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LIFE BEYOND EARTH: A QUR'ANIC AND MOLECULAR EXPLORATION OF BIOLOGICAL POTENTIAL IN THE UNIVERSE

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ABSTRACT

The question of whether life exists beyond Earth has long captivated the imagination of both scientists and theologians. This paper investigates the potential convergence between contemporary molecular biology and Islamic theology, focusing specifically on how developments in stem cell science, cellular resilience, and genetics may align with Qur'anic insights on cosmic life. Central to our discussion is Surah Ash-Shura (42:29), which states, "And of His signs is the creation of the heavens and the earth and what He has throughout them of creatures." This verse suggests a broader cosmological distribution of life, prompting us to consider whether science supports such a perspective. Drawing upon modern advancements in astrobiology and stress biology, we explore how extremophiles, cellular survival mechanisms, and developmental pathways indicate the biological plausibility of life in extraterrestrial environments. Stem cell plasticity and DNA repair mechanisms, for instance, showcase cellular adaptability that could be crucial for surviving extreme cosmic conditions. This study adopts an interdisciplinary approach, integrating molecular biology with theological interpretation to propose a framework where empirical inquiry and spiritual worldview inform each other. We argue that molecular biology provides not only the technical means to search for life on other planets but also enriches metaphysical understandings of God's creation. By bridging Qur'anic cosmology with emerging space science, this paper offers a holistic perspective that encourages dialogue between science and religion on the profound question of life beyond Earth.

Keywords: *Astrobiology; Qur'an; Extraterrestrial life; Molecular biology; Stem cell plasticity; Islamic cosmology; Cellular resilience*

1. INTRODUCTION

Human beings have speculated about life on the planet since ancient times. Even though it has only recently become possible to investigate this extraterrestrial life using technical tools (Fettahoğlu 2021). Life in the universe has not yet been discovered, but a cutting-edge achievement in Astrobiology was the identification of exoplanets (Impey 2022). In recent decades, the quest to uncover life beyond Earth has gained momentum with the discovery of over 5,500 confirmed exoplanets (NASA Exoplanet Archive 2024), many of which are in the so-called "habitable zone"- the region around a star where conditions may permit liquid water. Our awareness about life's diversity is enhanced greatly after Viking's mission to Mars, in

the mid of 1970, which developed a better understanding of harsh conditions that constrain life (Pace 2001). Currently, an improved and developed understanding of exoplanets is the result of the use of numerous planet-detection methodologies (Seager and Bains 2015). Missions like NASA's Europa Clipper and ESA's JUICE (Jupiter Icy Moons Explorer) target to investigate the subsurface oceans of moons like Europa and Enceladus, where hydrothermal activity provides strong evidence and potential supporting the basic prerequisites for life (Hand et al. 2020; Postberg et al. 2018).

Parallel to these scientific efforts, religious traditions—particularly Islam—offer rich philosophical and metaphysical frameworks for understanding the origins and diversity of life. Engagement of Islamic theology with the extraterrestrial beings begins with the Qur'an's foundational proclamation of Allah as the "Lord of the Worlds" (الْعَالَمِينَرَبِّ), and the word "worlds (عَالَمِينَ) is the plural that outpaces the earthly limits, symbolizing the universe bursting with a variety of creations (Hudawi n.d.). Alongside these scientific endeavors, religious traditions, especially Islam, repeatedly emphasize the vastness of creation in the Qur'an, the precision of natural laws, and the presence of signs (*āyāt*) across the cosmos. Surah Ash-Shura 42:29 states:

"And among His signs is the creation of the heavens and the earth and the living creatures He has dispersed throughout them." (Qur'an, 42:29)

The verse's use of the plural form of "heavens" *(samāwāt)* and the term "dispersed" *(baththa)* prominently implies the existence of living beings throughout both the heavens and the earth. This is acknowledged by both Classical and contemporary exegeses, which emphasize this as a reference to the expansive nature of divine creation, with some scholars, including modern commentators like Guessoum (2011), suggesting the wording resonates with current scientific discussions of the concept of extraterrestrial life.

