SUSTAINABLE AQUATIC RESEARCH
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Sustainable Aquatic Research (2025) 4(2):143-153
DOI: 10.5281/zenodo.16965745
e-ISSN: 2822-4140

EDITORIAL NOTE

When Will the Debate About the Origin of Life End?

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Abstract

The origin of life remains one of the most complex and persistent questions in science, philosophy and theology. Despite major advancements in molecular biology, chemistry and planetary sciences, current scientific theories, such as abiogenesis, the RNA world and panspermia, have not yet provided a comprehensive explanation for how life actually began on Earth. In contrast, religious texts, including the Qur'an, the Bible and the Torah, present creation narratives grounded in divine intention, often referencing the role of water and clay in the formation of living beings. These insights, while not methodical in scientific terms, offer foundational perspectives that can inspire further inquiry.

This paper explores the scientific, theological and philosophical dimensions of the origin of life debate, emphasizing that empirical research and metaphysical belief need not be in conflict. Instead, they may be viewed as complementary frameworks: science seeks to explain the *mechanism*, whereas theology explores the *purpose*. Also, the discussion reflects on the potential implications of fully uncovering life's origins — from ethical considerations to the future creation of synthetic life, especially when combined with artificial intelligence.

Ultimately, uncovering life's beginnings may require cross-disciplinary approaches and the humility to accept epistemological limits. As aquatic environments are essential to life and dominate both the Earth's surface and the human body, their study is crucial. Continued exploration, supported by emerging technologies, holds promise for revealing the mechanisms behind this fundamental mystery.

Keywords: Origin of Life, Water, Abiogenesis, Theology and Science, Philosophy of Life, Creation and Consciousness

Introduction

What is life? In the case of plant, animal and microbial cells, life may be considered to involve growth, multiplication and intracellular activity/metabolism, but this does not help with an explanation as to what actually is life (Vitas & Dobovisek, 2019). Active cells may well have these attributes, but what about the dormant/viable but non culturable state of bacteria, such as *Vibrio cholerae* (e.g. Bin Naser *et al.,* 2021) that are not routinely culturable on bacteriological media, or the freeze- tolerance of wood frogs, *Rana sylvatica,* that survive when frozen solid but without any brain, heart or lung activity or physical movement (Al-attar & Storey, 2022; Varna & Storey, 2022). Yet, these functions are quickly re-established in the frog with thawing, notably in spring (Al-attar & Storey, 2022). It is questionable whether these survival states Express

Citation

Austin, B., Can, E. (2025). When Will the Debate About the Origin of Life End? Sustainable Aquatic Research, 4(2), 143-153. Received: 23 July 2025, Accepted: 25 August 2025, Available online: 31 August 2025

The origin of life is one of the most profound and enduring mysteries in both science and philosophy. Despite remarkable advances in molecular biology, chemistry and astrophysics, the question "How did life begin?" remains unanswered. The scientific community offers a range of theories, from abiogenesis to panspermia, each attempting to trace the emergence of living systems from non-living matter. However, none of these theories have yet provided a fully satisfactory or universally accepted explanation. Conversely, religious texts, such as the Qur'an, the Bible and the Torah, offer specific accounts of the creation of life, often attributing it to a divine origin. These theological narratives differ from the mechanistic and materialist framework of modern science and generally emphasize purpose, intention and design.

This article aims to present a multidisciplinary analysis of the origin of life debate by exploring: the leading scientific hypotheses, selected scriptural insights from major monotheistic religions and the epistemological boundaries between empirical science and metaphysical belief. As a starting point, it is considered that life on Earth began 3.8 billion years ago when atmospheric oxygen had not yet formed, i.e., the conditions were anaerobic, and ferrous iron was the most common metal in the ocean (Rose *et al.,* 2025). So, what are the views about how life started on Planet Earth?

Theological Perspectives from Abrahamic Religions

The Qur'an

"…..And We made from water every living thing. Will they not then believe?" — Qur'an 21:30
"Allah created man from clay like [that of] pottery." — Qur'an 55:14
These verses suggest that life emerged through a combination of divine will and earthly materials (e.g., water and clay). "Indeed, we have created everything in measure and balance"

— Qur'an 54:49. The Qur'an repeatedly calls for reflection on the natural world as signs (ayat) of God's creative power (The Holy Qur'an; Multiple translations used: Yusuf Ali, Saheeh International. Surah Al-Anbiya (21:30), Surah Ar-Rahman (55:14), Surah Al-Hajj (22:5).

