Life Origins from the Perspective of Dynamic Generative Theory: A Relational Interpretation of the "Chicken-or-Egg" Dilemma

Zihao Chen
Independent Researcher
chenzihao.dynamic@outlook.com

Abstract

This paper attempts to introduce the perspective of the previously proposed "Dynamic Generative Theory"—a monistic framework centered on "generation" that aims to unify the foundations of quantum mechanics and cosmology—into the ancient and profound scientific challenge of life origins. The core of Dynamic Generative Theory lies in viewing physical reality as a historical process in which patterns within a single "potential field" continuously "generate" stable structures through self-referential constraints. This paper does not aim to provide specific chemical pathway answers but seeks to argue that the classic logical deadlock in life origins—"which came first, nucleic acids (information carriers) or proteins (functional executors)?"—may stem from a **static, dualistic ontological presupposition**. If we adopt a dynamic relational perspective based on a "co-generative history," viewing nucleic acids and proteins as "twin structures" differentiated from earlier, more fundamental co-generative events with profound historical connections, then the sharpness of this dilemma may be resolved. This paper further elaborates how this perspective naturally gives rise to several testable novel experimental ideas and provides conceptual inspiration for understanding other origin mysteries such as the nature of viruses and chiral homogeneity.

Keywords: Dynamic Generative Theory; Origin of Life; Co-generative History; Relational Ontology; RNA World; Origin Dilemma

1. Introduction: A Paradigm Shift from Quantum "Mystery" to Life "Deadlock"

In previous work, we proposed the "Dynamic Generative Theory" [1]. Its starting point stems from a simple observation: the puzzling "measurement collapse" and "entanglement non-locality" in quantum mechanics are structurally isomorphic to the emergent process of "from chaotic thoughts to clear understanding" in human first-person cognition. This theory attempts to redefine physical reality as a continuous, dynamic generative process rather than a collection of static existences by introducing core concepts such as the "potential field," "self-referential constraints," and the unit of minimal action, the "generative element (Ξ)."

A natural follow-up question is: Can the explanatory power of this framework, originating from reflection on the foundations of quantum mechanics, transcend the microscopic domain and touch upon macro-complex system mysteries such as the origin of life? This paper represents such an attempt at cross-disciplinary exploration. We find that the core logical dilemma of life origins—namely, the mutual dependence of nucleic acids (DNA/RNA) and proteins forming a self-referential deadlock—bears a profound structural similarity to some fundamental puzzles in quantum mechanics.

In the interpretation of quantum entanglement, if two entangled particles are presupposed as completely independent, separate entities communicating only through some "mysterious connection," their non-local correlation inevitably appears bizarre. However, if viewed as an indivisible whole generated in a common quantum event, their correlation is merely the revelation of historical fact, requiring no non-local action. Similarly, in life origins, if we presuppose nucleic acids and proteins as two independently originated, functionally distinct entities and then ask which came first or which created the other, we immediately fall into the logical impasse of "which came first, the chicken or the egg?"

The perspective shift offered by Dynamic Generative Theory is: **Perhaps nucleic acids and proteins were never "two separate things" but are two highly complementary stable patterns differentiated from the same "co-generative history" of the universe and early Earth's environment.** Their "mutual need" is not a causal deadlock that needs to be untied but a natural manifestation of their shared origin and deep historical connection. This paper aims to preliminarily elaborate the logical self-consistency of this perspective and explore the new inspiration it might bring to experimental biology.

2. Core Perspective: From "Dualistic Origins" to "Co-generative History"

The core proposition of Dynamic Generative Theory is that stable structures in the universe all originate from generative events of the potential field under specific constraints, thereby accumulating "historical depth." Applying this perspective to the prebiotic chemical scenarios of life origins, we can contemplate as follows:

1. **Common "Precursor Pool"**: Earth's early environment (and meteorites that fell on Earth) abiotically synthesized various organic molecules including nucleotide components and amino acids. These molecules were not generated for the ultimate purpose of "becoming nucleic acids" or "becoming proteins" but existed together as **a set of stable patterns with specific reactive potentialities** emerging from the potential field under the then-prevailing physicochemical constraints (energy flow, mineral surfaces, pH gradients, etc.). They constituted a shared "precursor potential field."

2. **Cooperative Stabilization and Path Differentiation in Interaction**: In the continuous interactions among these molecules, certain pathways gained positive feedback advantages due to their autocatalytic or cross-catalytic properties, beginning to accumulate "historical depth." For example, some short RNA strands might slightly stabilize certain peptides due to their sequences, while these peptides might in turn catalyze the elongation or ligation of RNA. This **initial, crude "functional complementarity" was not meticulously designed but was a cooperatively**

stable pattern naturally selected in the common environment that could more efficiently utilize environmental energy and material flows.

