

Moran Frenkel-Pinter, Ph.D.

Senior Lecturer (assistant professor)
Institute of Chemistry | The Hebrew University of Jerusalem
Givat Ram Campus, Jerusalem 91904 Israel
Member of the NASA Center for the Origins of Life
moran.fp@mail.huji.ac.il

Education:

2017 - Ph.D. in the Argentina Direct Ph.D. Honors Program for Excellent Students in Biology at Tel Aviv University (TAU), Israel. Advisors: Prof. Daniel Segal and Prof. Ehud Gazit.

Dissertation title: *Sweet Neurobiology: Establishing the Role of Protein Glycosylation Alterations in Alzheimer's Disease*

2012 - M.Sc. Biotechnology, received during the Ph.D. program.

2009 - B.Sc. "Biology with emphasis on Biotechnology" from Tel Aviv University, Israel. *Summa Cum Laude*

Research appointments:

July 2023 – present – Vice Director, Minerva Center for Studying the Planetary Emergence of Life

July 2021 - present – Senior lecturer (assistant professor), Institute of Chemistry, The Hebrew University of Jerusalem, Israel.

August 2019 - July 2021 – Research scientist, School of Chemistry and Biochemistry, member of the Center for Chemical Evolution (CCE) and the NASA Center for the Origins of Life, Georgia Institute of Technology, Atlanta, GA, USA (Williams, Hud and Grover groups).

August 2018 - July 2021 – Sub-Group Leader of the NASA Center for the Origins of Life (COOL) – Supervise the research of two undergraduates, three graduate students, and a technician.

August 2017 - August 2019 – NASA postdoctoral fellow, School of Chemistry and Biochemistry and the Center for Chemical Evolution (CCE), Georgia Institute of Technology, Atlanta, GA, USA (Williams, Hud and Grover groups).

August 2016 - August 2017 – Postdoctoral Fellow, School of Chemistry and Biochemistry and the Center for Chemical Evolution, Georgia Institute of Technology, Atlanta, GA, USA (Hud and Grover groups).

Teaching:

2022- present – Senior lecturer – Institute of Chemistry/The Hebrew University of Jerusalem, Israel. Courses:

- General Chemistry for medical students (300 students/year)
- Chemical Evolution and Origins of Life (expected 30 students/year)

2010 - present – Research guidance of undergraduate and graduate students

2010 - 2014 – Teaching Assistant in General Genetics course (4 semesters), Tel Aviv University

Service:

2023 - present - Local Ambassador of the Biochemical Society in Israel
2022 - Organizer of the Israel Society for Astrobiology and the Study of the Origin of Life (ILASOL) Annual Meeting
2022 - Discussion group leader, The Israel Institute for Advanced Research (IYAR)
2022 - Topical Advisory Panel Member, *International Journal of Molecular Sciences*
2022 - Panel Member of the Origins of Life Science Breakthrough Radar 2022, The Geneva Science and Diplomacy Anticipator (GESDA) Foundation
2021 - Committee member of the Israel Society for Astrobiology and the Study of the Origin of Life (ILASOL).
2021 - Guest Editor, *International Journal of Molecular Sciences*
2020 - 2021 - Topic Editorial Board Member, *Life*
2020 - NASA review panelist
2020 - NSF expert reviewer
2020 - Member of the COVID-19 Test Support Team at Georgia Tech
2018 - 2019 - Member of the School Safety & Risk Management Committee
2018 - Organizer of the annual Georgia Tech Astrobiology colloquium
2004 - 2006 - Israel Defense Forces - Served in the Intelligence Corps. Research leader for a unique technologically-oriented project in an elite unit

Membership of scientific societies and centers:

