION

University College London (UCL), London, UK *2013 - 2017*
PhD, Chemistry
Research with Matthew Powner, Chemistry Department
Thesis: Studies towards the prebiotic synthesis and phosphorylation of ribonucleotides
Studied the prebiotic synthesis of 5'-phosphate ribonucleotides through nucleophilic aqueous phosphorylation and systems chemistry. Discovered a generational node in the network of prebiotic chemistry that links the syntheses of amino acids with nucleotides 5'-phosphates.

University College London (UCL), London, UK *2008 - 2012*
BSc, Biochemistry *First Class honors*

BSc thesis with Helene Plun-Favreau: Unravelling molecular pathways implicated in Parkinson's Disease: Alpha-synuclein phosphorylation and localisation to the mitochondria
Studied the role of phosphorylated alpha-synuclein translocation to the mitochondria in tissue culture cells and patient brain samples using biochemical methods.

Centre National Recherche Spatial, Paris, France

2009 - 2010

ABCnet course on Astrobiology, in collaboration with the European Space Agency

Studied theories on the origin of life and prebiotic chemistry, planet formation and astrobiology space missions; and habitability and astrobiology of terrestrial planets in the solar system.

HONORS AND AWARDS

Best Talk Award Evolution of Complex Life conference (2019)
Dean's List Top 5% of my BSc class (2012)

PUBLICATIONS

* co-lead authors

Under review

Chou L*, **Grefenstette NM***, Borges S, Caro T, Catalano E, Harman CE, McKaig J, Raj C, Trubl G, Young A. *Astrobiology Primer 3.0 - Chapter 8: Searching for life beyond Earth*. Astrobiology 2022

Grefenstette NM*, Chou L*, Colón-Santos S, Fischer TM, Mierzejewski V, Nural C, Sinhac P, Vidaurri M, Vincent L, Weng MM *Astrobiology Primer 3.0 - Chapter 9: Life as we don't know it*. Astrobiology 2022

Published

Jia T, Johnson-Finn KN, Heenatigala T, Alian OM, Bonati I, Penev PI, Prondzinsky P, Smith H, Noda N, **Grefenstette NM**, Fujishima K, Li Y. *AbGradCon 2021: Lessons in Digital Meetings, International Collaboration, and Interdisciplinarity in Astrobiology*. International Journal of Astrobiology 2022

Chou L, Mahaffy P, Trainer M, Eigenbrode J, Arevalo R, Brinckerhoff W, Getty S, **Grefenstette NM**, Da Poian V, Fricke GM, Kempes C, Marlow J, Sherwood Lollar B, Graham H, and Johnson SS. *Current and Future Instrumentation for the Detection and Identification of Signatures of Life on Mars and Beyond*. Frontiers in Astronomy and Space Sciences 2021

Smith H, Hyde AS, Simkus DN, Libby E, Maurer SE, Graham H, Kempes C, Sherwood Lollar B, Chou L, Ellington A, Fricke GM, Girguis PR, **Grefenstette NM**, Pozarycki CI, House CH, and Johnson SS. *The Grayness of the origin of life*. Life 2021

Chou L*, **Grefenstette NM***, Johnson SS, Graham H, Mahaffy P, Kempes C, Elsila JE, Libby E, Ellington A, Anslin E, Hoehler T, Girguis P, Cronin L, Brinckerhoff W, and Sherwood Lollar B. *Towards a more universal life detection strategy*. Bulletin of the AAS, Planetary Science and Astrobiology Decadal Survey 2021 - white paper

Stoker C, Blank JG, Boston P, Chou L, DasSarma S, Eigenbrode J, **Grefenstette NM**, Northup D, Schuerger A, Schulze-Makuch D, Stamenkovi V, and Tarnas J. *We Should Search for Extant Life on Mars in this Decade*. Bulletin of the AAS, Planetary Science and Astrobiology Decadal Survey 2021 - white paper

Grefenstette NM, sub-team lead in Carrier BL, Beaty DW, Meyer MA and the Mars Extant Life Consortium. *Mars extant life: what's next? Conference report*. Astrobiology 2020

Ilardo M, Bose R, Meringer M, Rasulev B, **Grefenstette NM**, Stephenson J, Freeland S, Gillams RJ, Butch CJ and Cleaves HJ. *Adaptive properties of the genetically encoded amino acid alphabet are inherited from its subsets*. Scientific Reports 2019

Fernandez-Garcia C, **Grefenstette NM**, and Powner MW. *Selective aqueous acetylation controls photoanomerisation of a-cytidine-5'-phosphate*. Chemical Communications 2018

