

# 1 Microbes as Cosmic Kin – An Art-Science 2 Project at the Speculative Edge of Astrobiology

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## 8 Abstract

9 *BioQuantum Record* is a collaboration between an artist and an astrobiologist. The project is an imaginative  
10 gesture of sending microbial life into space as emissaries and living records of Earth, rather than human-  
11 centric messages, challenging anthropocentric frameworks of space exploration by centring microbial life.  
12 Desiccated extremophile microorganisms are embedded in ceramic arkships, which act as microhabitats and  
13 speculative message carriers. These arkships are created through an iterative process involving 3D printing,  
14 mineral infusion, and multiple firings, producing geologically inspired forms. The project raises ethical  
15 questions regarding human intervention in microbial life and the responsibilities of space exploration, while  
16 foregrounding the superior adaptive capacity of microbial life, raising the question of what we can learn from  
17 microbes. Microbial survival is rooted in co-dependent metabolism and forms of interdependence. It points  
18 toward collaboration and interspecies kinship as the foundation for the continued survival of our own  
19 species. The project frames microbes as time-travellers and world-makers capable of persisting across vast  
20 timescales and shaping planetary environments, proposing a form of cosmic kinship that recognises the  
21 interconnectedness of life across species and spatial scales.

22 **Keywords:** Speculative Arkship, Microbial Kinship, Living Archives, Laboratory Encounters, Material  
23 Alchemy, Entanglement

# 24 1. Origins: Cosmic Matter, Microbial Life

25 *What if the first Earthlings to voyage into deep space were not astronauts or machines but microbes?*

26 When Neil Armstrong took his first step on the Moon, he was not alone; a multitude of microorganisms,  
27 inhabitants of his skin, hair, mouth, and digestive tract, accompanied him on this journey. But microbes are  
28 not only invisible passengers in human stories; they have populated Earth for at least 3.5 billion years,  
29 occupying environments ranging from boiling water to glaciers, deserts, ocean floors, and subterranean  
30 realms. They are the very origin of life as we know it, arising from the earliest transition between prebiotic  
31 chemistry and living systems. LUCA, the Last Universal Common Ancestor of all life today, was a  
32 prokaryotic microorganism and the shared ancestor of all living organisms (Moody *et al.* 2024). Their  
33 adaptive capacity and metabolic diversity have shaped our planet and life on it across scales and epochs and  
34 continue to do so, pointing beyond our origins toward possibilities elsewhere in the universe. Thus, microbial  
35 life is both cosmic and foundational, a living medium in which matter and metabolism converge.

36 The microorganisms that rode with Apollo 11 are reimagined—not as accidental passengers, but as  
37 protagonists in journeys that bridge Earth and potential extra-terrestrial futures and pasts. In 2024–2025,  
38 within the context of an art-science residency, the idea for a speculative vessel took shape: an artificial  
39 asteroid, an interstellar ark (arkship), which is a generation starship carrying microbial explorers and a  
40 metabolic offering from Earth. *BioQuantum Record* explores the idea of sending microbial life into outer  
41 space—not as an object, but as Earth’s emissaries, and records, acting as both material and metaphor for  
42 interspecies alliances across temporal, spatial, and epistemological boundaries. This is envisaged through the  
43 inclusion of desiccated microbes within these vessels. Some microorganisms have the remarkable ability to  
44 enter a dormant state and resume their metabolic activity once rehydrated. Within this artistic framework,  
45 microorganisms are imagined as astronauts in hibernation.

46 Survival and revival from their dormant state depend not on human control but on microbial adaptation and  
47 interaction with new environments. In this way, the messenger is also the message: resilience,  
48 interdependence, and continuity are encoded in the microbial cells. By placing microbes at the centre of  
49 interplanetary imagination, the project shifts attention away from anthropocentric hierarchies and opens a  
50 space in which life, authorship, and planetary care can be rethought. The *BioQuantum Record* arkships  
51 prepare the ground for a practice of kinship—not on speaking for these beings but learning to listen to them.

## 52 From the Golden Record to the *BioQuantum Record*

53 In 1977, as NASA launched the Voyager Golden Record to speak for intelligent life, scientists on Earth  
54 discovered a new domain of life: *Archaea* (Woese & Fox 1977). Archaea are prokaryotes, like bacteria,  
55 unicellular organisms that do not have nuclei. However, their biochemistry (cell membrane lipids, cell wall

composition, and genetic machinery) is distinctly different from that of bacteria; in fact, some of it<sup>1</sup> resembles eukaryotes, the domain of organisms with nuclei, which includes *Homo sapiens* (van Wolferen *et al.* 2022). This makes them an important evolutionary bridge from the microbial origin of life to complex multicellular beings. The domain *Archaea* includes extremophiles, microorganisms that live in conditions well beyond what were once thought of as the limits of life, such as temperature regimes from -20 to 121°C (Rampelotto 2013). Their existence has expanded biology's understanding of where life is possible, with implications for ecology, evolution, and the search for life beyond Earth. Thus, 1977 marks a double moment in history—reaching outward and looking inward—signifying the beginning of a paradigm shift, from speaking to intelligence to listening for life unlike anything we know. This shift subtly began to penetrate our awareness, quietly raising questions about otherness—about what we perceive as the norm and what lies outside of it—and about the biases that have shaped our perception.

This shift in perception—from speaking as projection to listening as reception—has profound implications for how we imagine contact with extra-terrestrial life. If microbial collectives are the most likely forms of life beyond Earth, then the question is not whether they can understand us, but how we might learn to recognise and relate to them. Microorganisms communicate through chemical and metabolic signals, which are languages that we can observe but cannot fully interpret. *BioQuantum Record* approaches this question not as a scientific problem but as an artistic investigation. The project stages a question whose answer is necessarily incomplete, a gesture that points beyond our own perception and invites speculation and imagination.