This verse thus encourages contemplation not only on the biosphere of the Earth but also on the broader cosmos as a potentially living, dynamic system crafted by divine design. In this study, we explore how the Qur'anic implication of life's dispersion across the universe perfectly aligns with the advances in molecular biology, through insights into stem cells, cellular resilience, and genetic adaptability. Our goal is to provide a framework that can serve both scientific and theological communities to establish a coherent dialogue between empirical science and Qur'anic cosmology.

2. Qur'anic View of Life in the Cosmos

2.1 Surah Ash-Shura 42:29 and the Plurality of Life

Surah Ash-Shura is one of the most often referenced Quranic passages when discussing is about extraterrestrial life. According to Surah Ash-Shura 42:29, life is not limited to the Earth alone. Traditional Tafsir, including that of Ibn Kathir, understood "living creatures" (*dabbah*) as species residing on Earth. However, modern scholars argue that the verse's wording remains open, and in light of current development of astrobiology and cosmology, might present the presence of extraterrestrial life (Guessoum 2011).

2.2 Supporting Verses

Other verses support this cosmological openness:

- *Surah Al-Anbiya 21:30*: "We made from water every living thing."
- *Surah Fussilat 41:53*: "We will show them Our signs in the horizons and within themselves until it becomes clear to them that it is the truth."
- *Surah Al-Mulk 67:15*: "He it is Who made the earth subservient unto you, so traverse its paths and partake of His provision."
- *Surah At-Talaq (65:12)*: "It is Allah who has created seven heavens and of the earth, the like of them..."
- *Surah An-Nahl (16:8)*: "And He creates that which you do not know." These verses not only promote inquiry but also underscore water's essential role in life—a view consistent with scientific standards for sustaining life.

2.3 God's Universal Dominion

Islam holds that there is no way to argue over the oneness, unity, or existence of Allah. The perfect harmonious equilibrium between the Heavens, planets, and everything else cannot be observed if

there was no one to control it, or by a big bang we made to understand (Adeyemo 2012, *A Prolegomena to the Study of Islam*). The Qur'an frequently refers to God as *Rabb al-'Alamin* (Lord of all worlds), underscores God's sovereignty over a creation beyond human reach and perception (Qur'an 1:2). This depicts the possible diversity of biospheres and ecosystems all encompassed within divine governance. This affirms the ultimate sovereignty of God not only on Earth but stretches across all universe, heavens, and dimensions (Nasr 1976).

3. Foundations of Molecular Life: A Universal Blueprint

3.1 Defining Life Molecularly

In 1859, with the publication of *Origin of the Species*, many naturalists believed that life evolves from inanimate matter. Afterwards, advancement in the fields of biochemistry and cell biology resulted in the development of the theories that blended this idea and proposed that protoplasm is the origin of any life (Lazcano 2010). At its core, life is defined by properties such as growth, reproduction, metabolism, responsiveness to stimuli, and the capacity to evolve. Molecular biology recognizes DNA/RNA, lipid membranes, protein, and metabolic networks as elements serving as the building blocks of all known life (Rothschild and Mancinelli 2001).

3.2 Universality of Carbon-Based Life

Carbon forms the backbone of three basic structures (carbohydrates, amino acids, and lipids), which make up most of the structures of all bacteria, plants, and animals (Gupta 2017). Carbon's remarkable capacity to make stable and complex bonds with various other elements makes it a suitable material for life. On Earth, nearly majority of life is carbon-based and dependent on water, aligning with the Qur'anic emphasis that water is the primordial foundation of all living beings (Qur'an 21:30). In fact, the sixth most prevalent element in the cosmos is carbon, and in terms of mass, it's 19th in the Earth's crust (Gupta 2017).

