



## The Origin of Life: A Philosophical Hypothesis in Dialogue with Modern Biology

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Currently, abiogenetic theories enjoy wide support when it comes to explaining the origin of life. Although the advances are undeniable, these models face significant difficulties, which, in our view, stem from the challenge of explaining the emergence of a living being from inert agents. To fill this explanatory gap, interventionist models introduce the action of a higher cause—God—to explain the transition from the nonliving to the living. However, this idea does not fully respect the legitimate autonomy of secondary causes and is dangerously close to the “God of the gaps,” widely criticized over recent decades. Expanding on our previous work on biological evolution, we now propose a hypothesis that distances itself from both abiogenesis and interventionism. The resulting model, inspired by the philosophical proposals of Thomas Aquinas, harmonizes the action of God as the first and principal cause with the action of secondary and instrumental causes described by natural history in its own epistemological domain.

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## Introduction

The origin of the first living beings on our planet is shrouded in a thick fog not even the most sophisticated techniques available today can fully penetrate. Progress, however, is undeniable regarding the chronology and type of entity that may have inaugurated the course of corporeal life. The question that attracts most attention concerns the cause(s) explaining the origin of life. Historically, several alternatives have been explored. The first is the theory of spontaneous generation, usually attributed to Aristotle and only completely displaced with the experiments of Louis Pasteur in the eighteenth century (Farley and Gerald 1974; Roll-Hansen 1979). A second option, which continues to gain followers, especially in certain circles of the American evangelical world, appeals to a largely literal reading of the relevant Bible passages to explain not only the origin of organic life but also of humankind and all living forms (Matzke 2010, 145–62; Koperski 2015, 410–18). Third, we can mention the theory of panspermia, unhesitatingly endorsed by figures as reputable as Lord Kelvin, Svante Arrhenius, and Francis Crick (Ginsburg and Lingam 2021; Mitton 2022). The theoretical option that dominates the academic world today, however, is none of the aforementioned but that of abiogenesis. Rather than a single hypothesis, it is a broad group of hypotheses, all of which share the thesis that life is the predictable result of a process of material complexification.

In the next section, we present the general characteristics of current abiogenetic hypotheses, aiming to identify points of consensus, ongoing debates, and the strengths and weaknesses of prevailing explanations. The third section briefly summarizes the causal model inspired by the philosophy of Thomas Aquinas and proposed in a previous work to explain the evolutionary phenomena. Our goal here is to demonstrate that, while certain aspects of this model remain useful for addressing the problem of the origin of life, specific and distinctive challenges persist. In the fourth section, we outline our proposal regarding the origin of life, which attempts to integrate contributions from specialized research alongside conclusions derived from the study of evolution. We argue that our model avoids the extremes of both theistic interventionism and emergentist materialism. We conclude with brief epistemological reflections on our hypothesis.

## The Contribution of Abiogenetic Theories Regarding the Origin of Life

The object of this section is to critically examine the data, facts, and theories developed by the particular disciplines in the field of the origin of life with the aim of determining the extent of their value in formulating a plausible philosophical hypothesis concerning the emergence of the first corporeal living beings. In this regard, we must start by stating that the two preferred approaches adopted in origin of life research—as is true with the technological programs that aim to generate artificial life—are the top-down approach and the bottom-up

approach (Carreño 2017). In biology, the former is more popular. The top-down approach involves analyzing the components of living beings and the properties those components exhibit with the aim of producing new types of cellular organisms through chemical synthesis and gene editing (Preiner et al. 2020). The most widely used models in this type of experiment are bacteria, specifically different species of the genus *Mycoplasma*, due to the small size of their genomes. Thus, Daniel Gibson et al. (2008, 2010) synthesized, assembled, and cloned the genome of *Mycoplasma genitalium*—the living being with the smallest known genome—in 2008 and, just a couple of years later, reported the artificial design of a new genome using *Mycoplasma mycoides* as a model. These approaches have been widened in subsequent years, often in the context of the biotechnology industry (Carreño 2017, 642).

The bottom-up, or synthetic, approach has been used primarily in the fields of chemistry and bioengineering. Its objective is to generate living or, alternatively, living-like entities through the artificial production and assembly of their components (Hirschi et al. 2022). More specifically, such research has aimed to synthesize what is known in jargon as a protocell, a simple cell-like membranous structure that exhibits at least some of the characteristics considered distinctive of organisms, including the ability to sustain metabolism, growth, and reproduction (Dzieciol and Mann 2012). It should be noted that, to date, and beyond some particular achievements, even the most optimistic see the horizon of producing structures of this type as distant, especially due to the technical difficulties involved in the artificial generation of a self-replicating genome or the manufacture of compartments and organelles (Blain and Szostak 2014; Cho and Lu 2020; Adamala et al. 2024). The goal of producing an artificial cell from artificial molecules, different from those present in known living beings, seems even more distant. Although theoretical models and technical advances in synthetic biology leave open the possibility of an organic lifeform based on a biochemistry different from our own, the challenges are still great (Xu, Hu, and Chen 2016; Maffei et al. 2024).