The Bible

"Then the Lord God formed man of the dust from the ground, and breathed into his nostrils the breath of life; and man became a living being." — Genesis 2:7. This emphasizes the dual nature of life: physical (from dust) and spiritual (through divine breath). The Biblical account affirms intentional creation rather than random emergence. (The Holy Bible; New International Version; Genesis 1:20, Genesis 2:7.).

The Torah

"And God said, 'Let the waters teem with living creatures'..." — Genesis 1:20
Here, water is also central to the emergence of life, aligning interestingly with Qur'anic descriptions.

Besides, The Quran clearly states that life was created from water:

"We created every living thing from water." — (Surat al-Anbiya, 30)

Furthermore, the creation of the first human is described as follows:

"Allah created man from clay."— (Surat ar-Rahman, 14)

"We created you from dust, then from a drop of semen."— (Surat al-Hajj, 5). These verses indicate that life was created from the basic elements (soil and water) and that creation developed in stages (The Torah; JPS Tanakh translation. Genesis 1:20).

Philosophical Views

Philosophical inquiries regarding the origin of life are multifaceted discussions encompassing not only scientific explanations but also the meaning of existence, the source of order in the universe, and the fundamental principles of life. In ancient and Islamic thought, this topic was addressed within the context of metaphysics, natural philosophy and cosmology; sometimes interpreted through the fundamental principles of life. In ancient and Islamic thought, this topic was addressed within the context of metaphysics, natural philosophy and cosmology; sometimes interpreted through the fundamental elements of matter, and sometimes through the dynamic forces behind life. In these discussions, the concept of "water" has been a particularly prominent element in interpretations of the origin of life.

"Water" occupied a central position in ancient philosophers' thoughts on the origin of life, both as a necessary condition of physical life and as a metaphysical principle. The most prominent representative of this approach was Thales (624–546 BC). With his proposition "everything is water," Thales not only voiced an abstract metaphysical principle; Based on the rich water resources of the Miletus region where he lived, the dependence of agricultural production on water, and the fact that all living things cannot survive without water, he developed an observation-based natural philosophy (Aristotle, Metaphysics, 983b20; Graham, 2010).

Although Anaximander (610–546 BC) argued that life derived from an infinite and indefinite principle (apeiron), he emphasized water as the biological origin, arguing that the first living things developed in aqueous environments (Sambursky, 1956). Anaximenes (586–526 BC) proposed "air" as the primary element but stated that water was also one of the fundamental transformation stages in the processes of condensation and rarefaction (Kirk *et al.*, 2004). Heraclitus (535–475 BC), arguing that the universe is in constant change (panta rhei), emphasized water as an important transitional material in the transformation of the four elements into one another (Kahn, 1981). In this context, water has found a place in antiquity both as a material prerequisite for life and as an indispensable element of metaphysical systems that explain the order of the universe.

Aristotle (384–322 BC) presented a systematic framework for the origin of life. His doctrine of the four causes (matter, form, agent and purpose) explains that life possesses both a physical and purposeful order (Physics, II.3; De Anima, II.1). The concept of the soul (= psyche) encompasses the life principle of all living things, from plants to humans (Shields, 2016). This approach by Aristotle is the most comprehensive philosophical concept of biology before modern developments. Furthermore, Aristotle defined the concept of energeia, the origin of the modern term energy, as the state of activity in accordance with the nature of being; this concept expressed the transition from potentiality (= dynamis) to actualization (= entelecheia) (Metaphysics, Θ 6–10; Kosman, 1969). Ibn Sina argued that the universe came into being through the intellects emanating from God, the necessary being in the hierarchy of existence, and that life naturally emerged within this intellect (Kitab al-Shifa; Nasr, 2007). Also, he used the concept of "force" (= quwwa) to explain the fundamental functions of living beings, such as movement and nutrition.

Abu Bakr Razi took a more materialist approach, arguing that life arose from the combination of inanimate matter (Rizvi, 20 19). Shihab al-Din Suhrawardi interpreted existence through the metaphysics of "light," viewing the source of all beings as absolute light (= nur al-anwar) (Walbridge, 1999). Conversely, Fakhr al-Din Razi considered the existence of an active force that enables movement and change, in addition to material elements, in the formation of beings. Consequently, ancient thinkers and some Islamic thinkers, in explaining the origin of life, considered not only material elements but also the dynamic forces that sustain life. In these discussions, the concept of "water" has come to the fore, particularly in ancient philosophy, as both an indispensable element of physical life and a metaphysical principle. However, concepts approaching energy demonstrate that existence may be explained not only by matter but also by the principles that give activity, motion and vitality. While these ideas have different foundations from modern biology and physics, they reflect the depth of ongoing philosophical inquiry into the meaning of life and the order of the universe.