Fernandez-Garcia C*, **Grefenstette NM***, and Powner MW. *Prebiotic synthesis of aminooxazoline-5-phosphates in water by oxidative phosphorylation*. Chemical Communications 2017

PROFESSIONAL ACTIVITIES

Editor of Chapters 8 and 9 2020-present
Astrobiology primer 3.0, submitted to Astrobiology

Session convener and chair 2021-2022
AbSciCon 2022 oral and poster sessions, *Detecting life as we don't know it*, Atlanta, May 2022

Workshop organizer 2021-2022
Workshop on *New Frontiers in the Origins of Life*, Santa Fe Institute, March 2022

External organizing committee 2020-2021
Astrobiology Graduate Conference (AbGradCon), virtual, September 2021

Session convener and chair 2020
AGU 2020 oral and poster sessions, *Detecting life through space and time: from geochemistry to biology*, online, December 2020

Grant reviewer 2020
NASA review panel

Peer reviewer
Nature Ecology and Evolution 2021-present
Journal of Molecular Evolution 2021-present
Life 2020-present

TALKS, POSTERS AND ABSTRACTS

* *presenting co-author*

AbSciCon 2022, Atlanta GA, USA *invited talk, 2022*

Grefenstette NM*, Libby E, Kempes C. *Detecting evolution in populations of in silico polymers*

AbSciCon 2022, Atlanta GA, USA 2022

Chou L*, **Grefenstette NM**, Da Poian V, Kempes C, Graham H, Wimp G, Li X, Mahaffy P, Johnson SS. *Leveraging Planetary Mass Spectrometers for Agnostic Life Detection in the Solar System*

AbSciCon 2022, Atlanta GA, USA 2022

Schaible MJ*, Szeibaum N, Rodriguez LE, Colón-Santos S, Vázquez-Salazar A, Vincent L, Todd Z, Bozdog O, Thweatt J, Styczinski MJ, Chou L, **Grefenstette NM**, Caro T, McKaig J. *The Astrobiology Primer 3.0: Overview, Organization, and Collaboration Opportunities*

Georgia Tech, online *invited talk, 2021*

Grefenstette NM*, *Detecting life as we don't know it*

AbGradCon 2021, online *flash talk, 2021*

Grefenstette NM*, Kempes C, Libby E. *Detecting evolution in polymer populations*

Blue Marble Space Institute of Science, online *invited talk, 2021*

Grefenstette NM*, *Detecting life as we don't know it*

- Origins Conference**, online *talk, 2021*
Grefenstette NM*, Kempes C, Libby E. *Detecting evolution in polymer populations*
- NASA GSFC: Early Career Science Forum**, online *poster, 2020*
 Da Poian V*, **Grefenstette NM**, Chou L, Fricke M, Graham H, Kempes C, Mahaffy P, Johnson SS.
Comparing Agnostic Polymer Detection Methods Using Artificial Mass Spectrometry
- Goldschmidt Conference**, online *poster, 2020*
 Chou L*, Da Poian V, **Grefenstette NM**, Graham H, Kempes C, Johnson SS, Mahaffy P, Fricke
 DGM. *Agnostic Polymer Detection in Astrobiological Samples Using Mass Spectrometry and Data-
 driven Analysis* Goldschmidt Abstracts, 2020
- American Society for Mass Spectrometry Conference**, online *poster, 2020*
 Da Poian V*, Chou L, **Grefenstette NM**, Graham H, Kempes C, Mahaffy P, Johnson SS. *Agnostic
 Polymer Detection Using Mass Spectrometry for Astrobiological Samples*
- 51th Lunar and Planetary Science Conference**, online *poster, 2020*
 Chou L*, **Grefenstette NM**, Da Poian V, Kempes C, Graham H, Roussel A, Mahaffy P, Johnson SS.
Agnostic Polymer Detection Using Mass Spectrometry for Astrobiological Samples LPI Contribution
 No. 2706.
- Mars Extant Life**, Carlsbad NM, USA *poster, 2019*
 Johnson SS, Graham H, Anslyn E, Conrad P, Cronin L, Ellington A, Elsila J, Girguis P, House C,
 Libby E, Mahaffy P, Sherwood Lollar B, Steele A, Chou L*, **Grefenstette NM***, Da Poian V *Agnostic
 Approaches to Extant Life Detection* LPI Contribution No. 2108
- Evolution of Complex Life conference**, Atlanta GA, USA *talk, 2019*
Grefenstette NM* and the Powner lab. *A systems chemistry approach to the origin of RNA and
 amino acids*
- Earth Life Science Institute, ELSI Origin Network**, Tokyo, Japan *invited talk, 2017*
Grefenstette NM* and the Powner lab. *Towards the prebiotic synthesis and phosphorylation of
 ribonucleotides*
- UCL, Chemistry Department**, London, UK *invited talk, 2017*
Grefenstette NM* and the Powner lab. *Towards a one-pot prebiotic synthesis of ribonucleotides*
- Simons Foundation SCOL symposium**, New York NY, USA *poster, 2015*
 Fernandez-Garcia C*, Ashe K*, **Grefenstette NM** and Powner MW. *Prebiotic assembly and modifi-
 cations of nucleotide-5'-phosphates*
- Simons Foundation SCOL symposium**, New York NY, USA *poster, 2015*
 Islam S*, **Grefenstette NM***, and Powner MW. *Systems chemistry: the roots of biological organisa-
 tion*