2023-present: member of the Biochemical Society and its Local Ambassador in Israel
2022-present: member of the INNOGLY Cost Action
2022-present: member of the Israel Society for Biochemistry and Molecular Biology (ISBMB)
2022-present: member of The Israel Institute for Advanced Research (IYAR)
2021-present: committee member of the Israel Society for Astrobiology and the Study of the Origin of Life (ILASOL)
2021-present: member of the Center for Nanoscience and Nanotechnology, the Hebrew University
2019-present: - member of the International Society for the Study of the Origin of Life (ISSOL)
2018- present: member of the NASA Center for the Origins of Life (COOL)
2018-2020: member of the American Chemical Society (ACS)

Languages:

Hebrew - native speaker
English - fluent

Grants:

2021 - 2024 - Azrieli Early Career Faculty Grant
2022 - 2026 - Israel Science Foundation (ISF) - Personal Research Grant & New-Faculty Equipment Grant
2023 - 2026 - FEBS Excellence Grant
2023 - 2029 - Minerva Foundation Research Center grant

Selected Fellowships, Honors and Awards:

2023 - **Stanley L Miller Early-Career Research Award** (given tri-annually to the most promising early-career researcher in the origins of life field).

2023 – HUJI Faculty of Sciences Distinguished Researcher
2023 – Dream Chemistry Top Five Finalist Award (1000 EUR)
2022 – **FEBS Excellence Award** (given annually to 8 early-career European PIs).
2021 – **Azrieli Early Career Faculty Fellowship** (given annually to 8 newly-appointed Israeli PIs).
2020 – Awarded a travel scholarship for attending ILANIT 2020 (Eilat, Israel).
2018 – **TAU President's Women postdoctoral fellowship** for Advancing Women in Science (awarded annually to 5 postdocs).
2018 – **Selected talk** at the "Origins of Life" Gordon Research Conference (GRC) award.
2017 – **the NASA Astrobiology Postdoctoral Program Fellowship** (awarded annually to 10 postdocs in the US for two years).
2014 – Awarded the Sieratzki prize for advances in neuroscience, Adams Super Center for Brain Studies, Tel Aviv University (\$200, given to 4 students).
2014 – Awarded a travel scholarship for attending the 2014 Meeting of the Society for Glycobiology (Honolulu, USA) by the Committee of the Society for Glycobiology.
2014 – Awarded a scholarship for excellence in teaching, Tel Aviv University.
2014 – Awarded the Anat Krauskopf fund travel scholarship.
2013 – Awarded the Daniel Turnberg travel fellowship.
2013 – Awarded a travel scholarship by TAU to represent Tel Aviv University in the First Bilateral Israel-Taiwan Life Science Conference.
2012 – **Awarded the National Eshkol PhD Fellowship** (awarded annually to 10 Israeli PhD students for 3 years).
2012 – Awarded a scholarship for excellence in teaching, Tel Aviv University.
2011 – Awarded a travel scholarship by the TAU Center for Nanoscale Science and Technology.
2011 – Awarded a travel scholarship by the Joan and Jaime Constantiner Institute for Molecular Genetics, Tel Aviv University.
2010 – Awarded a travel scholarship by the Disease Models and Mechanisms of The Company of Biologists.
2010 – Awarded a travel scholarship by the Manna Center for Plant Biosciences, Tel Aviv University.
2010 – Accepted to the **Argentina Direct Ph.D Honors Program for Excellent Students** in Biology at Tel Aviv University.
2009 – Dean's honor roll.
2008 – Accepted to Ulpanot Amos De Shalit in Weizmann Institute for excellent life sciences undergraduates.

Research:

Current – In the Frenkel-Pinter lab we study how chemistry led to complex life and aim to bridge the gap between today's biochemistry and the chemical principles that led to emergence of life on Earth during the era of chemical evolution about four billion years ago. Moreover, we harness the creative power of chemical evolution to develop evolving functional biodegradable chains of molecules (polymers) for biotechnological applications. We emulate the environment that gave rise to the polymers of life in order to create and evolve functional polymers. Understanding the basics of chemical evolution will allow us to tame it for innovative purposes, with implications in a variety of fields such as drug delivery, agriculture, and tissue engineering.