3.3 Molecular Order and Qur'anic Notions of Balance

At the molecular level, highly balanced biochemical systems are responsible for maintaining life. A very precise molecular accuracy is maintained in cellular processes like catalysis of enzymes, replication of DNA, and protein folding, otherwise, a minor imbalance can lead to disease or dysfunction (Alberts et al. 2015). This systematic complexity illustrates the notion of balance, which stretches from the molecular to the ecological level where survival and stability are ensured by homeostasis. According to Astrobiology, to facilitate life, a habitat must sustain chemical and energy balance because this equilibrium is a fundamental criterion in evaluating habitability (Chyba and Hand 2005).

Likewise, the Quran emphasizes the balance (mīzān) as the fundamental principle underlying the creation. The Qur'an repeatedly speaks of the order and proportion in creation:

- *Surah Al-Qamar 54:49*: "Indeed, all things We created with predestination."
- *Surah Ar-Rahman 55:7-9*: "And the heaven He raised and imposed the balance." These suggest a divinely orchestrated molecular harmony, supporting the notion of universal biochemical logic.
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4. Stem Cells and Biological Resilience in Space

4.1 Properties of Stem Cells

Stem cells are distinguished by their dual ability for differentiation into several lineages and self-renewal, both of which are essential properties for tissue repair and regeneration (Poliwoda *et al.* 2022). These features render them a compelling biological model for investigating the impacts of cellular adaptations in space and for developing regenerative strategies in an extraterrestrial context (Wei *et al.* 2021). Categorized by potency, stem cells are divided into 3 major types: totipotent (capable of generating embryonic or extraembryonic tissues), pluripotent (specialized for forming whole body cells), and multipotent (restricted to form special cells only, such as hematopoietic stem cells) (Zakrzewski *et al.* 2019). Stem cells are particularly well-suited for resilience studies in extreme extraterrestrial environments

because of high genomic plasticity and robust stress-response mechanisms (Hussen *et al.* 2024).

4.2 Stress Responses in Space Environments

Normal cellular physiology is challenged by a combination of ionizing radiation, microgravity, and oxidative stress in a harsh space environment. Significant alterations in gene expression related to DNA repair, cytoskeletal organization, and apoptosis are witnessed in Human mesenchymal stem cells (hMSCs) and induced pluripotent stem cells (iPSCs) exposed to microgravity conditions (Blaber et al. 2014). In space, Microgravity is one of the biggest challenges. Additionally, it has been demonstrated that Microgravity suppresses proliferation in hMSCs and also impairs osteogenic differentiation, ultimately compromising their potential role for tissue regeneration and repair (Blaber et al. 2015). On Earth, gravity significantly influences the circulation of physiological fluids, bone density, and muscle tone. Astronauts in space usually experience high intracranial tension and facial puffiness, which results from allocation of fluids to the upper side of the body (Marshall-Goebel et al. 2019). Astronauts experience psychological problems such as persistent isolation, disturbance in biological cycles, leading to sleep issues, mood swings, and cognitive issues (Basner et al. 2019). These findings highlight the dual nature of stem cells for both susceptibility and adaptive capacity in space.

The harsh environment of the International Space Station (ISS) results in disrupted microbial-immune homeostasis, which also correlates with diminished levels of microbiome on the skin and gut of astronauts, exacerbating these problems and may trigger severe inflammatory or allergic reactions (Voorhies et al. 2019).

4.3 Extremophiles as Terrestrial Analogs

In astrobiology, extremophiles serve as essential analogs for speculating extraterrestrial life because of their ability to flourish in Earth's most inhospitable environments (Stetter 2006). Extremophiles are extremely important in the hunt for extraterrestrial life due to their metabolic variations. On icy moons such as Enceladus and Europa, where there is no access of sunlight to the subsurface ocean, many of the creatures use chemosynthesis (generation of energy from inorganic substances such as ferrous iron or hydrogen sulfide) instead of photosynthesis, an important analogue for the potential of life on icy moons (Chyba and Phillips 2001). Because of their ability to withstand intense desiccation, ionizing radiations, and even survival under the vacuum of outer space, extremophiles such as *Deinococcus radiodurans* and tardigrades have gathered significant attention. Jönsson et al. (2008) showed that tardigrades exposed to outer space conditions retained viability, owing largely to unique DNA protection and repair mechanisms. In human cells, these biological characteristics are being explored in synthetic biology to engineer resilience supporting the feasibility for long-term space missions (Milojevic and Weckwerth 2020).