Beyond the approach implemented, however, the very content of the theories about the origin of life reveals a widespread consensus about the timing of this event. Indeed, the quantification of carbon and sulfur isotopes and measurement of premetamorphic dolomite in sedimentary rocks on islands in Greenland, the detection of pyrite in South Africa, and the presence of stromatolites in Australia all support the thesis of a relatively brief period between the formation of our planet and the emergence of organic life. More specifically, current dating estimates the first living organisms to have appeared before the end of the Late Heavy Bombardment, around 4,000 million years ago (Vicuña 2014; Pearce et al. 2018; Javaux 2019).

Less clear, however, is the location or environment in which corporeal life originated. The aforementioned theory of panspermia postulates an

extraterrestrial origin of life—merely a shift in the level of the fundamental question, of course, for if life on Earth derives from another planetary system, it remains necessary to determine how life originated there. Among those who favor a terrestrial origin, a prevalent alternative is that of the primordial soup. Highly respected authors in the field, including Stanley Miller, Aleksandr Oparin, and J. B. S. Haldane, argue that life originated in a solution and that the first living forms thus generated possessed a heterotrophic metabolism.<sup>1</sup> Others, such as Günter Wächtershäuser and Michael Russell, hypothesize that the first organic living beings appeared on solid surfaces, in particular near marine or terrestrial hydrothermal vents that ensured a supply of energy and chemical elements relevant to organic life as we know it (Wächtershäuser 1998, 206–18; Russell and Hall 1997; Russell 2006). Other suggestions of initial locations include rocks near volcanoes and even aerosol particles (Donaldson 2004). While some of these proposals may cite indirect empirical support, this remains an open question and matter of debate among specialists.

The great debate in origin of life research, however (related to the problem of location, incidentally), has focused on the specific manner in which the first corporeal living beings could have emerged. The intensity of the discussion and divergence of adopted strategies have been such that, for some years now, the different explanatory models currently available to account for the origin of life have already surpassed the purely theoretical level to become a real division among experts (Preiner et al. 2020; Lane and Xavier 2024). In any case, and for the present purposes, the two major theoretical frameworks competing for hegemony among specialists can be said to be those called the replication-first theory and the metabolism-first theory.

The replication-first theory has enjoyed the support of authors such as Walter Gilbert (1986), Addy Pross (2004), and Paul H. Higgs and Niles Lehman (2015). It assumes that, in a prebiotic world, RNA arose from chemical reactions facilitated by the environment. RNA, in displaying a certain catalytic activity and the capacity to function as a template for its own replication, makes an ideal candidate, according to some, to explain the transition from inert to living (Pace and Marsh 1985). Subsequent research, however, has shown that this hypothesis faces serious difficulties, including the limited catalytic activity RNA has displayed in various tests (at least when compared to that exhibited by proteins) and its structural instability under extreme temperature and pH conditions, such as those that possibly existed on early Earth (Le Vay and Mutschler 2019). Furthermore, critics often contrast this model with Sol Spiegelman's famous experiments on self-replicating RNAs. These experiments demonstrated that successive replication cycles produced a marked shortening of the original sequences, a finding that was later confirmed and extended in subsequent studies (Mills, Peterson, and Spiegelman 1967).

Beyond these problems, however, the replication-first theory encounters the otherwise obvious difficulty that replication acts, by definition, to conserve a certain organization or arrangement, precisely that being copied or duplicated. The question remaining unanswered, however, is how that organization arose in the first place, so understandably, the objection is raised that this approach is unable to account for other relevant characteristics of living beings, such as compartmentalization and differentiation (Bregestovski 2015). One might suppose that phenomena such as mutations and genetic recombination invalidate this criticism, but this is not the case. Random modifications of genetic material acquire their true biological significance only when immersed in the vital operation of reproduction, which in turn presupposes the existence of a living being—the one that reproduces. But unlike an evolutionary model, a theory about the origin of life—such as the replication-first theory—cannot assume the existence of such a living being; that, and nothing else, is what it must plausibly explain.

