

The Universal Replication Principle and the Origin of Life

Author: Ignacio Lesta Pelayo

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Abstract

This work explores the relationship between the Universal Replication Principle (URP) and the emergence of life in the universe. Under this principle, fundamental physical configurations tend to preserve their coherence and, when mechanisms capable of doing so exist, to give rise to configurations of the same type, allowing the emergence of replicative systems to be interpreted as a natural consequence of the dynamics of the cosmos.

From this perspective, life does not constitute an anomaly within physical laws, but a continuation of the processes of organization and replication that have manifested themselves since the origin of the universe. The article analyzes the transition from physical and chemical replication to biological replication, as well as the role of information in this process, and examines its ontological implications.

This approach lies at the intersection of fundamental physics, prebiotic chemistry, and the biology of the origin of life, proposing a unified conceptual framework based on the URP.

1. Introduction

The emergence of life constitutes one of the deepest problems in contemporary science. Despite advances in biology, chemistry, and cosmology, the transition from inert matter to living systems remains a matter of debate, especially with regard to whether it is necessary or contingent within the development of the universe.

Within the usual scientific framework, the origin of life is approached as an emergent process arising from specific physicochemical conditions, in which complexity progressively increases until systems capable of replication and metabolism appear. However, this approach leaves open a fundamental question: whether life is an exceptional phenomenon resulting from fortuitous circumstances or, on the contrary, a natural consequence of the deepest properties of the universe.

This work addresses this question from the perspective of the Universal Replication Principle (URP), according to which fundamental physical configurations tend to maintain their coherence and, under certain conditions, can give rise to configurations of the same type. This principle can be understood as an ontological foundation of coherence in the cosmos.

In simple terms, the URP describes the tendency of coherent configurations to persist or reappear when physical laws and conditions allow their formation. This does not mean that any macroscopic object can replicate itself or generate another identical object. It does not introduce a new physical interaction, but rather expresses a general characteristic of the dynamics of being: the tendency of coherent configurations to prolong their existence.

From this perspective, the transition from matter to life does not represent a break in natural laws. Rather, it is a transition between different levels of organization of coherence: from physical stability, through chemical replication, to the emergence of systems capable of reproducing information in a structured way.

The aim of this article is to analyze this process of continuity, showing how the emergence of life can be understood as a coherent consequence of the URP, rather than as an isolated event in the history of the universe.

The article is structured as follows. First, the transition from physical coherence to chemical replication is analyzed. Next, the transition toward living systems based on the replication of information is studied. Finally, the emergence of life is examined as a coherent consequence of the Universal Replication Principle.

2. From physical coherence to chemical replication

The transition from inert matter to the first replicative systems cannot be understood as an abrupt transition, but rather as a gradual process of increasing structural coherence in open physical systems.

In the early stages of the universe, the formation of particles, atoms, and molecules already reflects the general tendency of energy to organize itself into stable configurations. These structures are not static, but maintain their identity through dynamic interactions that preserve their coherence against entropy.

As chemical complexity increases, certain molecular configurations acquire the capacity to participate in cyclic processes in which their own structure contributes to the formation of new similar configurations. This phenomenon, which can be described as a primitive form of replication, represents a turning point in the dynamics of matter.

In this context, replication does not appear as an external or exceptional phenomenon. It is a natural extension of the general principle of conservation of coherence. Molecules that, by virtue of their structure, favor their own reproduction tend to persist and multiply, generating increasingly complex systems.

From the perspective of the URP, this process does not constitute an anomaly, but rather a local manifestation of the same principle that expresses the persistence of coherence in fundamental physical configurations. The transition toward replicative systems does not introduce a new dynamic into the universe, but intensifies a property already present in its most fundamental states.

In this way, prebiotic chemistry can be understood as the domain in which replication begins to acquire an explicit character, preparing the ground for the emergence of biological systems capable of storing and transmitting information in a structured way.

Schematically, the process described can be represented as a progression of levels of coherence:

Physical coherence

→ **Formation of stable structures (particles, atoms, molecules)**

→ **Increase in chemical complexity**

→ **Emergence of molecular replication cycles**

- Replication of information
- Living systems

This scheme does not describe a strictly linear sequence, but rather a general tendency in which the replication of coherence acquires progressively more complex forms.

3. From chemical replication to life

The emergence of life represents a qualitative change in the way coherence is organized and maintained over time. Whereas in chemical replication structures reproduce on the basis of their physicochemical properties, in living systems a new level of organization emerges: the replication of information.