4.4 Autophagy, DNA Repair, and Oxidative Stress

Stem cells preserve genomic integrity through robust stress-response pathways, including autophagy for cellular renewal, antioxidative systems for neutralizing reactive species, and DNA damage repair (Wyles et al. 2014). In space, oxidative stress is exacerbated due to increased mitochondrial production of ROS and decreased activity of detoxifying enzymes such as catalase and superoxide dismutase (SOD), which results in compromised ability of stem cells to renew themselves (Garrett-Bakelman et al. 2019). Autophagy, in particular, helps defend against mitochondrial dysfunction and regulates oxidative stress processes that become significantly aggravated in the microgravity and radiation environment of space (Pani et al. 2021). These pathways are essential not only for preserving stem cell function but also for serving as key determinants in evaluating the prospects of human life and regenerative therapy in an alien setting. In this manner, the Qur'anic perception *"We have certainly created man in the best of stature"* may not only reflect the resilience of humans but also their ability to survive under harsh cosmic conditions (Al-Duwairi. 2023).

5. Astro-biological Possibilities and Qur'anic Implications

5.1 Scientific Theories on Life Elsewhere

Contemporary astrobiology seeks signs of life beyond the Earth through the study of biosignatures, such as atmospheric methane, oxygen, or complex organic molecules on exoplanets that may indicate biological processes (De Mol2023). A central aim of NASA's Astro-biological mission is to search for planets located within the "habitable zone" or "Goldilocks zone a region where temperature permits the existence of liquid water, a key solvent for all known life forms (Schulze-Makuch and Irwin 2018). Advancements in technology (spectroscopy and direct imaging) have allowed the identification of heat profiles and atmospheric fundamentals of far-off planets. Exploratory operations on Mars persist to investigate in situ chemicals and isotopic confirmation of habitability (Seager 2013). With more than 5,000 confirmed exoplanets by 2025, cutting-edge tools in planetary imaging, rover missions, and spectroscopy are deepening human understanding of life-supporting conditions in the cosmos (Seager 2013; NASA Exoplanet Archive 2025).

5.2 Compatibility with Qur'anic Cosmology

The Qur'an portrays life as a divine sign (*āyah*), inseparably connected to God's creative authority. Surah Ash-Shura (42:29) articulates this connection by stating, *"And among His signs is the creation of the heavens and the earth and what He has dispersed throughout them of creatures. And He, for gathering them when He wills, is competent."* Classical and current Islamic scholars think of this verse as suggesting the possibility and perhaps affirming the existence of extraterrestrial life (Nasr 2006; Ghaly 2012). Theologically, this passage also underscores the messianic themes. The ending sentence, *"And He, for gathering them when He wills is competent"*, has been interpreted to mean all creatures terrestrial and perhaps extraterrestrial are governed by divine's will and will be subjected to God's commands during the last assembly (al-Qurtubī 2006). Rather than opposing scientific discoveries, the Quran's perspective embraces new knowledge as a means of deepening understanding of the divine (*tadabbur*), even the detection of extraterritorial life would be considered as the sign of God's boundless creativity.