## Microbial Kinship as Practice

To begin with microbes is to begin with invisibility. They permeate every ecosystem, shaping the atmosphere, cycling minerals, and sustaining life (Ehrlich 1998), yet remain largely unacknowledged in human narratives. Their interactions with matter—minerals, metals, salts, and elements such as carbon, sulphur, and nitrogen—record histories that predate humanity and will persist beyond it. *BioQuantum Record* situates these beings as cosmic kin, not by ignoring their otherness, but by attending to difference while recognising the shared physical, chemical, and energetic conditions and structural dynamics that underlie all life (Margulis & Sagan 2000). This project aims to make the invisibility tangible.

We only have knowledge of a fraction of microbial life. Of the known species, only a small percentage can be cultivated in the laboratory by humans (Pham & Kim 2012). This fact in itself is humbling. First, we must understand that we are currently only capable of culturing microbial consortia<sup>2</sup> to a limited extent. The standard method relies on isolated strains of a single species grown in an artificial environment (Hahn *et al.*

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<sup>1</sup> Including archaeal basal transcription (RNA polymerase) and DNA replication machinery (for further information, see: Bell & Jackson 2001; Barry & Bell 2006; Schleper & Rodrigues-Oliveira 2026).

<sup>2</sup> Emerging approaches attempt to co-culture microbial communities, but these are still experimental and not yet widely standardised (for further information, see: Kapinusova *et al.* 2023; Govindaraju *et al.* 2026).

2019). Although this is a restrictive approach, it is the only one currently available for this purpose. For an artist, entering a microbiological lab this means working with microorganisms stripped of their natural cohabitation. Cultivation remains fragile and unpredictable: some species grow readily, others do not, and the underlying reasons often remain unknown. Working with microorganisms requires specialised know-how and strict adherence to laboratory protocols; cultivation, control, and harvesting cannot be improvised. Microorganisms have specific needs, such as chemical nutrients and clear physical and environmental parameters defining their growth conditions (Schlegel & Zaborosch 1995), and a radical otherness—rather than sameness—with humans at the core of their existence.

The artist in the lab learns to fully acknowledge what is happening when one species nurtures another into growth: how one attunes to their rhythms, reading their signs of vitality—odours, blooms of colour, ambivalent shapes under the microscope—one is slowly learning to recognise. In this attention, familiarity quietly arises—strange, intimate, and wholly new.

## **Otherness and Astrobiology as Transdisciplinary Undoing**

Astrobiology<sup>3</sup> confronts us with the possibility of life that may be radically different, while opening the possibility of de-othering by relating across difference rather than erasing it. The concept of othering originates from postcolonial theory (Said 1979; Bhabha 1988). In astrobiology, the term is increasingly being adopted in specific discussions on how we conceptualise different forms of life and their recognisability. Within the project, this was first encountered at the interdisciplinary conference "Exploring Otherness on Earth and Beyond" (Freie Universität Berlin, April 2025), where astrobiology was discussed alongside philosophy, theology, and planetary science as a field that destabilises human-centric categories. *BioQuantum Record* positions microorganisms as protagonists, rather than objects of observation, and enacts a practice of de-othering. Microbes resist complete epistemic capture. By centring them, the project foregrounds a relational mode of thinking in which microbes, humans, planets, and processes are understood to be constituted by their interactions and entanglements with others. Difference is acknowledged as continuity rather than deviation—otherness is not a break from a perceived norm but an extension of it. This conceptual framing is translated into material practice, where disciplinary distinctions between the laboratory and studio, and the biological and geological, are reconfigured in making. Astrobiology is approached as a transdisciplinary epistemic field, functioning as a lens through which questions of otherness become thinkable.

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<sup>3</sup> Astrobiology investigates the origin, evolution, and adaptation of life across the universe, from the extreme ecosystems of Earth to other planets and moons. Combining biology, chemistry, physics, astronomy, and geology, it explores not only the possibility of extra-terrestrial life but also the boundaries of life itself (Schaible *et al.* 2024). The authors are members of the AstroBioArt Lab (ASTRAL), the art and astrobiology project group of the European Astrobiology Institute (EAI).

## 116 2. Lab, Studio, and Planet: Co-Labouring with Microbes

117 The artwork focuses on sculptural vessels conceived as artificial asteroids. They are imagined as carriers of  
118 dormant extremophile archaea into a possible non-Earth future. Within the project, microorganisms were  
119 cultured, desiccated, and incorporated into sculptures. The sculptures do not function as life-sustaining  
120 vessels for active biological metabolism rather they serve as containers for latent or conceptual microbial  
121 presences. Because they are presented as carrying possible multitudes of future microbial life, the term  
122 "arkship" is used for them. In the making of these sculptures, artistic and scientific practices intersect, in  
123 what might be called co-labouring with microbes. By embedding microbial life into sculptural forms, the  
124 vessels emerge as hybrid artefacts, temporary habitats, and sites of projection. They connect the microscopic  
125 to the planetary, staging kinship across scales, disciplines, and temporalities.

### 126 Laboratory Encounters

127 The project's laboratory work focuses on two extremophile archaea: *Halobacterium salinarum* and  
128 *Metallosphaera sedula*. *H. salinarum* is a halophilic (salt-loving) archaeon that thrives in hypersaline  
129 environments and can withstand desiccation and radiation, making it a compelling model for imagining  
130 survival in space-like conditions, such as the salty oceans hypothesised beneath Europa and Enceladus, the  
131 respective icy moons of Jupiter and Saturn. In contrast, *M. sedula* is thermoacidophilic (heat- and acid-  
132 loving) and is found in acidic hot springs, where it metabolises metals such as iron and sulphur. Its resilience  
133 to desiccation makes it a useful analogue for extreme planetary terrains, including Mars. Therefore, both  
134 species were selected for this project.