This step does not imply the introduction of a completely new dynamic. Rather, it is the consolidation of processes already present at earlier stages. Molecules capable of participating in more efficient replication cycles tend to stabilize and integrate into increasingly complex systems, in which structure and function begin to differentiate.

In this context, the emergence of information-based systems—such as the first mechanisms analogous to DNA or RNA—marks a turning point. Replication ceases to depend solely on the immediate structure of molecules and becomes mediated by sequences capable of encoding and transmitting stable configurations over time.

In other words, information begins to play a central role: it is not only the structure that matters, but also the pattern that allows it to be reproduced.

This new level introduces a fundamental property: heredity. That is, the capacity to preserve and transmit specific configurations over time. Structures not only reproduce, but do so while maintaining patterns that can vary and adapt.

Replication thus becomes a cumulative process, in which coherence is not only maintained but can also be progressively transformed and refined.

From the perspective of the URP, life does not constitute a break with the physical dynamics of the universe, but rather its most elaborate expression. The replication of information represents the highest known degree of the universal tendency to preserve and reproduce coherence.

In this way, living organisms can be understood as systems in which matter has acquired the capacity to sustain, transmit, and develop highly organized structures of coherence, extending into the biological realm the same principle that governs the stability of the cosmos.

4. Life as a consequence of the URP

In light of the preceding sections, the emergence of life can be interpreted not as a contingent phenomenon, but as a coherent consequence of the fundamental dynamics of the universe described by the Universal Replication Principle.

From the earliest physical structures to complex chemical systems, the development of the cosmos shows a constant tendency toward the preservation of stable configurations and, where

replicative dynamics exist, toward their replication. This process is neither uniform nor linear, but it does display a clear direction: structures that succeed in reproducing their coherence tend to persist and amplify over time.

In this context, life emerges when replication reaches a level at which not only structures are reproduced, but also the information that defines them. In other words, not only the form is repeated, but also the pattern that allows it to be reproduced.

This step does not introduce an exception into the dynamics of the universe, but represents its continuity in a regime of greater complexity.

The existence of systems capable of storing, transmitting, and modifying information cannot be understood as an isolated phenomenon. It is the most elaborate known manifestation of the universal tendency toward the replication of coherence.

Life thus constitutes a point of convergence between structural stability, energetic dynamics, and informational capacity.

From the perspective of the URP, the question of whether life is an accident or a necessity takes on a new meaning. If the replication of coherence is a fundamental property of the universe, then the emergence of advanced replicative systems—such as living organisms—is not arbitrary, but compatible with the very logic of cosmic development.

This does not imply that life must arise in every environment or under every condition. However, wherever the appropriate circumstances exist for the stabilization of complex replicative processes, its emergence becomes a natural possibility within the general framework of the universe.

In this way, life can be understood as a structural consequence of the URP: not as an exceptional event, but as one of the ways in which the universe prolongs and develops its coherence through time.

5. Implications and conclusion

The analysis developed in this work makes it possible to reinterpret the emergence of life within a framework of continuity with the fundamental dynamics of the universe. From the perspective of the Universal Replication Principle, life does not constitute an exception or a break in physical laws, but an advanced manifestation of the general tendency of reality to preserve and reproduce coherent configurations.

This approach introduces a unified view in which the evolution of the cosmos, the organization of matter, and the emergence of living systems form part of the same continuous process. The distinction between the physical, chemical, and biological does not disappear, but can be understood as a differentiation of levels within the same underlying dynamic.

Physical persistence and replication, in their chemical and informational forms, thus appear as successive manifestations of the conservation of coherence. From the stability of physical configurations to the transmission of information in living systems, the universe displays an internal consistency based on the persistence and recurrence of coherence.

This framework makes it possible to approach the origin of life from a non-reductionist perspective. Physicochemical processes are not regarded as sufficient on their own, but as integrated within a broader principle that gives meaning to their continuity.

Life does not arise outside the universe, but as one of the ways in which the universe develops its capacity for organization.

In this sense, the question of the accidental or necessary character of life can be reformulated. Life is not necessarily inevitable under every condition, but neither can it be understood as an arbitrary phenomenon. Its emergence lies within the set of possibilities that the universe itself allows and favors wherever the appropriate conditions are present.

In this way, the Universal Replication Principle offers a conceptual framework in which life is understood as a coherent consequence of the dynamics of the cosmos. Not as an isolated fact, but as the prolongation of a fundamental tendency that runs through all reality: the conservation and replication of coherence through time.

Thus, life does not constitute an anomaly in the universe, but one of its most significant expressions.