5.3 Possible Biochemical Similarities

While the nature and complexity of extraterrestrial life are unknown, many scientists still believe that if life is discovered elsewhere in the cosmos, it would likely operate under the same physical and chemical laws observed on Earth. This assumption affirms the universal distribution of carbon-based compounds, amino acids, and water as fundamental biochemical precursors (Benner et al. 2004). Research on meteorites, comets, and galactic clouds has shown complicated molecules of organic compounds, particularly amino acids and nucleobase analogs, indicating that basic elements of life are prevalent beyond the Earth (Ehrenfreund and Charnley 2000; Altwegg et al. 2016). The Qur'an highlights the concept of common origin of all, noting: *"He created you from a single soul, then made its mate from it..."* (Qur'an 39:6). These verses can be understood theologically as implying a shared pattern (*sunnat Allāh*) corresponding to the scientific recognition of biochemical universality. This context indicates that the discovery of life elsewhere in the universe, rather than presenting randomness, would signify continuation with divine authority because the Quranic viewpoint also correlates perfectly with the scientific notion of biochemical uniformity (Brennan. 2023).

6. Theological Reflections on Consciousness and Soul

6.1 The Divine Breath and Human Uniqueness

Within Islamic theology, the Quran's concept of human awareness and moral agency derives from the dual nature of *nafs* (soul) and *rūḥ* (spirit). This is illustrated in Surah Al-Ḥijr (15:29), which states that:

"When I have fashioned him and breathed into him of My spirit, fall before him in prostration," connected to Adam's creation. This phrase is commonly taken to mean that infusion of *rūḥ* signifies the transition from mere biological existence to the scientific life endowed with moral accountability

(Nasr 2006; Murata and Chittick 1994). The Quranic discourse discerns between *nafs* (comprising emotions, ambitions, and originality) and ruh (the spiritual spirit transmitted to humanity), collectively forming the dual dimensions of human existence: the supernatural and materialistic (Murata and Chittick 1994). Humanity has been bestowed a special ontological position by the breath of divine (*nafakhtu fīhi min rūḥī*), which confers on humanity a unique ontological status, defined by reason (*ʿaql*), moral freedom, and the ability to attain spiritual knowledge (*maʿrifah*) (Brera and Galante. 2019).

6.2 Could Extraterrestrial Life Be Sentient?

A crucial theological dilemma is raised if extraterrestrial life exists: whether these beings are capable of having consciousness or possession of (*rūḥ*)? The Qur'an presents verses that point to the existence of diverse sentient communities:

"There is no creature on Earth nor bird flying with its wings, but they are communities like you. We have neglected nothing in the Book. Then unto their lord they will be gathered" (Qur'an 6:38). This verse acknowledges both the social structure of non-human being and their ultimate submission to God. Classical scholars, including Al-Ṭabarī and Al-Qurṭubī, perceive this verse as the proof of the intricate and collaborative nature of animal life, suggesting varying levels of consciousness within the creation. According to modern scholars, recognizing sentience or moral capacity in non-human beings, whether earthly or extraterrestrial, poses no contradiction to Islamic theology but rather would demonstrate the greater scope of divine vastness (Malik 2021; Qadhi 2019). Malik (2021), the Qur'an envisions moral and spiritual knowledge as not confined to humankind only. Similarly, Qadhi (2019) recognizes that the existence of intelligent beings would not undermine the uniqueness of mankind but instead affirm divine authority and creativity, which calls for human humanity before the immensity of the cosmos.

6.3 Religious and Moral Agency

According to some Islamic theologians, if life beyond the Earth exists, then they may have received their own type of divine direction or covenant (*ʿahd*) in the same way humans are bestowed the responsibility *amānah* (trust) *when it states:*

"Indeed, We offered the Trust to the heavens and the earth and the mountains, and they declined to bear it and feared it; but man undertook it. Indeed, he was unjust and ignorant" (Qur'an 33:72). This perspective asserts the God's lordship (*rubūbiyyah*) and perfect level of justice extended to every level of creation, rather than conflicting with the foundational idea of *tawḥīd* (divine unity). In this light, extraterrestrial life, if real, would constitute an additional expression of divine governance, exemplifying yet another facet of God's creative will. According to Malik (2021) and Qadhi (2019), acknowledging the potential for moral activity beyond Earth strengthens Islamic anthropology and eschatology, providing a more universal theology without diminishing the human prophetic heritage. Collectively, these viewpoints show that Islam conceives of moral responsibility as both a special human trust through prophecy and universal, as it may apply to other intelligent beings as a part of God's wider creation (Mohamed. 2024).