Scientific Theories on the Origin of Life

Extraterrestrial origin of life on Earth

Looking at the complexities of modern plants and animals, and the structure of individual cells with their intricate arrangement of subcellular structures, it is reasonable to believe that life could not possibly have developed on Earth, but must have started elsewhere in the Galaxy (see Davis & McKay, 1996; Lal,

2008) and was transported here accidentally or deliberately (= panspermia), such as on comets, meteorites, cosmic dust or asteroids.

Panspermia Hypothesis

Panspermia proposes that life or its precursors arrived on Earth via extraterrestrial sources, such as comets, meteorites, or cosmic dust (Crick, 1973). While this shifts the origin site to elsewhere in the cosmos, it fails to address how life originally began — only where it might have come from.

This would mean that life occurs or has occurred elsewhere on other planetary systems in which case the question concerning the origin of life remains unanswered, and is merely pushed elsewhere. The simple answer is that there is no direct evidence that life-forms have been transported across space, such as by advanced civilisations and/or in/on asteroids, comets or meteorites. However in 2020 and 2023, Japan's Hayabusa2 and NASA'S OSIRIS-Rex spacecraft returned to Earth with rocks from asteroids, where subsequent analyses identified a previous evidence of water, and the presence of organic compounds, including amino acids, and the basic constituents of DNA and RNA, i.e. some of the building components of life (Aponte *et al.,* 2023; Pilorget *et al.,* 2023; Lauretta *et al*., 2024). Moreover in 1996, scientists led by David McKay of NASA's Johnson Space Flight Center reported the presence of structures resembling microscopic fossil nannobacteria of 20-100 nm in size in a meteorite dubbed ALH84001 found in the Allan Hills, Antarctica, and considered to have landed from Mars in the 1980s (McKay *et al*., 1996). Nevertheless, whether these so-called nannobacteria were from Mars or terrestrial contaminants was unclear (Folk & Taylor, 2002). Overall, the photographic evidence of micro-organisms was not convincing and subsequently discounted; the scientific community soon forgot about the possibility of life from Mars spreading to Earth, although there has been exploration aimed at finding water and life on the Red Planet (NASA, 2020). Nevertheless, there is indirect evidence, which has demonstrated that organisms, including tardigrades and micro-organisms, notably bacterial endospores, may survive for limited periods in conditions resembling those of outer space. The question to be resolved is how long could such micro-organisms survive in space, and could they realistically tolerate extremely long periods during interplanetary transportation across vast distances? Data from some of the relevant publications may be summarized:

- Endospores of *Bacillus subtilis* were exposed to space-like conditions on the Russian FOTON satellite using the BIOPAN facility of the European Space Agency. The outcome of the work was that the best survival of the endospores from the harmful effects of extraterrestrial solar ultraviolet radiation depended upon their protection/incorporation with Martian analogue soil. However, the experiments were conducted over only 2-weeks, which is much shorter than the period needed to traverse large distances in space; viability was assessed by very traditional microbiological methods of questionable sensitivity, namely development of colony-forming units (CFU; Horneck *et al.,* 2001). Previous work by the same team using the NASA Long Duration Exposure Facility exposed endospores of *B. subtilis* to conditions of outer space, including cosmic radiation (4.8 Gy), solar electromagnetic radiation up to the vacuum-ultraviolet range and/or vacuum, using the NASA Long Duration Exposure Facility. In brief, 80% survival of the endospores occurred if preparations were shielded against solar UV radiation with the experiments lasting for 6-years (Horneck *et al.,* 1994).
- Endospores of *B. pumilus* were recovered from surfaces associated with spacecraft, and demonstrated a high level of resistance to decontamination techniques of the type designed to eliminate terrestrial organisms from surviving journeys into space (Vaishampayan *et al.,* 2012). Thus, *B. pumilus* endospores were resistant to UV irradiation and exposure to peroxide disinfectants. Cultures transported to the International Space Station for use in the European Technology Exposure Facility resulted in 85-100% survival rate after 18-months in a dark simulated Martian atmosphere, but not so when irradiated with UV at >100 nm (Vaishampayan *et al.,* 2012). Higher levels of UV resistance and greater concentrations of superoxide dismutase, which is associated with resistance, was determined by proteomics analysis to be present in endospores exposed to space compared to

controls (Vaishampayan *et al.,* 2012).