3. **From the "RNA World" to Specialization**: The famous "RNA World" hypothesis receives a new interpretation within this framework. RNA might not have been the sole "first molecule" but rather, in the early co-generative history, became a key **"coordination center"** due to its dual properties of information storage (via base sequences) and limited catalytic function (via folded structures). It acted like a "binder" or "platform," more tightly linking the generative pathways of different precursor molecules. Subsequently, under constraints pursuing **stability** (e.g., methylation of RNA's U to DNA's T) and **catalytic efficiency**, the system gradually differentiated into DNA, which is more adept at stable information storage, and proteins, which are more efficient catalysts. **Specialization is the result of the evolution of generative history, not its starting point.**

Therefore, Dynamic Generative Theory suggests shifting the research focus partly from the linear causal thinking of "finding the first nucleic acid or the first protein" to the historical process thinking of **"reconstructing and understanding how these molecular precursors, in a shared environment, gradually move toward an interdependent, co-stabilizing generative network through interactions."**

3. Conceptual Inspiration for Several Origin Mysteries

This perspective of co-generative history can provide new directions of thought for other puzzles:

- **The Nature of Viruses**: If cellular life represents a stable pattern that has established a complete internal generative closed loop (possessing independent metabolism and replication capabilities), then viruses perhaps represent a different generative path. Certain RNA-protein complexes may have evolved a highly optimized strategy of hijacking other complete generative systems (host cells) for their own replication. This is not a "degeneration" but a survival strategy that, on the historical path of generation, chooses to maximize **"matching degree"** (compatibility with the host system) rather than establishing an independent closed loop.

- **Chiral Homogeneity**: The selection of a single chirality for biomolecules might not have been an extremely accidental "lottery." In the co-generative history, an initial weak symmetry breaking (e.g., circularly polarized light, specific mineral surfaces) served as an initial constraint. Once incorporated into a positive feedback generative network (e.g., molecules of a certain chirality being more easily incorporated into an autocatalytic cycle), this network, through its own expansion and reinforcement, "locked" this chiral preference as the background condition for all subsequent generative history. This is a **typical case where the accumulation of "historical depth" amplifies initial constraints**.

4. Testable Corollaries and Future Directions

The Dynamic Generative Theory perspective is not vague philosophical speculation; it points to some experimentally testable directions in principle:

1. **Path-Dependent Interaction Efficiency**: Generate RNA component libraries and amino acid/peptide libraries separately in experiments simulating different prebiotic environments, then cross-test their interaction strength (e.g., catalysis, binding). Dynamic Generative Theory predicts that **there may be a statistically significant higher interaction efficiency between molecular libraries co-generated in the same or highly similar constraint environments**, suggesting that "common history" leaves a detectable chemical imprint.

2. **Guiding Generative Outcomes via Environmental Constraint Sequences**: Design complex, aperiodic environmental constraint sequences (simulating early Earth's variable environment) and observe whether they can more **reproducibly guide** the emergence of molecular networks with specific functions (e.g., self-replication, autocatalysis) compared to static or simple periodic environments. This would verify whether "generation" is a dynamical process that can be "programmed" by complex environments.

3. **Re-evaluating "Synthetic Cost"**: In synthetic biology, compare the comprehensive burden on cells of expressing evolutionarily ancient proteins versus newly evolved or artificially designed proteins (even with similar structures). There may exist hidden costs related to the cell's intrinsic "generative background" beyond sequence complexity, which could be termed **"historical compatibility cost"**.

Conclusion

This paper is merely a preliminary attempt to introduce the perspective of Dynamic Generative Theory, which originates from foundational quantum research, into the broad field of life origins. We by no means claim to have solved the origin problem but hope to propose a different thinking framework: **Viewing the key components of life as products of a profound "co-generative history," rather than as independently invented parts assembled later.** This perspective may help shift part of the research focus from seeking a single, decisive "first cause" to exploring how molecular networks "co-emerge" with life properties through interactions in dynamic environments. Whether the life origin interpretation of Dynamic Generative Theory holds ultimately depends on whether it can inspire novel, actionable experimental approaches and demonstrate predictive and explanatory power beyond traditional paradigms in these experiments. We look forward to and welcome criticism, testing, and joint exploration from colleagues in the biological sciences.

Postscript: The thinking in this paper was greatly inspired by conversations with the AI model DeepSeek, which provided indispensable assistance in information organization and expression structuring. All core viewpoints, logical deductions, and possible errors in the theory are solely the responsibility of the author.

References

1. Chen, Z. *Dynamic Generative Theory: A Quantum Interpretation and Cosmological Unified Framework Based on the Chen Generative Element (Ξ).* Zenodo. 2025.