

THE LIFE DETECTION KNOWLEDGE BASE: ORGANIZING ASTROBIOLOGY KNOWLEDGE AND TECHNOLOGY WITH A NEED FOR ENGAGING THE ASTROMATERIALS AND ORIGIN OF LIFE COMMUNITIES

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Introduction: Recent planetary exploration has revealed a multiplicity of potentially habitable worlds within and beyond our solar system. Future spaceflight missions to seek possible evidence of life on these worlds are currently being conceptualized and developed for the next decade and beyond. In motivating this broad and ambitious endeavor, a National Academies consensus study report in 2019 recommended that NASA “...should support the community in developing a comprehensive framework for assessment—including the potential for abiosignatures, false positives, and false negatives—to guide testing and evaluation of in situ and remote biosignatures” [1].

The problem of organizing life detection strategies into a coherent, functional framework has multiple possible solutions (e.g., [2–4]). All share common challenges, stemming from the fact that astrobiology knowledge is *diverse*, often taking forms not directly amenable to mission analysis; *diffuse*, in that it is spread across many disciplines and a wide-ranging literature; and, in some key areas, *incomplete*. Similarly, the full range of relevant expertise lies distributed across science and technology communities that, in many cases, have had little previous experience with the design and/or implementation of robotic spaceflight missions, or have not perceived the relevance of their science to the search for evidence of life beyond Earth.

The Life Detection Forum (LDF; <https://www.nfold.org/ldf>) is a community-owned suite of online tools to help organize and evaluate astrobiology knowledge and technology in a way that facilitates their infusion into life detection studies and missions. The LDF suite is being developed by the Center for Life Detection (CLD), a collaboration among scientists, technologists, and engineers. The first and core component of the LDF is the Life Detection Knowledge Base (LDKB; <https://ldfknowledgebase.com>), which serves as a user-contributed repository of knowledge relating to biosignatures.

LDKB Structure: In the LDKB, knowledge is structured in the form of arguments supporting or contradicting the value of a given measurement as evidence for life. Arguments are grouped according to

common criteria developed with community inputs, and each argument is supported by evidence drawn from the scientific literature. The structure of LDKB thus mirrors normal scientific discourse and serves to map diverse content into essential measurement assessment concepts, such as false positives, false negatives, and signal-to-noise ratio (e.g., see [5]).

Community Involvement from Astromaterials and Origins of Life Researchers:

The LDKB is intended to be continuously updated with user-contributed knowledge. LDKB was rolled out to the community in 2021 at a second workshop that involved 180+ participants. Those participants later formed five CLD-facilitated “Content Development Groups” to create LDKB entries for at least fifteen life detection measurement types, to both engage and train users toward building a base of community-sourced content.

This first round of content development identified a need for more contributions and expertise regarding *abiotic sources* of many potential biosignatures. More broadly, it highlights a need for the astromaterials and origins of life communities to be more deeply involved in defining the body of knowledge that will guide future efforts to seek evidence of life beyond Earth. For example, those involved in the organic analyses of meteorites could contribute knowledge on the abiotic existence, generation, and long-term survival of biologically relevant and lesser-known organic compounds and their enantiomeric signatures. Similarly, those who pursue research in prebiotic chemistry, synthesis, and areas of chemical evolution, could contribute knowledge on the generation of more complex organic structures, vesicles, polymers, or chemical systems. Such contributions are essential for defining the conditions and environments that can lead to the formation of sophisticated abiotic mimics of potential biosignatures.

The objective of this presentation is to engage scientists in the origin of life and astromaterials communities in helping to define the ‘abiotic background’ against which any evidence of life will need to be distinguished. Specifically, we seek to involve interested researchers of all career stages in building LDKB content, as a means of both capturing critical knowledge and facilitating its application to the

design of missions that will seek evidence of life beyond Earth.

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References: [1] NASEM (2019) *The National Academies Press*, Washington, D.C. doi: 10.17226/25252. [2] Neveu M. et al. (2018) *Astrobiology*, 18, 1375–1402. [3] Glavin et al. (2020) *Chem. Rev.* 120, 4660–4689. [4] Chou et al. (2021) *Front. Astron. Space Sci.* 8, 755100. doi: 10.3389/fspas.2021.755100. [5] Hoehler T. et al. (2021) Planetary Science and Astrobiology Decadal Survey 2023-2032 white paper e-id. 202, doi: 10.3847/25c2feb.bd9172f9.