Postdoctoral Research - Elucidating mechanisms that lead to the formation of proto-peptides that can spontaneously polymerize, fold and interact with nucleic acids under prebiotic conditions.

PIs: Prof. Loren D. Williams, Prof. Nicholas V. Hud, and Prof. Martha A. Grover, Georgia Institute of Technology

PhD research - The role of protein glycosylation alterations in Alzheimer's disease and elucidation of the effect of glycosylation on peptide self-assembly. Advisors: Prof. Daniel Segal and Prof. Ehud Gazit, Dept. of Molecular Microbiology and Biotechnology, TAU

PhD Lab Rotation: Novel approaches for inhibition of α -synuclein aggregation in Parkinson's disease.

List of publications (updated 13/03/24):

H-index: 21

<https://scholar.google.co.il/citations?user=A7B5GucAAAAJ&hl=en>

1. Edri R[‡], Fisher S[‡], Menor-Salvan C, Williams LD, and **Frenkel-Pinter M** (2023). Assembly-Driven Protection from Hydrolysis as Key Selective Force during Chemical Evolution. *FEBS Letters*, 597(23), 2879-2896.
2. Guth-Metzler R, Mohamed A M, Cowan ET, Henning A, Ito C, **Frenkel-Pinter M**, Wartell RM, Glass JB and Williams LD (2023). Goldilocks and RNA: where Mg²⁺ concentration is just right. *Nucleic Acids Research*, gkad124.
3. **Frenkel-Pinter M**, Bouza Areces M, Fernández Facundo M, Leman LJ, Williams LD, Hud NV and Guzman-Martinez A (2022). Thioesters Provide a Plausible Prebiotic Path to Proto-Peptides. *Nature communications*; 11;13(1):2569
4. C Martin[‡] - **Frenkel-Pinter M**[‡], Smith KH, Rivera-Santana V, Sargon AB, Jacobson KC, Guzman-Martinez A, Williams LD, Leman LJ, Liotta CL, Grover MA and Hud NV (2022). Water-Based Dynamic Depsipeptide Chemistry: Building Block Recycling and Oligomer Distribution Control Using Hydration-Dehydration Cycles. *JACS Au*, 2, 6, 1395–1404
[‡] contributed equally to this work
5. **Frenkel-Pinter M**, Jacobson KC, Eskew-Martin J, Forsythe JG, Grover MA, Williams LD, and Hud NV (2022). Differential Oligomerization of Alpha versus Beta Amino Acids and Hydroxy Acids in Abiotic Proto-Peptide Synthesis Reactions. *Life* 12(2):265
6. **Frenkel-Pinter M**, Petrov AS, Matange K, Travisano M, Glass JB, and Williams LD (2022). Adaptation and Exaptation: From Small Molecules to Feathers. *Journal of Molecular Evolution*, 90(2):166-175
7. **Frenkel-Pinter M**, Sargon AB, Glass JB, Hud NV and Williams LD (2021). Transition metals enhance prebiotic depsipeptide oligomerization reactions involving histidine. *RSC Advances* 11 (6), 3534-3538
▪ The paper was selected as a [HOT RSC Advances article](#).
8. **Frenkel-Pinter M**, Rajaei V, Glass JB, Hud NV and Williams LD (2021). Water and life: the medium is the message. *Journal of Molecular Evolution*, 89.1-2 (2021): 2-11
▪ The paper was highlighted in [NewScientist](#).
9. Losev Y[‡] - **Frenkel-Pinter M**[‡], Hussien MA, Viswanathan GK, Elyashiv Revivo D, Geries R, Khalaila I, Gazit E and Segal D (2020). Differential effects of putative N-glycosylation sites in human Tau on Alzheimer's disease-related

neurodegeneration. Cellular and Molecular Life Sciences; doi: 10.1007/s00018-020-03643-3