135 *H. salinarum* was cultivated in 50 mL glass flasks in a strain appropriate medium (DSMZ Medium 97) with  
136 high salinity under aerobic conditions at 37°C. The culture was directly sampled for further experiments, and  
137 the cell material was transferred to metal exposure wells.

138 *M. sedula* was grown in a 1 L glass bioreactor supported by a controlled stream of O<sub>2</sub>, creating an aerobic  
139 environment with an additional stream of CO<sub>2</sub>. Excess CO<sub>2</sub> mimicked the natural environment of volcanic  
140 springs, with a constant temperature of 73°C and a highly acidic pH of 2.0. The growth medium (DSMZ  
141 Medium 88) consisted of a basic elemental composition, such as N, O, Mg, P, S, Cl, K, Ca, and Fe, along  
142 with additional trace elements. Most importantly, it contains the added mineral pyrite (FeS<sub>2</sub>), which serves as  
143 a nutrient source for the microorganisms. The mineral material must be manually ground to a particle size  
144 between 63 and 100 µm to increase the surface availability for cell-mineral interactions. Cultivation was  
145 performed in triplicate, and a more detailed cultivation protocol can be found in Gfellner *et al.* (2025).  
146 Growth was monitored throughout the cultivation period using sampling and light microscopy, and the cells  
147 were harvested and concentrated upon reaching the stationary phase. The concentrated cell material was then  
148 re-cultivated by changing the mineral nutrient source from solely pyrite to a Mars analogue material (JEZ-1

149 Jezero Delta Simulant, Exolith) and ESA01-E Martian basalt analogue, pyrite, rutile, anatase, ilmenite, and  
150 titanium dioxide in small 50 mL glass flasks for 72 h. Upon harvest, the cell-mineral material was transferred  
151 to metal exposure wells.



152  
153 **Figure 1. Laboratory encounters.** a) Counting *Metallosphaera sedula* cells under a microscope. b)  
154 Cultivation of *Metallosphaera sedula* on mineral materials (from left to right: ESA01-E, JEZ-1, pyrite, rutile,  
155 anatase, titanium dioxide, and ilmenite). c) Transferred cell-mineral material into metal exposure wells.

156 The use of mineral media, including pyrite and Mars analogue materials, grounds the work in geochemical  
157 conditions that connect the Earth and space environments. This grounding informed the development of  
158 asteroid-shaped vessels, a form that echoes the natural carriers of panspermia, drawing on the hypothesis that  
159 life can be transported between planetary bodies via space debris (Kawaguchi 2019).

160 **Handling Life**

161 Daily cultivation makes ethical and practical paradoxes more tangible. The same tools that support microbial  
162 life—pipettes, agar plates, and flasks—also constrain it. The microorganisms are cultivated, counted,  
163 concentrated, harvested, desiccated, and ultimately embedded in 3D-printed ceramic vessels for exhibitions.  
164 What does it mean to manipulate, suspend, or instrumentalise living systems for an artistic purpose. If such  
165 interventions are accepted in scientific research, what changes when they are undertaken in art? Where does  
166 artistic inquiry meet, borrow from, or divert from scientific practice? In considering these questions, the  
167 work of Oron Catts and Ionat Zurr becomes especially relevant. Their practice cultivates semi-living tissue  
168 constructs to examine ethical responsibility and the unstable boundary between life and artefact (Ginsberg

169 2017; Burwell 2025)<sup>4</sup>. This raises questions about how ethical responsibility emerges from the cultivation  
170 and maintenance of living systems in artistic and scientific contexts. The *BioQuantum Record* extends these  
171 questions beyond the maintenance of life into its transformation across states.

172 Our speculative spaceship is also a time capsule that places the dormant vitality of a microbial ecosystem in  
173 altered temporal conditions. This raises the paradox of preservation as an anthropocentric act that  
174 reconfigures life's temporal and vital status. By transforming these life forms into ceramic reliquaries, we ask  
175 what is preserved, what is altered, and how potential life is redistributed through this latency. This work  
176 operates within the tension between living matter and material practice. The vessels hold microbes whose  
177 future remains uncertain, capable of persistence, dormancy, or loss, depending on the storage conditions,  
178 material environments, and future interventions. By containing and displaying them, the work intensifies  
179 ethical concerns that arise not from the end of life but from its suspension into desiccation and dormancy. In  
180 doing so, microbial life is positioned within a speculative horizon in which it may outlast human existence—  
181 not as passive residue but as a form of post-human continuity.

## 182 **Studio Practice and Fragile Collaboration**

183 The practice is permeable: open to influence from human and non-human, biotic and abiotic matter.  
184 Experimentation and observation are interwoven, moving between the laboratory and studio. Method and  
185 improvisation, fact and intuition, continually cross-fertilise each other. The design of arkships arises from  
186 this open process. There are no fixed blueprints, only trajectories shaped by the material encounters.

187 Ideas are inseparable from their material translations: rock collections and mineral samples are examined,  
188 small sketches in clay are fired, 3D-scanned, and digitally reworked. Each translation leaves a trace. This  
189 process of translation and variation is realised in the work with a ceramic 3D printer, where the machine's  
190 "errors" become part of the co-production. Clay records impressions from both hands and machine, whereas  
191 science informs the work conceptually. This approach resonates with the material-semiotic ontology. Jane  
192 Bennett's notion of vibrant matter sees all materials as lively and agentic (Bennett 2010). Iovino and  
193 Oppermann's material ecocriticism proposes storied matter, emphasising that materials inscribe and  
194 communicate narratives (Iovino & Oppermann 2014). Building on these perspectives, Başak Ağin and Tuçe  
195 Erel highlight how eco- and bio-artistic practices exemplify this ontology in which matter is both agentic and  
196 meaning-producing (Ağin & Erel 2025). Based on these premises, Ağin's concept of mattertext<sup>5</sup> extends

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<sup>4</sup> In particular, referring to Oron Catts: "We are suffering from an acute poverty of language to describe the things that we are doing to life..." in Ginsberg (2017), *Synthetic Aesthetics: Investigating Synthetic Biology's Designs on Nature*.