The metabolism-first theory, for its part, attempts to explain the origin of life by resorting to the formation of autocatalytic networks, chemical reactions capable of sustaining themselves over time. It is from this primitive organization, therefore, that replication gradually develops, with its more complex inheritance mechanisms. Oparin is one author inaugurating this approach. In his work *The Origins of Life on Earth* (1957), he conjectures that an atmosphere rich in methane, ammonia, hydrogen, and water, all derived from the Earth's geothermal activity, could have been the propitious substrate for the formation—still prebiological—of complex organic molecules, such as amino acids. As a result of a series of environmental processes, these molecules would have acquired a primitive organization he calls “coacervate,” which would have experienced increasing complexity thanks to its compartmentalization (Oparin 1957, 301–21; Priya et al. 2022). More recently, Juli Peretó (2005) has hypothesized that metabolic networks self-organize within what were previously called protocells; these structures can now be considered alive, since they not only possess a metabolism and certain capacity for growth but also replicate, generating new similar organizations through stochastic processes.

Several approaches, more experimental in nature, have adopted and attempted to support the metabolism-first framework. A classic precedent in this regard is the results reported by Stanley L. Miller and Harold C. Urey in the 1950s. By emulating the conditions thought to have existed on the early Earth, Miller and Urey managed to form a few varieties of simple amino acids (Miller 1953, 1955; Miller and Urey 1959). Other theories, such as the iron-sulfur model, also suggest the spontaneous generation of autocatalytic systems, albeit under different initial environmental conditions (Russell 2006). In recent years, the GADV hypothesis has gained notoriety; each letter refers to an amino acid (glycine, alanine, aspartic acid, and valine, respectively), which, when mixed in different combinations, can function as a code, giving the “system” the capacity

for self-replication (Ikehara 2005). There is much interest in this class of models, as they emphasize a peptide molecule that, under the adverse conditions in which the origin of life presumably occurred, displays a stability far superior to that of RNA (Ikehara 2012).

Despite the interest, the metabolism-first theory also faces some pitfalls. Consider the account offered by Alvaro Moreno and Matteo Mossio (2015, 120–23) in support of this model, wherein life began as an autocatalytic system that underwent a compartmentalization process, i.e., incorporated a membrane in its causal closure.<sup>2</sup> This system already constituted a protocell capable of reproduction because, despite lacking template molecules (such as DNA and RNA), it had a structure that allowed it to replicate in new individuals with a statistical pattern.<sup>3</sup> According to the canons accepted in neo-Darwinian theory, once this stage was reached, natural selection did its work, allowing for increased complexity and functionality.

Leaving aside the challenge of explaining these spontaneous assemblies from a thermodynamic point of view—already arduous in itself (Bergström 2011)—this explanans of the origin of life suffers from a patent loophole: How could it be explained that the membrane of this protocell is included in the causal closure? There are only two alternatives. If we start with the autocatalytic system, we would have to assume it formed first and was then able to accommodate that membrane in its closure. But without a membrane, there cannot really be an autocatalytic system, because the metabolites necessary to ensure the effective occurrence of the countless chemical reactions essential for organic life would not reach the appropriate concentration, nor would there be any control over the flow of energy and matter. Taking the other alternative assumes that the membrane formed first, and then, within it, the autocatalytic system was generated. But this scenario does not seem plausible either, because the stability and selectivity of biological membranes depend on and are produced by what happens inside them, i.e., the autocatalytic system that maintains and regenerates them. Aristotle, as will be recalled, admits the possibility of two causes causing each other reciprocally, as in fact occurs between form and matter, but only as long as this mutuality does not occur on the same causal plane (Aristotle, “Physics” II, 3 [Bk 195a 7–12]; Aquinas, *De princ. natur.*, c. 4; *In Physic.*, II, lect. 5, n. 7). In this model, however, we have a catalytic system and a membrane that are effects of each other in an efficient sense, and this is not admissible.

### **The Uniqueness of the Question of the Origin of Life**

We have already addressed in a separate work the question of the evolution of the corporeal living being in light of the philosophical doctrine found in the corpus of the medieval theologian Thomas Aquinas (Carreño 2024a).<sup>4</sup> Without recapitulating the entire complexity of this problem, it is appropriate to review

some of the main ideas proposed there to contrast them with the issue of the origin of life.

Resuming a distinction held by scholars of various disciplines, it is important to start by distinguishing between the intraspecific and transspecific dimensions of the evolutionary journey (Carreño 2024a, 491–558). The former occurs within the entitative sphere of a given species, resulting in the generation of new varieties and races of living beings. From an ontological point of view, therefore, these are accidental changes, but they have at least two peculiarities: being shared by a community of living beings of the same species and being heritable. Understandably, it is not this evolutionary variant but rather the transspecific one that has captivated theologians, philosophers, and biologists alike. In this case, the evolutionary event involves what is known in biology as speciation, i.e., the generation of a living being of a new species.<sup>5</sup>

Now, in the light of hylomorphism—at least in Aquinas’s interpretation—a process of this kind implies that the generated living being possesses a substantial form not only numerically distinct but specifically different from that of the organism that preceded it in chronological terms. Indeed, according to Aquinas, the species or definition includes a determinate matter, designated by the name of its genus, and a determinate form, designated by the name of difference, even though it is the substantial form that has primacy in the definition, given its status as an actual co-principle (Aquinas, *De ente et ess.*, c. 1; *S.Th.*, I, q. 14, a. 6, co; I–II, q. 67, a. 5, co; III, q. 72, a. 4, co; *In Post.*, II, lect. 13, n. 6; *In Metaph.*, VII, lect. 3, n. 22). Viewed from this perspective, transspecific evolution raises a series of questions. Is such a substantial change feasible in an already-constituted organism? If not, when does the event itself occur? What types of causalities intervene in such a change?