‡ contributed equally to this work

10. Paul A, **Frenkel-Pinter M**, Escobar Alvarez D, Milordini G, Gazit E, Zacco E, and Segal D (2020). Tryptophan-galactosylamine conjugates inhibit and disaggregate amyloid fibrils of A β 42 and hIAPP peptides while reducing their toxicity. Communications biology; 3(1):484. doi: 10.1038/s42003-020-01216-5
11. Guth-Metzler R, Bray MS, **Frenkel-Pinter M**, Suttapitugsakul S, Montllor-Albalade C, Bowman JC, Wu R, Reddi AR, Okafor DC, Glass JB, and Williams LD (2020). Cutting in-line with iron: ribosomal function and non-oxidative RNA cleavage. Nucleic Acids Research; 48(15):8663-8674. doi: 10.1093/nar/gkaa586
12. **Frenkel-Pinter M**, Haynes JW, Mohyeldin AM, C M, Sargon AB, Petrov AS, Krishnamurthy R, Hud NV, Williams LD* and Leman LJ* (2020). Mutually Beneficial Interactions Between Proto-Peptides and RNA. Nature communications; 11(1):3137. doi: 10.1038/s41467-020-16891-5
 - The paper was featured as Nature's editorial choice for the [Organic Chemistry and Chemical Biology webpage](#) and was highlighted in [Nature Research Chemistry Community](#), on the [NASA Astrobiology webpage](#), and in [Nature](#).
13. Bowman JC, Petrov AS, **Frenkel-Pinter M**, Penev PI and Williams LD (2020). The Root of the Tree: Significance, Evolution and Origins of the Ribosome. Chemical Reviews; 120(11):4848-4878. doi: 10.1021/acs.chemrev.9b00742. [review article]
14. **Frenkel-Pinter M**, Samanta M, Ashkenasy G* and Leman LJ* (2020). Prebiotic Peptides: Molecular Hubs in the Origin of Life. Chemical Reviews; 120(11):4707-4765. doi: 10.1021/acs.chemrev.9b00664 [review article]
15. Sun Y, **Frenkel-Pinter M**, Liotta CL and Grover MA (2020). The pH-dependent mechanisms of non-enzymatic peptide bond cleavage. Physical Chemistry Chemical Physics; 22, 107-113
16. **Frenkel-Pinter M**, Haynes JW, C M, Petrov AS, Burcar BT, Krishnamurthy R, Hud NV, Leman LJ* and Williams LD* (2019). Selective Incorporation of Proteinaceous over Non-Proteinaceous Cationic Amino Acids in Model Prebiotic Oligomerization Reactions. Proceedings of the National Academy of Sciences; 116(33):16338-16346
 - The paper had major media coverage, including: [Popular Mechanics](#), [Nature](#), [Yahoo! News](#), [Science Daily](#), [Space Daily](#), [Israel Space Agency](#), [Davidson Institute eNewsletter](#) and [Chemistry World](#).
17. Losev Y, Ashim P, **Frenkel-Pinter M**, Abu-Hussein M, Khalaila I, Gazit E and Segal D (2019). Novel model of secreted human tau protein reveals the impact of the abnormal N-glycosylation of tau on its aggregation propensity. Scientific reports; 9(1):2254
18. **Frenkel-Pinter M**, Richman M, Belostozky A, Abu-Mokh A, Gazit E, Rahimipour S and Segal D (2018). Distinct Effects of O-GlcNAcylation and Phosphorylation of a Tau-Derived Amyloid Peptide on Aggregation of the Native Peptide. Chemistry–A European Journal; 24(53):14039-14043
19. Chemerovski-Glikman M‡ - **Frenkel-Pinter M‡**, Mdah R, Abu-Mokh A, Gazit E and Segal D (2017). Inhibition of the aggregation and toxicity of the minimal amyloidogenic fragment of tau by its Pro-substituted analogs. Chemistry–A European Journal; 23(40):9618-9624