<sup>5</sup> Ağin defines mattertext as follows: "Broadly speaking, 'mattertext' names the material-discursive system in which living matter, inscription, and apparatus co-author one another across scales. It treats nanoscale and microscale events (ranging from ion flows and muscle micro-vibrations to microbial metabolism, micro-deformations on clay, or yeast culture inside a lidded ceramic jar) as inscriptions that are transduced by sensors, codes, and all forms of media into meso- and macroscale percepts such as sound, movement, and tactility. As a concept, therefore, mattertext collapses the user/device/text triad or the artist/artwork dichotomy: bodies, tools, and environments are actants in a single dynamic writing process that iteratively writes and rewrites itself" (Ağin 2026, forthcoming; the author's own translation).

197 beyond narrativity, stressing the performative entanglement of living matter, material traces, and artistic  
198 apparatuses (Ağın 2022; Ağın 2026, forthcoming).

199 In the arkships, microbial vitality, mineral presence, and human attention intertwine. The vessels are  
200 mnemonic objects of a co-produced practice, holding dormant biological and mineral processes in a shared  
201 temporal suspension. Dormancy acts as a temporal hinge that links microbial, human, and planetary rhythms.  
202 A paradox lies at the heart of this: microorganisms are neither partners nor subjects. What appears to be  
203 fragility is, in fact, a form of microbial agency.

## 204 **From Material Practice to Planetary Imagination**

205 The project juxtaposes microscopic and cosmic scales not only through the gesture of sending microbes into  
206 space, but also through its material practice. Intimate, hands-on engagement with microorganisms, minerals,  
207 and matter becomes a way of thinking through planetary relations in material form. The vessels are small,  
208 but they point outward to other worlds and deep time.

209 Scientific perspectives on biogeodynamics—the reciprocal shaping of life and planet, as described by  
210 geologists Frances Westall and Long Xiao (Westall & Xiao 2024)—inform the understanding of the vessels  
211 as speculative sites where geological and biological processes intersect and co-produce form. Working with  
212 microbial cultures and clay, the interplay of biotic and abiotic matter, shapes the sculptural process. The  
213 archaea, in their mineral and saline media, and the distinctive qualities of the chosen clay are points of  
214 orientation. The resulting forms connect processes from microbial activity to material behaviour, drawing on  
215 biogeodynamic principles within artistic practice.

## 216 **3. Who speaks for Earth?**

217 Representation is never neutral. To speak for Earth is always to filter—choosing which stories, images, or  
218 organisms stand in for planetary life. *BioQuantum Record* operates within this constraint but makes a  
219 fundamental shift from symbolic representation to material presence. Representation here emerges through  
220 metabolic presence, attentive care, and material practice. At its centre: microbes—not messages about life,  
221 but life itself. In this gesture, representation shifts toward biology and matter, suggesting that communication  
222 across cosmic distances may unfold through presence rather than symbols.

223 This work makes no claim to offer a complete portrait of Earth. Instead, it offers a foundational fragment.  
224 The microbial "crew" is not chosen to speak *for* other life forms but to *be* a living piece of the planet's  
225 ongoing material becoming. This embraces a partial, material truth resonant with Gaia theory (Lovelock &  
226 Margulis 1974): that Earth, at its core, is a living system. *BioQuantum Record* moves beyond the logic of the  
227 Golden Record, which curated a message about human intelligence for an extra-terrestrial "someone"  
228 fathomed in our own image. Instead, it proposes life itself as a form of intelligence that may be universally



228 legible. Not as conscious thought, but as a persistent, negentropic process: the capacity of matter to  
229 complexify and sustain organised relations against the cosmic drift toward entropy. In this sense, intelligence  
230 is not a fixed property but an emergent one arising from material and biological processes. Representation  
231 shifts to a mode of responsiveness: an invitation to future encounters where meaning is made.

## 232 **The Fragility of Representation**

233 *BioQuantum Record's* microbial proposition gains significance against a contemporary backdrop in which  
234 space exploration is increasingly defined by privatisation and militarisation. Billionaires such as Elon Musk  
235 and Jeff Bezos have become central actors in orbital infrastructure, shaping access and priorities according to  
236 private commercial interests (Deudney 2020). Simultaneously, military actors are asserting dominance, with  
237 states explicitly planning manoeuvres beyond Earth's atmosphere and formally constituting space as a war-  
238 fighting domain (United States Space Force 2020). In this context, claims to defining planetary futures are  
239 constrained by concentrated economic and political power, a paradigm of control antithetical to the project's  
240 relational, distributed approach. In this context, the project's choice to "send" microbes is a fragile gesture. It  
241 is not merely symbolic but performative: the language and form we use to imagine space exploration actively  
242 shape the reality we build. By proposing microbes as "emissaries", the project opens toward a future that  
243 fosters more-than-human kinship rather than extraction and dominance.

244 Juxtaposing microbial life against technological moguls and power politics seems fragile. However, this  
245 perception is deceptive: what appears weak from an anthropocentric perspective—a microscopic organism—  
246 is among the most enduring and powerful forms of life in a planetary context. Microorganisms have shaped  
247 the Earth's atmosphere and geology for billions of years. The true "fragility" lies not in them but in human  
248 systems of control that overlook this microbial power. Thus, this gesture is a form of resistance. It resists the  
249 hubris of authoritative speech—corporate, national or military by replacing claims of control with microbial,  
250 non-sovereign forms of presence. The arkships embrace partiality and humility, proposing that a planetary  
251 representation might begin not with an authoritative statement but with a quiet, metabolic offering of  
252 encounter.