- *Halorubrum chaoviator* and the halophilic cyanobacterium *Synechococcus* were used in the European Space Agency's Biopan facility, and exposed to a space environment for 2-weeks leading to higher survival than other organisms with the exception of *Bacillus* endospores. Subsequent experiments lasted for 2-years when specimens maintained in the dark, but exposed to space vacuum, demonstrated a 90+/-5% survival rate compared to controls (Mancinelli, 2015).
- Spores of the fungal species *Aspergillus terreus* have been exposed to simulated space under solar radiation, specifically irradiated with vacuum ultraviolet leading to varying levels of survival reflecting the actual dose (Sarantopoulou *et al.,* 2011).
- Tardigrades (= water bears) are small arthropods, which are resilient of extreme environmental stresses of temperature and desiccation, and contain radiation resistant DNA. These organisms have been used as desiccated and active states in space research because of their ability to enter anhydrobiosis, which is a response to desiccation being a reversible ametabolic state with results indicating survival in low Earth orbit conditions (Jönsson *et al.,* 2008; Rebecchi *et al*., 2009; Persson *et al*., 2011).

The outcome of these studies is that micro-organisms may survive in space, but the evidence does not prove that viability will last for the time necessary to make interplanetary journeys or that life forms were definitely transported to Earth from distant planetary systems.

The school of thought that life originated on Earth?

The landmark publication concerning the origin of life on Earth was by Oparin (1938), who opined that with the conditions on Earth billions of years ago and with the presence of electrical discharges, e.g., lightning, simple organic molecules were formed initially from inorganic materials leading subsequently to more complex compounds forming a "primordial soup". Some of those compounds resembled homochiral peptides/proteins all within aqueous solution, i.e. water (Toxvaerd, 2025). Certainly, it is considered that amino acids and nucleic acid bases may be synthesized as a result of ultraviolet irradiation with bicarbonate, carbonate and/or carbon dioxide, and in aqueous environments (Kihara *et al.,* 1991). With increasing chemical complexity, it is speculated that simple organisms were formed, i.e., by abiogenesis. What are the possibilities:

Abiogenesis: Life from Non-life

Abiogenesis posits that life originated spontaneously from simple organic molecules under prebiotic Earth conditions. This concept gained traction after Miller & Urey (1959), who demonstrated that amino acids could form under simulated early Earth conditions. Nevertheless, abiogenesis remains speculative due to the complexity of forming self-replicating and metabolically active systems without genetic instructions.

RNA World Hypothesis

The RNA World hypothesis suggests that RNA, capable of both storing genetic information and catalyzing biochemical reactions, was the first biomolecule to kickstart life. While promising, this theory faces challenges regarding the spontaneous synthesis of stable RNA chains in prebiotic environments (Gilbert, 1986; Orgel, 2004).

Protocells

- life may have begun as inorganic (= clay) forms and/or that the initial energy source was chemical or sunlight supplying thermal energy or photochemical activation in the atmosphere, together with involvement of gravity and electro-magnetic radiation (Davis & McKay, 1996; Baltscheffsky *et al.,* 1998; Trevors, 2002; 2006; Muller & Schulze-Makuch, 2006; Boiteau & Pascal, 2011).
- it has been suggested that life started in gels attached to the surface of minerals that transitioned to biofilms (Trevors, 2011).
- Martin & Russell (2003) proposed that life as eubacterial and archaebacterial chemoautotrophs developed in structured iron monosulfide precipitates around marine hydrothermal vents, and facilitated membrane-lipid biosynthesis, namely isoprenoid ether membranes and fatty acid ester membranes for the former and latter, respectively.
- protocells have been likened to water micro-droplets surrounded by a lipid bilayer (Ichihashi, 2020) and may have needed to acquire energy from the surrounding environment leading to heterotrophic growth (Deamer & Weber, 2010).
- minimal living cells were considered to be synthetic or semi-synthetic structures with minimal components of proteins and solutes surrounded by lipid membranes in lipid vesicles to allow the principle biological properties of a living cell (Stano & Luisi, 2011).
- soluble ferrous compounds catalyzed redox reactions, and thus developed into early forms of anaerobic life (Rose *et al.,* 2025).