‡ contributed equally to this work

20. **Frenkel-Pinter M**, Shmueli M, Raz C, Yanku M, Gazit E and Segal D (2017). Interplay between protein glycosylation pathways in Alzheimer's disease. Science advances; 3(9):e1601576
 - The paper was recommended in F1000Prime.
21. **Frenkel-Pinter M**, Stempler S, Tal S, Waldman Y, Losev Y, Ruppin E, Gazit E and Segal D (2017). Altered protein glycosylation predicts Alzheimer's disease and modulates its pathology in disease model *Drosophila*. Neurobiology of Aging; 56:159-171
22. **Frenkel-Pinter M**, Tal S, Scherzer-Attali R, Abu-Hussien M, Alyagor I, Eisenbaum T, Gazit E and Segal D (2017). Cl-NQTrp alleviates tauopathy symptoms in a model organism through inhibition of tau aggregation-engendered toxicity. Neurodegenerative Diseases; 17(2-3):73-82
23. **Frenkel-Pinter M**, Richman M, Belostozky A, Abu-Mokh A, Gazit E, Rahimipour S and Segal D (2016). Selective inhibition of aggregation of amyloidogenic Tau-derived peptide using its glycosylated analogs. Chemistry–A European Journal; 22(17):5945-52
 - Inside cover of *Chemistry* ([Volume 22, Issue 17](#)).
24. **Frenkel-Pinter M**, Raz C, Gazit E and Segal D (2016). Boiling reduces glycan detection of glycoproteins. CIBTech Journal of Bio-Protocols; 5 (1), 4-8
25. **Frenkel-Pinter M**, Tal S, Scherzer-Attali R, Abu-Hussien M, Alyagor I, Eisenbaum T, Gazit E and Segal D (2016). Naphthoquinone-tryptophan hybrid inhibits aggregation of the tau-derived peptide PHF6 and reduces neurotoxicity. Journal of Alzheimer's Disease; 51(1):165-78
26. Shaltiel-Karyo R[‡] - **Frenkel-Pinter M**[‡], Rockenstein E, Patrick C, Egoz-Matia N, Masliah E, Segal D and Gazit E (2013). A BBB disrupter is also a potent α -synuclein aggregation inhibitor: A novel dual mechanism of mannitol for the treatment of Parkinson's disease. Journal of Biological Chemistry; 288(24):17579-88
 - ‡ contributed equally to this work
 - The paper had major media coverage, including: [Popular Science](#), [MedicalNewsToday](#), and [Science Daily](#).
27. Shaltiel-Karyo R, Davidi D, Menuchin Y, **Frenkel-Pinter M**, Marcus-Kalish M, Ringo J, Gazit E and Segal D (2012). A novel, sensitive assay for behavioral defects in Parkinson's disease model *Drosophila*. Parkinson's disease; Volume 2012, Article ID 697564
28. Shaltiel-Karyo R, Davidi D, **Frenkel-Pinter M**, Ovadia M, Segal D and Gazit E (2012). Differential inhibition of α -synuclein oligomeric and fibrillar assembly by cinnamon extract. Biochimica et Biophysica Acta (BBA)-General Subjects; 1820(10):1628-35
29. Drug E, Landesman-Milo D, Belgorodsky B, Ermakov N, **Frenkel-Pinter M**, Fadeev L, Peer D, and Gozin M (2011). Enhanced Bioavailability of Polyaromatic Hydrocarbons in the Form of Mucin Complexes. Chemical research in toxicology; 24(3):314-20
30. Shaltiel-Karyo R, **Frenkel-Pinter M**, Egoz-Matia N, Frydman-Marom A, Shalev DE, Segal D and Gazit E (2010). Inhibiting α -synuclein oligomerization by stable cell-penetrating β -synuclein fragments recovers phenotype recovery of Parkinson's disease model flies. PLoS One; 5(11): e13863