## 253 **Toward Speculative Planetary Futures**

254 Fragility here is a condition here is a condition of ongoing relational emergence. The project stages microbes  
255 not as symbols but as companions in ongoing collaboration. Microorganisms demonstrate strategies for  
256 enduring and adapting, showing that life's continuity relies on processes that exceed the human capacities.  
257 This has profound implications: Earth's future depends on forms of cooperation that we can nurture but  
258 never fully control.

## 259 4. Material Alchemy: Sculpting with Extremophiles

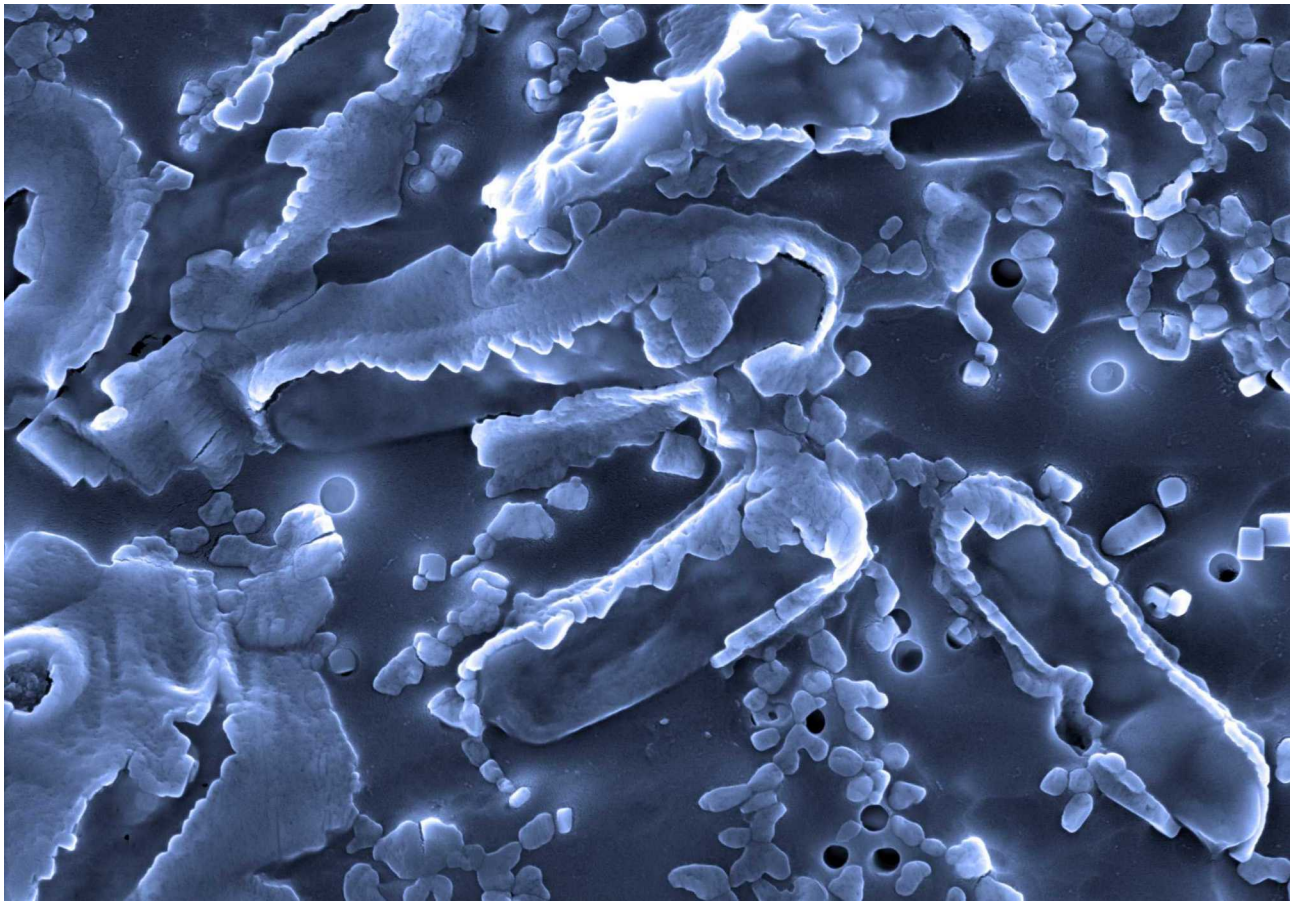
260 Clay, minerals, and microbes come together and forms emerge through experimentation: cultivation, shaping,  
261 and firing. Materials respond to heat, handling, and chemical changes, echoing geological processes.  
262 Through these processes, scientific research, microbial cultivation, machine operations, and material  
263 encounters converge. Cultivation, firing, and form-giving are entwined, translating microbial life processes  
264 into objects that move from microscopic to planetary scales. The arkships materialise these entanglements as  
265 vessels shaped through encounters with extremophile organisms.

### 266 Sculpting with Extremophiles

267 The arkships emerge from a process that blends scientific insight with material intuition and attentiveness to  
268 unpredictability, following where the materials lead, resulting in two vessel series shaped by the ecological  
269 realities of their respective extremophiles. *M. sedula*, thriving on iron- and sulphur-rich minerals, informed  
270 vessels that echo geochemical landscapes. Faïence blanche, a fine white earthenware clay, was selected for  
271 its plasticity, 3D-printing suitability, and ability to absorb mineral washes. Typically fired at lower  
272 temperatures, the clay was pushed to higher limits, provoking geological-like reactions.

273 The clay body was infused with iron oxides, lava flour and sulphur. After bisque firing, the surfaces were  
274 repeatedly washed with mineral oxides (iron, manganese, titanium, rutile, and vanadium) and layered with  
275 powders such as basalt, pyrite, and ilmenite. These minerals were chosen for their presence in the culture  
276 medium as well as their relevance to astrobiology and theories of the origin of life. High-silica glazes  
277 enabled surface vitrification, resulting in unexpected mineral effects. Multiple kiln passes built geological  
278 strata, recording the clay's response to heat and mineral saturation as layers fused, fractured, and  
279 transformed, with each vessel being a material chronicle of its own making.

