

# NATALIE GREFENSTETTE

Research Scientist ◊ nataliegref@gmail.com

## RESEARCH INTERESTS

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

## PROFESSIONAL EXPERIENCE

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**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

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**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

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

## PUBLICATIONS

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\* co-lead authors

### Published

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 2024

**Grefenstette NM\***, Chou L\*, Colón-Santos S, Fischer TM, Mierzejewski V, Nural C, Sinhac P, Vidaurre M, Vincent L, Weng MM *Astrobiology Primer 3.0 - Chapter 9: Life as we don't know it*. Astrobiology 2024

**Grefenstette NM**, and other editors in the Astrobiology primer 3.0. *Chapter 1: The Astrobiology Primer 3.0*. Astrobiology 2024

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, Brinkerhoff 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, Anslyn E, Hoehler T, Girguis P, Cronin L, Brinkerhoff 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

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**Editor of Chapters 8 and 9** 2020-2024  
*Astrobiology primer 3.0*, published in *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 2021-2023  
 Journal of Molecular Evolution 2021-2023  
 Life 2020-2023

## TALKS, POSTERS AND ABSTRACTS

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\* *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 modifications 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 organisation*

## OTHER CONFERENCES ATTENDED

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- IRP DynS<sup>3</sup>Bio: Advanced Course on Applied Dynamics in Systems and Synthetic Biology**  
 Centre de Recerca Matemàtica, Bellaterra, Spain 2021
- Alife 2021: Artificial Life conference**, online 2021
- DynS<sup>3</sup>Bio: 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

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

## MENTORING, OUTREACH AND MEDIA APPEARANCES

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

## PROFESSIONAL MEMBERSHIPS

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<b>American Geophysical Union</b>	2020 - 2022
<b>International Society for Artificial Life</b>	2020 - 2023
<b>Network for Life Detection (NFoLD)</b>	2020 - 2023

## SKILLS

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### **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