Presentations at conferences and symposia:

Invited Talks

- **2024:** International Winter School on Origins of Life - WISOL 24, Pavia, Italy
- **2023:** ASM Microbe 2023 meeting, Houston, Texas, USA
- **2023:** Origins 2023, Quito, Ecuador
- **2023:** The first metabolostasis conference, Israel (*virtual*)
- **2023:** International Winter School on Origins of Life - WISOL 23, Pavia, Italy
- **2023:** ILASOL 36th Meeting, BGU, Israel
- **2023:** Biotechnology and Food engineering Seminar, Technion, Israel
- **2022:** Molecular Origins of Life Munich (MOM) meeting, Ludwig-Maximilians-Universität München, Munich, Germany
- **2022:** Towards Molecular Complexity: At the crossroads between astrophysics and biochemistry, Max-Planck-Institut für Astronomie, Heidelberg, Germany
- **2022:** AbSciCon 2022, Atlanta, USA (also served as PCE3 sessions chair)
- **2022:** Earth-Life Science Institute (ELSI) Seminar, Japan (*virtual*)
- **2022:** The 1st Hebrew University – University of Vienna Workshop on Organic Chemistry Meeting, HUJI, Israel
- **2022:** Keynote speaker, NanoBioMed 2022, Barcelona, Spain
- **2022:** Innogly COST workshop: Neuroglycoprotein in health and disease, Alicante, Spain
- **2022:** The Racah Institute of Physics Biological Physics Seminar, HUJI, Israel
- **2021:** The 19th International Society for the Study of the Origin of Life (ISSOL) conference, *virtual meeting*
- **2021:** Keynote speaker and session chair, Trends in NanoTechnology 2021 (TNT2021), Tirana, Albania
- **2021:** Departmental seminar, University of Puerto Rico, Mayagüez (*virtual*)
- **2020:** PCE₃ NASA Workshop – [*What is Chemical Evolution*](#)
- **2020:** Keynote speaker, the 33rd annual meeting of The Israel Society for Astrobiology and the Origin of Life (ILASOL), TAU, Israel
- **2020:** Seminar - *Structure-Function Guided Exploration of Interactions Between Cationic Depsipeptides and RNA*, BGU, Israel
- **2019:** Seminar - *Depsipeptides and RNA: From Molecules to Early Interactome*, The Weizmann Institute, Israel
- **2017:** Seminar - *Dynamic Polymerization of Prebiotic Depsipeptides Allows Selection of Stable Structures*, BIU, Israel

Oral Presentations

- **2020:** ILANIT Conference, Eilat, Israel
- **2019:** AbSciCon, Bellevue WA, USA
- **2019:** Astrobiology Colloquium GT, Atlanta GA, USA
- **2018:** NASA Astrobiology Institute (NAI) Meeting, Atlanta GA, USA
- **2018:** AbGradCon, Georgia Tech, Atlanta GA, USA
- **2018:** “Environments of Terrestrial Planets Under the Young Sun: Seeds of Biomolecules” Symposium, NASA Goddard Space Flight Center, Greenbelt MD, USA
- **2018:** **Selected talk** at the "Origins of Life" Gordon Research Conference (GRC), Galveston TX, USA
- **2016:** The 24th Tel-Aviv University Alzheimer’s Disease Conference, Tel Aviv University, Israel
- **2014:** The annual Meeting of the Society for Glycobiology, Honolulu HI, USA
- **2014:** The 13th Bratislava Symposium on Saccharides, Smolenice castle, Slovakia