280 *H. salinarum*, a salt-loving organism, guided porcelain vessels, a material that is both fragile and resilient.  
281 This ceramic vitrifies at high temperatures into a dense, luminous body evocative of the microbe's sunbaked  
282 salt-pan habitat. Thin porcelain sections are semi-translucent—an homage to the archaeon's light-driven  
283 metabolism via bacteriorhodopsin, a protein in its cell membrane. Post-firing salt washes produced crystal  
284 growth across surfaces and within crevices, linking the vessels to the saline world of their microbial  
285 passengers. Together, these processes situate each vessel as a material trace of microbial–mineral  
286 entanglement under extreme conditions.



287

288 **Figure 2. Extremophiles.** Rod-shaped, salt-encrusted *Halobacterium salinarum* cells with a cell length and  
 289 width of 3  $\mu\text{m}$  and 1  $\mu\text{m}$ , respectively, were observed under a scanning electron microscope. The analysis  
 290 was conducted at the Archaea Centre at the University of Regensburg, Germany (ZEISS GeminiSEM).

## 291 **Clay: Archive, Catalyst, Speculation**

292 The vessel design merges two ideas: meteorites—shaped by cosmic forces—and the vessel—deliberately  
 293 engineered, like the Golden Record. 3D printing bridges these realms, producing complex organic forms  
 294 with technological precision, reminiscent of how information or code becomes matter. But the machine never  
 295 prints perfectly; subtle deviations—akin to mutations or disturbances in DNA replication that generate  
 296 evolutionary variety—are embraced, becoming part of the vessel’s emergent logic and reflecting the  
 297 unpredictability of biological systems. The artist is coaxing the machine to the edge of failure to invite these  
 298 generative errors, challenging it enough to provoke mistakes while still maintaining the form printable. This  
 299 is a methodology of iterative making across material, digital, and machine processes.

300 Clay situates the work in a material that is both ancient and future oriented. One of the oldest human material  
 301 practices, it is also used in contemporary space applications. It offers natural shielding from space radiation  
 302 and has long-standing applications in space technology. Clay also plays a crucial role in the theories of the  
 303 emergence of life. In the presence of simple biochemicals such as gamma-aminobutyric acid (GABA)—an

304 amino acid commonly found in meteorites—montmorillonite clay undergoes exfoliation, forming nanoscale  
305 cavities that may have acted as primitive compartments in prebiotic chemistry, concentrating and organising  
306 organic molecules—a crucial step in the origins of living systems (Bezaly *et al.* 2025).

307 Thus, clay becomes a multi-directional compass for the project, oriented toward deep time and the origins of  
308 life, where mineral–organic interactions are theorised in prebiotic chemistry; toward the present, where  
309 laboratory and technological practices investigate these interactions through material and experimental  
310 protocols; and toward speculative futures of spacefaring. Its material properties, such as structural stability  
311 and radiation shielding, make it a potential carrier medium for biological matter. Within this temporal field,  
312 panspermia operates as a conceptual axis linking the possible interplanetary transmission of life across past,  
313 present, and future trajectories. In this framing, the arkships function as speculative life-seeding devices.

## 314 **Thinking-with Microbial Futures**

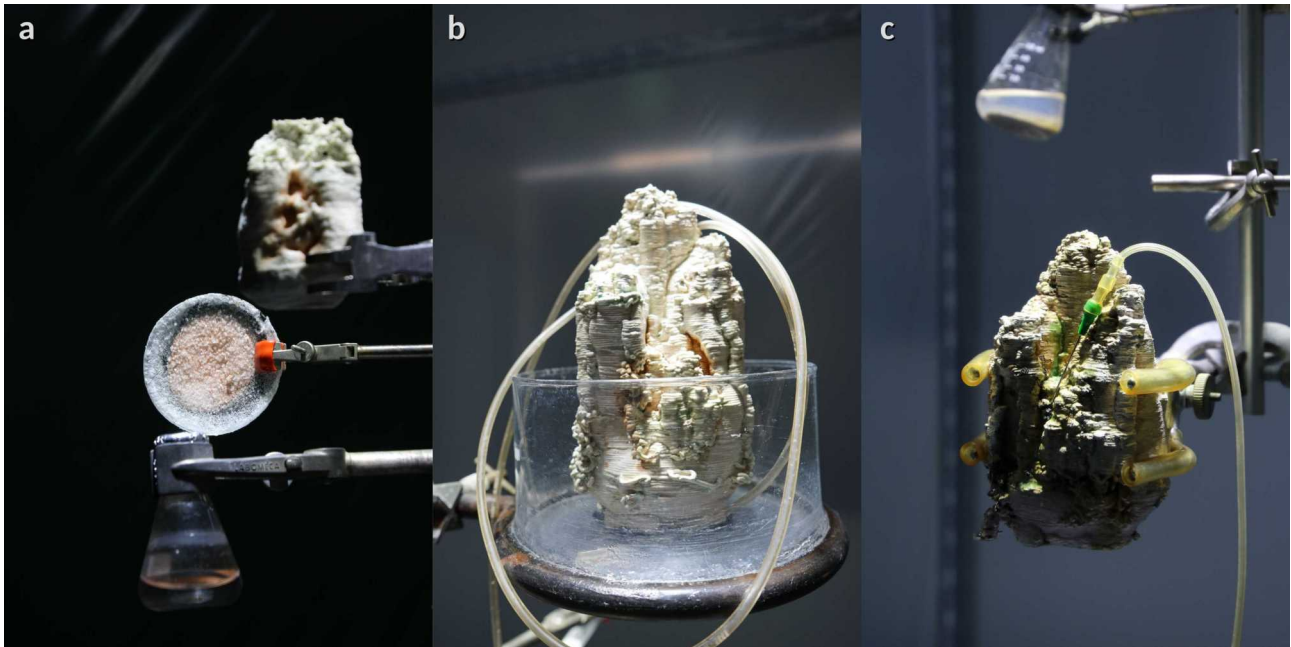
315 Karen Barad’s concept of “intra-action” (Barad 2007) provides a way of understanding the arkships as  
316 emergent rather than composed entities. Microbes, minerals, technologies, and human intention do not pre-  
317 exist their relations but come into being through them. The vessels are therefore material nodes in a  
318 distributed process in which laboratory protocols and sculptural procedures co-constitute one another. In this  
319 sense, clay, microbial cultivation, and technological fabrication are not sequential stages of production but  
320 rather intra-acting components of a single material system.