To answer these questions, we have developed the transgenerational substantial transformation model, whereby transspecific change assumes and incorporates the generative activity of the living being such that at time  $X_0$ , living body  $A$  is animated by a substantial form  $a$  and belongs to or constitutes the species  $a$ . At instant  $X_1$ , living being  $A$  exercises its generative activity, but instead of educating a form  $a$  (specifically identical to its own) from the potentiality of matter, it educes a new substantial form  $b$ . In this way, from instant  $X_1$ , the progenitor (living being  $A$ ) continues to exist, and its descendant (living being  $B$ ) has begun to exist, belonging to or constituting the species  $\beta$ . Therefore, in this scheme, it is not an already-constituted living being that experiences the transformation or supraformation,<sup>6</sup> but rather the new living being  $B$  is such, animated by the substantial form  $b$  from the moment it begins to exist (Carreño 2024a, 265–66).

We believe this proposal is not only more viable than other evolutionary hypotheses developed within Thomism, from a factual point of view, but also gives rise to a more consistent causal model. Projecting the suggestions of Jacques Maritain and Mariusz Tabaczek, we maintain that a plurality of causes

intervene in the occurrence of transgenerational substantial transformation (Carreño 2024a, 542–58):

- God, as the first cause of evolution, gives being and causal efficiency to a set of secondary causes that participate in speciation. Among these, we can distinguish factors both intrinsic to the living being itself (changes in genetic material, epigenetic modifications, etc.) and extrinsic (geographic distribution, the influence of the environment on reproductive efficiency, artificial selection, etc.). Note that many of these factors—and perhaps others—also act in intraspecific evolution.
- While this is, in fact, applicable to all creation, closely following Maritain's suggestion, we postulate that, in the case of evolution, God exercises a peculiar type of motion, a superelevating type, under which influence the generative activity of the living being (which then behaves as an instrumental cause of evolution) can produce an effect superior to its nature and virtuality, namely, a living being of a new species, thus achieving the end to which the whole process tends.

This model can be distinguished from two alternatives that emerged in the past and that we judge unbalanced. The first, which we describe as interventionist, postulates that God acts in the development of organic life, directly and completely provoking the transspecific change whose traces the biologist detects through his or her own methods. At the other extreme are the typically materialist explanans (whether in their physicalist or emergentist variants), in which there is only room for strictly natural causalities. In the present hypothesis, however, transspecific evolution is the effect of a causal plurality in which first and principal causes converge with secondary and instrumental ones, each in its own way and in accordance with its status. But as the title of this section suggests, it is worth asking whether this causal model can be extrapolated to the question of the origin of life.

Our previous study on the evolution of living beings left this question open, since answering it required an independent study to treat remaining opaque and hypothetical points. These are precisely the points addressed here, and they relate to the type of secondary causes that would combine in a substantial transformation<sup>7</sup> whose *terminus a quo* is a nonliving entity and whose *terminus ad quem* is a living being. Indeed, the acceptance of God's role as the first cause that activates and enables secondary causes is not a problem at this level, nor indeed at any other, because this is a truth of universal scope, which therefore extends to all finite beings. Far from clear, however, are the kinds of secondary causes that could intervene in the origin of corporeal life. We cannot resort here to the causal factors mentioned as possible candidates for the evolution of

living beings, because they are directly or indirectly related to generation, a vital activity. If this can be an explanans for the evolution of life, when it comes to its origin, it is nothing but an explanandum.

The same can be said of the causal superposition postulated in our model. God, of course, can elevate a causality inherent to the creature so that it produces, instrumentally, an effect (a living being) superior to its power and virtue. But this cannot happen in just any way (Aquinas, *S. Th.*, I, q. 45, a. 5, co). Undoubtedly, the elevation of a secondary cause presupposes and respects the type of action it naturally exercises, and thus, it is possible for a brush in Rembrandt's hands to produce effects that far exceed what that brush could produce on its own. But for this to happen, the brush must possess certain characteristics that make it a suitable instrument for pictorial art. Returning to the case of biological evolution, the secondary cause that, it seems to us, could play this instrumental role is the generative operation of the organic living being. But as already pointed out, this generation cannot be what explains the origin of life; on the contrary, it is part of what must be explained. Ultimately, what is needed to formulate a plausible philosophical hypothesis about the origin of corporeal life on our planet is a type of secondary cause that plays an instrumental role analogous to that played by the generative activity of living beings in biological evolution.