OTHER CONFERENCES ATTENDED

- IRP DynS³Bio: Advanced Course on Applied Dynamics in Systems and Synthetic Biology**
 Centre de Recerca Matemàtica, Bellaterra, Spain *2021*
- Alife 2021: Artificial Life conference**, online *2021*
- DynS³Bio: International Conference on Dynamics in Systems and Synthetic Biology**
 online *2021*
- EANA Astrobiology conference**, online *2020*
- AbGradE**, online *2020*
- Alife 2020: Artificial Life conference**, online *2020*

Gordon Research Conference: Origin of Life , Galveston TX, USA	2020
Gordon Research Seminar: Origin of Life , Galveston TX, USA	2020
EANA Astrobiology conference , Orleans, France	2019
AbGradE , Orleans, France	2019
AbSciCon: Astrobiology Science conference , Seattle WA, USA	2019
Unconventional Computation and Natural Computation conference , Manchester, UK	2016
Astrobiology Society of Britain, 6th biennial meeting , London, UK	2015

MENTORING, OUTREACH AND MEDIA APPEARANCES

MIT Technology Review DE , Nicht nur Wasser: ‘Auerirdisches Leben knnte auf anderen Moleklen beruhen’ / <i>EN: Not just water: ‘Extraterrestrial life could be based on other molecules’</i> , interview	2022
The Economist , How to improve the search for aliens , quoted	2022
Alien Crash Site , What are the best strategies for finding life in space? , podcast	2021
Undergraduate Complexity Research mentor , <i>co-mentoring an undergraduate researcher for a summer project</i>	2021
Art of Inquiry , <i>An interactive online school for ages 10-14</i>	invited talk, 2021
Looking for weird life	
Astrobiology NASA news , NASAs Dragonfly Mission Will Seek Clues about Titans Habitability , <i>quoted</i>	2020
Blue Marble Space Institute of Science , Dr Natalie Grefenstette and her Innovative Research on Polymer Evolution , <i>interview</i>	2020
Complexity by the Santa Fe Institute , Natalie Grefenstette on Agnostic Biosignature Detection , <i>podcast</i>	2020
Smithsonian magazine , Scientists Discover Exposed Bacteria Can Survive in Space for Years , <i>quoted</i>	2020
Biomusings , My astrobiologist view of life , <i>article</i>	2020
72 Hours of Science , <i>SFI postdocs producing a noval speculative scientific paper in 72h</i>	2020
Bacaksizlar G, Crabtree S, Garland J, Grefenstette NM , Kao A, Kinney D, Kolchinsky A, Marghetis T, Price M, Riolo M, Shimao H Teufel A, van der Does T and Yang VC. <i>Greetings from a Triparental Planet</i> . arXiv preprint arXiv:2011.01508	
Leadership team	2020-present
Network for Life Detection (NFoLD), <i>Early Career Council</i>	

PROFESSIONAL MEMBERSHIPS

American Geophysical Union	2020 - 2022
International Society for Artificial Life	2020 - present
Network for Life Detection (NFoLD)	2020 - present

SKILLS

Experimental and computational skills

Programming: Python, stochastic simulations, PCA, Cheminformatics (JChem, GenerateMD, Dragon, Cxcalc)

Organic chemistry: NMR, MS, synthetic organic chemistry, aqueous organic chemistry, column chromatography

Cell and molecular biology: mammalian cell culture, Western blot, DNA extraction, PCR, fluorescent microscopy, confocal microscopy

Soft skills

Languages: Fluent in English and French, conversational in Spanish

Others: Graphic design, Event management, Language teaching, Jazz singing