321 Cultivating, harvesting, desiccating, and partially embedding mediate these exchanges across different  
322 microbial states, revealing a paradox of collaboration: life is constrained yet active, instrumentalised, yet  
323 resilient. Microbes in desiccated and dormant states do not actively reshape vessels. However, the idea of  
324 them and their hypothetical reawakening is shaping human choices of materials, design, and techniques,  
325 which in turn inform imagined future microbial life after homeostasis during a speculative space voyage. The  
326 anticipation of microbial futures feeds back into present material decisions, which condition the same  
327 imagined futures—a recursive loop.

## 328 **The Exhibition as a Suspended Gesture**

329 Outside the gallery space, a poetic text served as a pre-narrative threshold for the exhibition. It read: "*In the*  
330 *year 2024–2025 a vessel was imagined, to send life itself beyond the familiar... a conversation poised at the*  
331 *edge of the cosmos, waiting to begin.(...)*". The vessels were displayed in an immersive installation,  
332 envisioned as a deserted, possibly post-human, quarantine tent. The vessels were suspended while being  
333 injected with minerals, biopolymers, and microbial samples—a staged material process rather than a finished  
334 state. The ceramic and porcelain sculptures were held aloft by laboratory clamps on aluminium rods,  
335 surrounded by elements of their making: mineral powders, microbial cultures, and an L-glucose sample.

336 Outside the tent, a laminar flow hood stood silent, displaying space exposure wells alongside scientific  
337 literature on archaea, biopolymer mixtures, volcanic rocks, and clay experiments—a geological and  
338 microbiological tableau of interrupted processes. Visitors encountered speculative objects: quasi-laboratory  
339 artefacts that bridge scientific investigation and artistic imagination. A glossary provided scientific  
340 orientation without closing the interpretive space of the encounter.



341 **Figure 3. Exhibition.** a) 3D-printed porcelain vessel with *Halobacterium salinarum* cultures; salt-crystallised surface with glass dish and culture vial. b) 3D-printed faïence blanche vessel with mineral powders and glaze. c) 3D-printed faïence blanche vessel with mineral powders, glaze, and biopolymer additions.

346 Here, Jens Hauser’s notion of micro-performativity is key: microorganisms are not illustrative or symbolic  
347 but agents whose interactions generate material, conceptual, and speculative consequences (Hauser &  
348 Strecker 2020). In this sense, the arkships are relational vessels that record interactions while honouring  
349 autonomy, resilience, and metabolic presence. Microbial agency remains constrained by laboratory protocols  
350 but is conceptually amplified through their role as space voyagers. This amplification, while not altering their  
351 biological capacity, reframes their role within the speculative astrobiological narrative<sup>6</sup>.

352 The vessels do not resolve or conclude. They unsettle. They are strange objects that invite us to consider  
353 futures shaped through relations. In the gallery, they act as temporal laboratories: audiences step into this  
354 field not as observers alone but as participants in an experiment in attention. The arkships trace the limits of  
355 human knowledge, anthropocentrism, control, while suggesting possible futures beyond them. These are not

<sup>6</sup> Here, “narrative” is used in the artist’s sense as a reflective device rather than linear storytelling or plot. It may serve as an anchor point for the audience to enter the work, a lens to explore concepts, or a kaleidoscopic frame that fractures perceptions. In practice, she works with pre- and post-narrative structures, allowing her ideas to be framed and deconstructed.

356 fixed futures but futures that emerge through relations—through the ways in which life, matter, and attention  
357 are organised and encountered. The project closes with an opening: a space to imagine worlds that are yet to  
358 be made.

## 359 **Sensory and Affective Dimensions**

360 Within this staged scene of suspended experimentation, the vessels do not operate as static displays but as  
361 sensory objects. Their textured surfaces evoke planetary landscapes, while their forms hover between  
362 organisms and artefact, inviting a haptic gaze. The primordial quality of the clay and the luminous quality of  
363 the porcelain anchor questions of origin, deep time, and planetary formation in material reality.  
364 Microorganisms remain invisible collaborators. Knowledge of their presence subtly transforms the  
365 experience of the objects. This is an affective proposition that foregrounds relations, destabilising the  
366 boundaries between life and object, and living and non-living. The arkships offer no answers to these  
367 questions. They ask: what might we send into space, and who—or what—might receive it?

## 368 **5. Microbial Companions: Time-Travellers, World-Makers**

369 The arkships evoke asteroids or speculative spacecraft, staging microbes as time-travelling companions  
370 across scales and epochs. Extremophiles exist in suspended animation between vitality and stillness. These  
371 microorganisms are not mere passengers, but beings in metabolic latency—neither fully active nor inert, but  
372 suspended in relation to time itself. This metabolic pause suggests temporal flexibility: latency, rather than  
373 stasis. Their ability to survive across deep time connects matter, meaning, and duration, making microbial  
374 life a nexus in which the past, present, and speculative futures converge. Carrying the chemical memory of  
375 ancient environments, these microbial companions also hold potential for revival in the unknown future.  
376 Their endurance registers a deep-time asymmetry: they precede and outlast human presence. In contrast,  
377 human life depends entirely on microbial systems that sustain the atmosphere, metabolism, and ecology.