### **Instrumental Causality Operating in the Origin of Life**

Before proceeding into discussion of the model we propose, it is important to clarify certain central truths within the philosophy of Aquinas and the tradition that bears his name. One of particular importance is the notion of life. In clear contrast to the materialist, emergentist, and mechanistic approaches used today to address virtually any dimension of organic life, Aquinas emphasizes—following Aristotle's lead and some contributions from Pseudo-Dionysius—that life is not an accidental but a substantial predicate, since it is nothing but the *esse* of the living being. It follows that, *stricto sensu*, a living being is not such because it possesses *something* a nonliving entity lacks; rather, this living being *is more being* than a nonliving being, in the most radical sense of the term; the same is true for knowledge: it is not something some living beings possess but rather a more complete and whole way of living (Carreño 2020).

This more perfect mode of being, which we call life, is cognitively accessible through the characteristic actions a living being performs, its operations. Its two distinctive features are autonomy and immanence. The first highlights the fact that the living being acts *ex se*, by and from itself, while the second emphasizes that it is the living being itself that receives the effect and is perfected by such operations (Carreño 2015). The perfection of the vital act thus conceived is analogously realized in the three degrees of corporeal life Aquinas takes from

Aristotle, namely, vegetative, animal, and human. The first is identified by the operations of nutrition, growth, and reproduction<sup>8</sup> and is the one of most interest here because, in the Aristotelian and Thomistic proposals, it constitutes the basic and fundamental level of organic life: basic because it represents the first separation between the nonliving and the living and fundamental because the other two levels must assume, in their own way, this first step, without which corporeal life cannot exist (Aquinas, *De anima* II, 2 [Bk 413a 20–b2]; *In De anima*, II, lect. 3, n. 14).

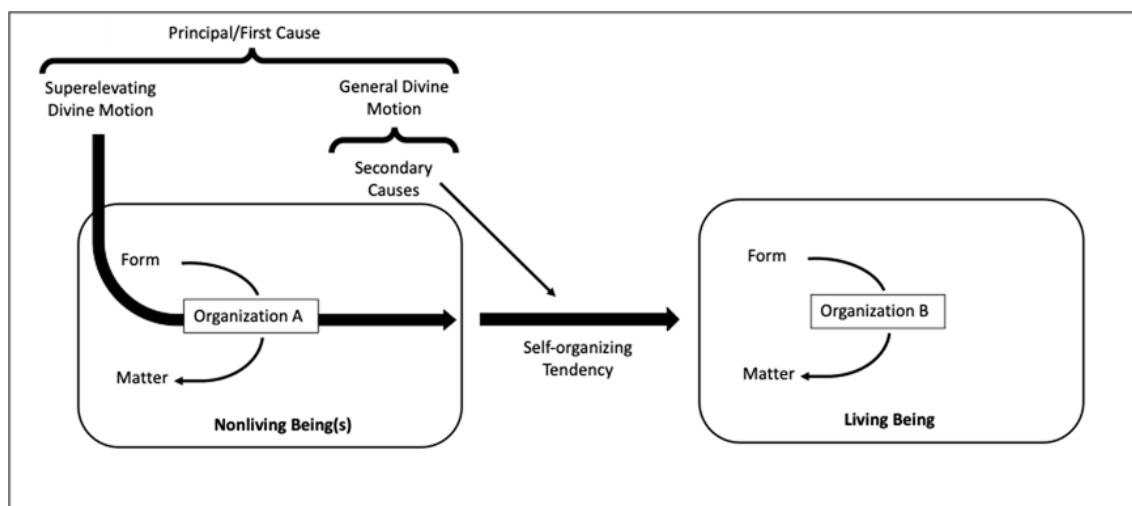
Considering that presented in the second section of this article, everything seems to indicate that the vegetative life we have described as basic and fundamental in ontological terms is also so from a historical perspective. Certainly, the data available today suggest life originated on our planet with unicellular organisms, probably prokaryotes (Pearce et al. 2018; Javaux 2019). Beyond their precise taxonomic classification, what is relevant for our purposes is that they were capable of nourishing themselves, growing, and reproducing and therefore correspond to what in the classical gradation is conceived of as a type of vegetative life (Serani 2000, 97; Carreño 2024b, 33–38). But no matter how rudimentary these early organisms may have been on the physiological and morphological levels, at least in a truly Thomistic approach, the entitative distance separating these primitive life forms from their inert precursors remains abyssal. If a living being is an entity in a more complete and perfect sense than one that lacks life, it is not feasible to explain the origin of life by resorting to the mere assembly of parts. In such a case, it would be necessary to admit that there is more being in the effect than in the cause, a pure impossibility according to Aquinas (*Comp. Theol.*, I, c. 79; *De pot.*, q. 3, a. 18, ad 8; *In Sent.*, II, d. 17, q. 1, a. 2, co; *Q. D. De anima*, aa. 1, 14; *S.Th.*, I, q. 75, a. 2, co; *S.Th.*, I–II, q. 63, a. 2, arg 3; *S.Th.*, I–II, q. 112, a., co; *S.Th.*, II–II, q. 24, a. 6, sc; *ScG.*, I, c. 67, n. 5).