By developing Oparin's (1938) work, the key components were undoubtedly organic (carbon-containing?) compounds (Chyba & Sagan, 1992), water and energy. e.g., electricity from lightning. Those early life forms must have been very simple compared to modern day cells. A parallel could be made between eu-and pro-karyotic cells and prions, the latter of which are proteinaceous infectious particles lacking nucleic acids (Wille & Requena, 2018; Casey & Sleator, 2025). Modern cells are engulfed in membranes, which serve to retain the intracellular components and provide key functions including enzyme activity (Deamer, 2016). Were protocells surrounding by membranes or was the structure more reminiscent the edges of lipid vesicles. Indeed, is there a role for liposomes/lipid vesicles, which contained key components of life, i.e. minimal cells (Ariga *et al.,* 2009; Walde, 2010; Stano & Luisi, 2011)?

Hypothesis

By considering the relevant publications to date, it is apparent that the development of life would inevitably have occurred over a prolonged period in anaerobic aqueous environments with many failures before success occurred, but the protocells may have been very short lived, i.e. it was really a case of survival of the best! Those early life forms would surely have been very simple, becoming more complex and sophisticated with time. It is likely that those original protocells would not be recognized as viable cells in the present context. One could imagine extremely short-lived thin, 2D, rather than 3D units without rigid cell structures, such as oil droplets, of indeterminate size and variable shape flowing in the water column or over moist surfaces, and enclosing particulates, such as inorganic or organic materials. These units may well have combined with other protocells thereby becoming larger and more complex with extra compounds/traits contained within them. It is impossible to determine the actual size of these original protocells. It is purely conjecture to regard the units as most likely microbial in size, but there is also a case for larger structures, which could split into smaller units and re-combine into bigger systems. However, at some point, the protocells would have acquired sufficient components to function as viable, living cells. Darwinian principles would surely have applied, i.e. survival of the fittest, i.e. the best adapted to the environment in which they existed. Thereafter, there would be specialization and the association of "cells" to form multicellular conglomerations.

Energy is the crux of the issue. Was this provided by thermal discharges, such as hot springs or warm/hot water vents, volcanic activity, strong sunlight, or lightning strikes? Could lightning energize molecules with electricity, which would be stored and released in very primitive unicellular life forms? Agreed that thunder storms have electrical activity, which reaches Earth as flashes of lightning (Gallin *et al.,* 2016). Although the primary lightning strikes on Earth may be extremely forceful, dissipation of the force in an aqueous environment would occur quickly. Thus, droplets in the areas in the vicinity of but not necesssarily close to a lightning strike could receive a much-reduced pulse of electrical current/energy. Could this energy be retained in intracellular compounds, such as metals e.g. iron-phosphorus (Byrne *et al.,* 2010; Ghosh *et al.,* 2022), glycogen or lipids (Benz *et al.,* 1975), and released subsequently as an energy source to fuel those initial life forms? At some point, replication and specialization would ensue. However, newly developed protocells would continue to evolve. The question is – are we sure that new protocells are not produced in current times even if they are effectively swamped by and outcompeted by existing life forms? Are we now satisfied that spontaneous generation does not occur? To borrow a biblical statement "life begets life" (The Holy Bible; Genesis 1:11-13) and "Every living being in the heavens and the earth seeks all its needs from the Rahman. Allah, with Allah's countless names and attributes, is in a state of infinite manifestation and creation at every moment" (The Quran;Surat al-Rahman, 29). However, these statements do not explain how life began. Certainly, spontaneous generation has never been found to occur (Tepfer, 2008), although the concept, which dates to the ancient Greeks and Aristotle, has ironically been discredited (Aristotle, ca 350 BCE; Al-Ghazali, 11th Century; Aquinas, 1265–1274)! How could spontaneously occurring life be so balanced and orderly? Is this not an important issue that should make scientists think? "Indeed, we have created everything in measure and balance" — Qur'an 54:49. Surely, this is an important question that should provoke scientists' consideration? In this case, could a more complex creature than humans spontaneously arise? Or will scientists be able to create such a creature in the future? What if they do? What will change in this world? Will there be any balance left? Many similar questions await us.