378 Humans engage with microbial life from a position of dependency rather than equivalence. This creates an  
379 asymmetrical entanglement: microbial and human life are materially interconnected yet unevenly distributed  
380 across lifespans, dependencies, and durability. By situating microbes as time-travellers, the *BioQuantum*  
381 *Record* places relational practice at the heart of the project: transformation unfolds through relations between  
382 species, materials, and speculative planetary futures. Engaging with microbial timescales reframes human  
383 time horizons, situating human life within continuities that exceed it. In this sense, when we imagine  
384 microbes as time-travellers, we become time-travellers ourselves. An expanded vision that may counter the  
385 short-termism that has shaped human relations with the Earth.



## 386 **Provocation: Panspermia, Planetary Protection, and the Lighter** 387 **Touch**

388 If microbes are time travellers, they are also world-makers. Over billions of years, their metabolism has  
389 shaped Earth’s environments—producing oxygen, cycling carbon, and transforming minerals (Gupta *et al.*  
390 2016)—and in speculative futures, might shape extra-terrestrial worlds, giving rise to nascent microbial  
391 landscapes The *BioQuantum Record* arkships suggest a set of conditions in which human intention,  
392 biological processes, and abiotic matter are in relation through contingent transformation. This entanglement  
393 of care and projection does not resolve how to act within such futures but instead opens a field of competing  
394 ethical orientations.

395 The project explores a provocation: the arkships simultaneously echo panspermia while invoking planetary  
396 protection—a thought experiment in responsibility, exploring what it means for life to reach other worlds  
397 while attending to the fragility of those worlds through forward contamination. The tension between  
398 adventurous seeding and responsibility is deliberate, inviting reflection on ethical actions and imaginative  
399 engagement with distant worlds. One response appears in Becky Chambers’ *To Be Taught, If Fortunate*, in  
400 which humans reshape their physiology to inhabit otherworldly ecologies rather than disrupt them  
401 (Chambers 2019). Becky Chambers’ protagonist explains (Chambers 2019): “I’m an observer, not a  
402 conqueror. I have no interest in changing other worlds to suit me. I choose the lighter touch: changing myself  
403 to suit them.” This does not resolve the tension between seeding—or settling—and restraint but shows one  
404 possible ethical attitude when dealing with other worlds.

## 405 **Mirror Life and Speculative Kinship**

406 When, within the project framework, considering how Earth-based microbial life might interact with possible  
407 extra-terrestrial microbial life—and what such life might be like—the project turns to the concept of mirror life.  
408 This concept is grounded in chirality, the “handedness” of molecules. Life on Earth is built exclusively on  
409 left-handed amino acids and right-handed sugars (Guijarro & Yus 2009), whereas a mirror-life form would  
410 be built on the opposite chiral handedness. Chemically identical, yet biologically incompatible, substances  
411 challenge Earth-centric assumptions (Adamala *et al.* 2024). Within the *BioQuantum Record*, this is enacted  
412 as a hypothetical “chiral gift”—a biopolymer substrate metabolically accessible only to the opposite-handed  
413 life (Steward *et al.* 2026). For terrestrial microbes, it remains inert and unrecognisable. It functions both as a  
414 scientific proposition and a poetic experiment: a gift receivable only by a life that biochemistry has folded  
415 the other way. Chirality thus becomes a metaphor for relationality and kinship that recognises differences  
416 without requiring symmetry. Co-constituted through human intervention, microbial collaborators may

417 participate in a relationship across the molecular watershed. Kinship may not depend on a shared biological  
418 language but on a willingness to reach across such divides<sup>7</sup>.

## 419 **Living Archives**

420 If the arkships frame microbes as time-travellers and world-makers, they must also be understood as  
421 proposing a new form of record. Traditional archives hold fixed traces of human knowledge—texts, images,  
422 and artifacts—anchored in time. In contrast, the arkships explore capturing vitality, precariousness, and  
423 potential. They are a less static repository than a provocation about responsibility across deep time. The  
424 concept of a living record refigures agency: the question is no longer simply "How do we preserve this?" but  
425 "Who—or what—is doing the preserving?". Microbial metabolism and resilience are constitutive of the  
426 record. This perspective reframes suspension as a mode of preservation within a material process of  
427 transformation, acknowledging the autonomy of the life cycle it interrupts. The living archive is a horizon of  
428 potential—receptive and generative—extending toward radically other, unthinkable futures. Ultimately, these  
429 vessels are living inscriptions of the past. What they hold is not only suspended microbial life, but also the  
430 relations through which they have been handled and imagined—between human and microbe, among  
431 microbial lives, and across planetary conditions and speculative futures. They propose that what endures is  
432 not dominance but relations—and the care they require.

## 433 **Poetic Gesture: Toward Cosmic Kinship**

434 The arkships do not project a human voice into the cosmos; they stage its withdrawal. In traditional Japanese  
435 Noh theatre, there exists the gesture of pointing to the moon. As Yoshi Oida writes in "The Invisible Actor":  
436 a good actor is one where you do not see the finger, but the moon (Oida 2013). Proposing to send microbes  
437 into space is like pointing a finger at anthropocentrism—a finger that remains irreducibly human. The beauty  
438 lies in the impossibility: we cannot shed our anthropocentric skin. We cannot communicate with microbes.  
439 What remains is a poetic pointing—toward imagination, toward a reflection on our longing, our hubris, and  
440 our inability to escape human frameworks. The microbes act as participants in a ritual: their presence directs  
441 our gaze elsewhere, toward an absent and unreachable moon.

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<sup>7</sup> The concept of mirror life and chirality will be explored more extensively in a follow-up project, resulting in a series of glass objects and a dedicated exhibition (Steward, in preparation).



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