7. Integration of Science and Faith

7.1 Complementary Epistemologies

Religion and science have long been portrayed as antagonistic ideologies, but according to Islam, they are more appropriately understood as compatible epistemic frames. Science provides insight into the mechanisms underlying the natural world, how things function through observation, testing, and reversibility (Inayati and Pratama. 2022). Religion, on the other hand, explores the questions of purpose, focusing on meaning and responsibility. In the Qur'anic perspective, scientific inquiry is a pathway of appreciating God's limitless creativity. According to the Surah Al-Mujādilah (58:11), which states that

"God will raise those who have believed among you and those who were given knowledge, by degrees."

This verse confirms the sacred value of knowledge (*ʿilm)* as an expression of spiritual growth (Nasr, 2006; Sardar, 2011). Theological engagement is

further emphasized via verses like Surah Āl ʿImrān (3:190) declares:

"Indeed, in the creation of heavens and the earth and the alternation of the night and the day are signs for those of understanding".

Academic scholars like Sardar (2011) suggest, that the Qur'anic worldview frames scientific inquiry as a form of *ibādah* (worship) when aimed at revealing God's underlying wisdom in creation. Thus, the scientific quest for exploring extraterrestrial life can be understood not only as empirical research but also as an endeavor rich with theological significance.

7.2 A Humble Exploration

Islamic epistemology encourages *tafakkur* (deep contemplation) and *tadabbur* (reflection), especially upon the signs (*āyāt*) of God in the heavens and the Earth. Surah Āl ʿImrān (3:191) describes the believers as

"*Those who remember Allah while standing or sitting or [lying] on their sides and give thought to the creation of the heavens and the earth.*"

In this light, contemporary scientific inquiry into the cosmos, including the quest for extraterrestrial life, could possibly be an extension pf this meditative imperative (Sardar 2011). The investigation of space and life beyond Earth can thus be interpreted as a modern form of spiritual reflection. Islamic traditions highlight *tawāḍu* ʿ(humanity) in the form of an immense cosmos, a humility which complements the empirical caution of science. This common position allows for a holistic integration of empirical curiosity and spiritual reflection. This shared posture opens a space for integrating scientific curiosity with spiritual awareness, developing knowledge with no prejudice (Ryff. 2021).

8. Conclusion

The scientific search for extraterrestrial life beyond Earth has evolved from speculative fiction to a factual and active area of study. Advances in search for planetary studies, astrobiology, and molecular biology offer rigorous methods for investigating the conditions where life could emerge and endure beyond the terrestrial environment. Where science offers the empirical tools to investigate life beyond the Earth, the Quran contributes a theological foundation. Surah Ash-Shura (42:29) illustrates that:

"And among His signs is the creation of the heavens and the earth and what He has dispersed throughout them of living creatures," suggesting the possibility of life dispersed throughout the universe.

By bringing together findings from molecular and cellular biology, stress response mechanisms, and genetic adaptability with a Qur'anic perspective, a mutually enriching discourse unfolds, one that unites scientific information with intellectual contemplation. The endurance and adaptability of life to exist in a variety of settings are supported by cellular processes such as DNA repair, autophagy, and pluripotent differentiation, which underscores the remarkable capacity and resilience of living things to exist in diverse environments, supporting the scientific plausibility.

Such integration of science and technology not only broadens our comprehension of biological potential across the universe but also simultaneously enriches the perspective of theological discussion concerning creation, meaning, and the sacred nature of life. This perspective encourages a more comprehensive understanding of the heavens not only as distant physical entities but as symbols that inspire wonder, contemplation, and reflection. It thereby highlights the duty of humanity as custodians of creation and knowledge and affirms the divine sanctity of life in all life forms.

Conflict of Interest

The author declares that there is no conflict of interest regarding the publication of this work.

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