We believe the difficulties faced by current origin of life theories and models—all clearly mechanistic in influence—arise from a long-term neglect of this primary evidence. It is striking, in this regard, the discouragement sometimes expressed by researchers specializing in the origin of life after periods of relative optimism (Steele 2018; Vicuña 2025). This is precisely where our causal model comes in. We left in suspense the identity, even conjectural, of the secondary and instrumental causes involved in the origin of life—for the abovementioned reasons, they cannot be identical to those involved in evolution, although it is reasonable for a certain continuity to exist between the two events. Thus, considering the theories and hypotheses currently gaining acceptance, it seems appropriate to propose that the secondary causes involved in the origin of life are inorganic factors and entities that, together, ensure the availability and concentration of energy sources and the chemical elements and compounds that are the material cause of corporeal life. As an example of these secondary causalities, and without intending to settle a dispute within the domain of the

natural historian, we can mention here marine hydrothermal vents, which, in addition to forming a surface that facilitates the adhesion and accumulation of various substrates relevant to life, provide a favorable redox environment and a constant flow of energy (Russell and Hall 1997; Russell 2006). But beyond this illustration, it is important to emphasize that none of these factors, singly or together, possess the potential to generate even the simplest living being. It is not enough to resort to time to resolve this difficulty, first, because everything indicates that the interval between the formation of the Earth and the origin of life was, on a geological scale, quite brief, but also, and above all, because it is an absolute impossibility. No cause can produce an effect greater than itself, in ontological terms, unless another proportionate agent intervenes.

It is in light of this difficulty that we postulate the necessity of a superelevating divine motion acting through a suitable instrumental cause. What could this cause be? The research of recent decades offers at least a clue. Indeed, ever since Miller and Urey (1959) showed that some simple amino acids could be generated spontaneously given the right conditions, the fundamental and shared thesis within the theoretical framework of abiogenesis is that the first organisms arose from the spontaneous structuring of inert components in a process of self-assembly or self-organization.<sup>9</sup> Of course, there are many differences and disputes that separate theorists when it comes to explaining the details of this process, but in all of them, without exception, the effective existence of this organizational tendency is assumed, acting as the force or causality behind the appearance of life (Rasmussen 2003; Karsenti 2008; Lehn 2009) and, according to some, the entire arrangement of the universe, including mankind (Webster and Goodwin 1996; Kauffman 1990, 1995; McShea and Brandon 2010).

From our perspective, this idea of an organizational directionality inscribed within corporeality can be retained without adopting the full theoretical framework of abiogenetic models. According to our hypothesis, the potential for self-assembly and self-organization exhibited by inanimate bodies cannot transcend the ontological boundary that distinguishes the sphere of the inert from that of the living, since such an effect simply exceeds its virtuality. Here, we distance ourselves from the theories currently in vogue and also from some theistic interpretations that fail to capture this fact properly (Soriano and Hecce 2024). Only when this tendency is moved and elevated under the action of the principal cause can it produce an effect greater than its virtuality; conversely, if it can act as an instrument of the principal cause, it is because it possesses a causal power that, in a certain way, prepares and announces the ontological level of organic life. Replication and metabolism become, therefore, not causes but rather consequences that follow from an organizational tendency inscribed in the nature of the inanimate body and perfected under the action of the primary cause. In this sense, this idea fits the expectations of current research much more closely than the alternatives (Preiner 2020, 7).



**Figure 1:** An efficient causal scheme proposed for the origin of life. Note that the divine superelevating motion acts not as a purely extrinsic cause but in and from the very essence of the nonliving beings (which includes form and matter, according to Aquinas), projecting and elevating its self-organizing tendency. As a consequence, the organization *A*, that belongs to the nonliving being, gives rise to a superior biological organization *B*. This self-organizing tendency could also be affected by secondary causes which are activated by the First Cause.