- **2014:** The 22nd Tel-Aviv University Alzheimer's Disease Conference, Tel Aviv University, Israel
- **2014:** The Israeli Fly-Worm meeting, Bar Ilan University, Israel
- **2013:** Freie Universität Berlin – Tel Aviv University Symposium, Berlin, Germany.
- **2013:** EuroCarb conference, Tel Aviv, Israel
- **2013:** Brain storming PD conference, Haifa, Israel
- **2011:** ISFN conference, Eilat, Israel
- **2011:** The Fly-Worm annual meeting, Tel Aviv University, Israel
- **2011:** The 19th Tel-Aviv University Alzheimer's disease conference, Tel Aviv University, Israel

Selected Posters

- **2019:** The 7th ELSI Symposium, Tokyo, Japan
- **2018:** The "Origins of Life" Gordon Research Conference (GRC), Galveston TX, USA
- **2017:** The XVIII International Conference on the Origin of Life, San Diego CA, USA
- **2013:** The First Bilateral Israel – Taiwan Life Science Conference, Taiwan
- **2013:** ADPD conference, Florence, Italy
- **2011:** Amyloid Fibrils, Prions and Precursors: Molecules for Targeted Intervention conference, Halle (Saale), Germany

Popular press write-ups (samples):

- "Building Blocks" - Brian Owens, April 2022 (https://azrielifoundation.org/wp-content/uploads/2022/02/Building-Blocks_Web-Single-Pages-1.pdf)
- "Water may be even more crucial to life than we thought" Michael Marshall, New Scientist, Jan 2021 (www.newscientist.com/article/mg24933184-400-water-may-be-even-more-crucial-to-life-than-we-thought).
- "How the first life on Earth survived its biggest threat – water" Michael Marshall, Nature, Dec 2020 (<https://www.nature.com/articles/d41586-020-03461-4>)
- "Don't think too deeply about the origin of life – it may have started in puddles" Moran Frenkel-Pinter on Nature Podcast, December 2020 (<https://podcasts.google.com/feed/aHR0cDovL3d3dy5uYXR1cmUuY29tL25hdH VyZS9wb2RjYXN0L3Jzcy9uYXR1cmUueG1s/episode/MmNmMzBkNTAtMDNhYy00M2UzLWFKYTAtZWYzMTY3YjIhMjk3?sa=X&ved=0CAUQkfYCahcKEwj4guuMwsPtAhUAAAAAHQAAAAAQAw&hl=en>)
- "Life's building blocks", Daniel Zaidman, Davidson Institute, Dec 2020 (<https://davidson.weizmann.ac.il/online/askexpert/%D7%90%D7%91%D7%A0%D7%99-%D7%94%D7%91%D7%A0%D7%99%D7%99%D7%9F-%D7%A9%D7%9C-%D7%94%D7%97%D7%99%D7%99%D7%9D>).
- "Cooperation between RNA and Proto-Proteins" Aaron Gronstal, NASA Astrobiology webpage, Oct 2020 (<https://astrobiology.nasa.gov/news/cooperation-between-rna-and-proto-proteins/>)
- "Forget the chicken or the egg: It doesn't matter if RNA or proteins came first, rather that they need each other" Moran Frenkel-Pinter, Nature Research Chemistry Community, June 2020 (<https://chemistrycommunity.nature.com/posts/forget-the-chicken-or-the-egg-it-doesn-t-matter-if-rna-or-proteins-came-first-rather-that-they-need-each-other>)

- “Why does all life use the same 20 amino acids?” Emma Stoye, RSC Chemistry World, Aug 2019 (www.chemistryworld.com/news/why-does-all-life-use-the-same-20-amino-acids/3010824.article).
- “Everything Is Born from the Same 20 Amino Acids, So Can't We All Just Get Along?” Aug 2019, David Grossman, Popular Mechanics
- “A Chemical Clue to How Life Started on Earth” Science Daily, Aug 2019 (www.sciencedaily.com/releases/2019/08/190801093310.htm)
- “Life’s building blocks”, Oded Carmeli, Israel Space Agency, August 2019 (<https://www.space.gov.il/news-space/131689>)