Philosophical Reflections and Epistemological Limits

The quest to understand the origin of life does not merely concern empirical data or laboratory simulations. Inherently, it raises philosophical questions regarding existence, causality, purpose and consciousness. Whereas science seeks to explain how life began, philosophy and theology often ask why life exists in the first place — a question that empirical methods may not be equipped to answer (Al-Ghazali, 11th Century; Aquinas, 1265–1274). Or can it be answered? What happens if it is answered? The origin of life: how did the first living being come into being? What happens if humans clearly prove this? Can we create new living things from nothing? Do we want this to happen? Can we predict what kind of living things might emerge? And when it's combined with artificial intelligence?

Convergence and Conflict: Can Science and Faith Coexist in Explaining Origins?

The historical relationship between science and religion has often been portrayed as inherently adversarial — a "conflict thesis" suggesting that scientific progress displaces religious belief. However, this view is increasingly being challenged by scholars, who advocate for a more integrative perspective, especially in complex questions such as the origin of life. Religious texts do not provide details about how life began, but they do at least include some statements that prompt research. For example, living things were created from water, or humans were created from clay-like soil. The fact that approximately three-quarters of the Earth is water, and the proportion of water in the human body is similar, may also prompt scientists to consider the importance of water in life. The presence of water, the primary ingredient of life, on other planets will encourage the search for evidence of life's origin there as well (Nasr, 1993; Polkinghorne, 2005; McGrath, 2010).

Conclusion: Seeking Answers Beyond Certainty

It would be convenient to blame the origin of life on Earth upon some distant planetary system, although this would redirect the underlying issues elsewhere, i.e., how did life begin elsewhere in the Universe?

Instead, there is a reasoned view that life did indeed begin on Earth although the process inevitably occurred over long periods until units could acquire sufficient components to survive, replicate independently and associate into rudimentary multicellular entities.

These early "cells" may well have outcompeted less successful protocells. However, it is unknown for how long the development of new protocells continued, or whether the process is still occurring but is effectively swamped by existing life forms. Clearly, life has come a long way since its origins 3.8 billion years ago. However, the origin of life remains one of the most enduring enigmas in the history of human thought. Despite significant advances in fields, such as molecular biology, prebiotic chemistry and planetary science, no scientific theory has yet offered a definitive or universally accepted account of how life began. Abiogenesis, RNA world hypotheses and panspermia provide partial insights, but all face critical explanatory gaps. At the same time, religious and philosophical traditions offer rich and coherent narratives about the origin and purpose of life, often rooted in divine intentionality and metaphysical foundations. Sacred texts from Islam, Christianity and Judaism not only affirm the creation of life by a higher power but also frame this act within a moral, spiritual and teleological context.

The apparent tension between science and faith, often exaggerated in public discourse, dissolves when both are recognized as distinct yet complementary paths to knowledge. Science explains the mechanisms, whereas theology explores the meanings. One seeks to uncover how life could arise; the other asks why it exists at all. Ultimately, the debate about the origin of life may never reach an absolute conclusion — and perhaps it need not. Instead, this ongoing dialogue invites humility, curiosity and cross-disciplinary collaboration. As long as human beings seek to understand where they come from, the question of life's origin will remain not just a scientific inquiry, but also a philosophical and spiritual journey.

Whereas religious teachings do not contain detailed information about how creation occurred, they do offer some clues. Whether created or spontaneous, there is inevitably a scientific methodology behind this creation. Therefore, the common ground for all scientists, whether they believe in creation or not, should be uncovering this methodology. So, we believe that scientists will get closer to their important findings about the origin of life with the support of developing science, technology and artificial intelligence. Theories abound, but the definitive proof remains to be obtained. How successful was cloning? How ethical can it be for a human to create a living thing from nothing? The more important question is that "What happens if humans clearly prove this, i.e., the origin of life?" There will be many issues to discuss.

However, the most important issues are related to water. Could water, an indispensable resource for living things on our planet, be the source of life? Could water be the raw material for all living things? Whereas these issues require further investigation, it could be considered the oldest substance that has survived since our planet's creation. Ultimately, water, which constantly circulates throughout the planet—surface, subsurface and atmosphere—truly needs to be protected and saved. We recognize that aquatic research is essential for the continuation of all living and non-living existence on our planet. Yet in the 3.8 billion years since life forms appeared on Earth, the most intellectually developed species, i.e. human beings, is responsible for significant and harmful effects to the biological (e.g. changes in species composition), chemical (e.g. microplastic pollution) and physical (namely global temperature increases = climate change) environment. Who knows what effect these changes will have in the long term for life on Earth.

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