In sum, we propose a model in which God, as the primary and first cause, neither competes with nor nullifies the legitimate participation of instrumental and secondary causes (Figure 1). Although this hypothesis warrants many further considerations, we shall limit ourselves to the most fundamental ones for the sake of brevity:

1. The hypothesis assumes a relative continuity between nonliving and living beings, consistent with the narratives and facts described by natural-historical knowledge and natural science. The organizational tendency of the inorganic sphere is projected onto the corporeal living being but without annulling the ontological distance that separates and distinguishes the two domains. Following the principle that the sublime of the lower level approaches the lowest of the higher level (Aquinas, *S. Th.*, I, q. 78, a. 2, co), it can be said that the vegetative living being assumes in its own way the organization inherited from the inert being, just as the sensitive living being does with vegetative life (Aquinas, *De anima* II, 3 (Bk 414b 28–32); *ScG.*, II, c. 58, n. 9; *In De anima.*, II, lect. 4, n. 1; Carreño 2024a, 90–91).
2. Our hypothesis avoids the interventionist–emergentist dichotomy. Regarding the first term of this dispute, it maintains that the first and principal cause of the event (or events, if this happened more than once in the history of the universe) underlying the origin of life is God, but

this action neither replaces nor violates the secondary and instrumental causes that naturally intervened in the emergence of life. Regarding the other side of the dispute, our hypothesis is abiogenetic only with regard to the secondary and instrumental causes. But if one takes into account that its principal cause is God, who is Life (Aquinas, *S. Th.*, I, q. 13, a. 2, ad 2; *S. Th.*, I, q. 18, a. 4; *In Metaph.*, XII, lect. 8, n. 9; *ScG.*, I, c. 98, n. 4, 5; Leget 1997, 41–45), we are not forced to conclude that it is an abiogenetic model in the strongest sense of the expression.

3. Assuming that superelevating divine motion is permanently operating in nature, we have previously conjectured that, by manipulating the secondary and instrumental causes described, one could, in principle, emulate the origin of life to generate living beings (Carreño 2017). However, this is not a creation *ex nihilo*, since it would be manipulating preexisting entities and recapitulating a causal sequence already inscribed in nature; any living beings thus generated would only be artificial in a derived sense (*secundum quid*), i.e., insofar as human intervention has taken place in their production. The feasibility of this conjecture depends on the progress of research, which, for the moment, is incipient.
4. That the first/principal cause cannot be verified by the procedures of empirical science does not make it a mere ad hoc hypothesis but rather the most certain aspect of the entire model presented. Of course, while possible that future investigations will identify the intervention of secondary and instrumental causes whose nature and relevance are not even suspected today, it is an immutable and incontrovertible truth that the most cannot come from the least. The gap between the nonliving and the living can only be overcome by a proportionate cause, and there is only one candidate for that position.<sup>10</sup>

## Final Remarks

In this article, we have attempted to extend our previous work on evolution to the question of the origin of life. In doing so, however, we have been careful to respect the specificity and originality of the latter, avoiding the extrapolation of causalities and explanations from one domain to the other without the necessary adaptations and modifications. Although our epistemological framework is rooted in philosophy, we have examined the theories and hypotheses currently proposed in a variety of fields to account for the emergence of the first living beings and, in doing so, felt compelled in some cases to assess their plausibility. In the current context, such an approach could be seen as “external” intervention or even an unwarranted intrusion into a debate that ostensibly pertains exclusively to relevant experts.

However, we find it important that, within the Thomistic tradition, it is acknowledged that philosophy, as *scientia reatrix*, is called to exercise a function of ordering, judgment, and defense with respect to the particular disciplines—a role that should not interfere with matters that fall within the specialist’s domain but rather offer a critical assessment of the ontological, gnoseological, epistemological, and ethical assumptions underlying any particular disciplinary approach (Aquinas, *In Post.*, I, lect. 25; *Super Boet. De Trin.*, I, q. 2, a. 2; Poinsoot, *Ars Logica* II, q. 26, aa. 2, 3; Maritain 1933, 135–41). This task becomes all the more urgent when it involves an integrative exercise such as the one described here. Indeed, interdisciplinary dialogue—so widely promoted and celebrated today—can take on various forms, ranging from the mere juxtaposition of methods and results to the incorporation of content. In the latter case, such incorporation cannot be carried out without a prior examination of the concepts and judgments to be assimilated. Moreover, these must be reformulated and articulated in accordance with the standards and nomenclature of the disciplines within which the exercise is being conducted.

Following this line of thought, while opting not to draw upon the materialist premises that inspire many hypotheses and theories currently conceived as constitutive of the “scientific attitude” (Dawes 2011; Ruse 2013, 383–97), nothing prevents these contributions being viewed within a different ontological and epistemological framework, one centered on the distinction between first/principal cause and second/instrumental cause. What origin of life research offers regarding the details of the secondary causalities involved in the emergence of corporeal life is not only legitimate within its own domain but also an invaluable resource for philosophy, insofar as philosophical reflection is enriched by the theoretical and empirical findings of extensive specialized research. We also hold that the converse is true: A model such as is proposed here can offer those studying the origin of life a different while complementary perspective on their subject matter. We believe that the time for such integrative perspectives is long overdue, as the legacy of nineteenth-century positivism steadily wanes. Our proposal represents a humble contribution to this ongoing and evolving dialogue.

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## Notes

- <sup>1</sup> Carbon is a key element for maintaining organic life as we know it. Depending on the source from which it is obtained, living beings are classified into two major metabolic groups: autotrophs and heterotrophs. The latter group obtains its energy from organic molecules and includes animals, protozoa, fungi, and some bacteria. Autotrophs use inorganic molecules as an energy source, with plants being the main representative.
- <sup>2</sup> In this approach, a constraint is an entity (e.g., an enzyme) that plays a causal role in a process (e.g., a chemical reaction) by stabilizing it without being affected by the process itself. A network of constraints constitutes causal closure if each of them enables the production of at least one other constraint in the network and is, in turn, enabled by one or more other constraint in that network (Moreno and Mossio 2015, 11–15, 20–24).
- <sup>3</sup> The fundamental idea here is that a self-sustaining chemical network enclosed in a vesicle could grow until it emptied part of its contents into a separate vesicle. A larger network would then be generated there, giving rise to a third vesicle, and so on. For details of this type of reproduction and how it might be encoded in what is called a compositional genome, see Daniel Segré and Doron Lancet (2000), Segré et al. (2001), and Vera Vasas et al. (2012).
- <sup>4</sup> Thomas Aquinas's works are cited here with the abbreviations common in articles and monographs dedicated to his thought.
- <sup>5</sup> What is said in the body of the text raises the difficult question of defining "species." As is well known, contemporary biology has no consensus regarding this concept, but clearly nothing fully coincides with what is understood by it in the Thomistic philosophical tradition. Clinging to this difference of perspective, authors such as Dennis Bonnette (2008) have attempted to deny the existence of such a thing as transspecific evolution in its philosophical sense; in Bonnette's view, the species recognized by biology are merely the correlate of the accidental changes that affect living beings of the same ontological species. We disagree. Indeed, while strict parallels cannot be established between the biological and philosophical notions of species, it is also clear that some characteristics described by biology point to a specific diversity. Two more reasons can be added. First, both Aristotle and Aquinas admit the existence of three different degrees of corporeal life—plant, beast, and man—that cannot be contained within the same ontological species. Second, we must not overlook those passages in which Aquinas expressly defends the desirability of a specific diversity of corporeal creatures, which, accordingly, brings greater perfection to the universe than a diversity of individuals (Aquinas, *ScG.*, II, c. 45, n. 6; *In Sent.*, I, d. 36, q. 2, a. 3; *S.Th.*, I, q. 50, a. 4, ad. 1). For these reasons, we judge it reasonable to accept that corporeal living beings have been subject to a process of specific diversification.
- <sup>6</sup> With the term "supraformation," we designate the possibility that a new substantial form assumes and integrates the one that, until a given moment, animated a living being; a "substantial transformation," on the other hand, implies the advent of a new substantial form in an already-constituted living being, replacing the one that had, until that moment, actualized it (Carreño 2024a, 284–366).
- <sup>7</sup> We have avoided adding the word "transgenerational" to describe this change, since, strictly speaking, it is highly doubtful, to say the least, that a generation actually exists in the inanimate sphere.
- <sup>8</sup> Here we quote the catalogue that has become traditional, but the truth is that Aquinas's naming of vegetative operations is not always uniform. See, for example, Aquinas (*ScG.*, II, c. 58; *In De anima.*, II, lect. 3, n. 13; lect. 9; *S.Th.*, I, q. 78, a. 2, co; *S.Th.*, II–II, q. 179, a. 1, co).
- <sup>9</sup> Although there is no single approach in the literature, it can be said that the term "self-assembly" refers to the grouping of components into an organized structure but without necessarily changing the overall dynamics of the system; "self-organization," on the other hand, can involve a change in the overall behavior of the system. Another term sometimes used is "self-ordering," which is broader and designates a transition from a disordered state to a more ordered one. For these various uses, see David Abel and Jack T. Trevors (2006, 211–28) and Evelyn F. Keller (2009, 131–40).

- <sup>10</sup> One might conjecture that, within the framework of Thomistic theology, angels could play that role. But as Aquinas repeatedly points out, they do not have the power to infuse forms but rather move to them. Therefore, if they have a role in the process, it would be only as an instrumental cause of God. For a more detailed discussion of the causal model proposed by Aquinas and other medieval authors to explain angelic action in the world, see Carreño (2023).

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