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Review

# Making biological theory more down to Earth

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ABSTRACT

All of the basic functional components of living organisms participating in describing, translating and constructing themselves are described deep within the supporting dynamics itself. A most common material vehicle for implementing this type of self-organization is a material vehicle holding its own identity through the constant exchange of the constituent material elements. The exchange of materials serves as a material means for temporarily ameliorating the infliction of vicious circles being inevitable and latent in the self-referential complications when descriptively approached in the present tense alone, thus dissolving the difficulties in making their predication logically transparent on material terms. Since the exchange of materials is demonstrable experimentally as in the running of the citric acid cycle in the absence of biological enzymes under the conditions simulating the prebiotic environments in the vicinity of hydrothermal vents on the primitive ocean floor, the prior emergence of metabolism could make the subsequent emergence of metabolism-replication complex more likely compared to the cases otherwise. An essence of the occurrence of the material vehicle holding its identity through the exchange of reacting molecules with the new ones recruited from the outside is in the soundness of internalizing the description of the dynamics into the dynamics itself, which is approachable through the constant update of the present perfect tense in the present progressive tense.



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## 1. Introduction

To distinguish biology from physics is getting harder and harder as we approach the problem area related to the origins of life. If one happens to adopt the process-perspective instead of the state-perspective prevailing in physics, biology could be seen as a construct out of elementary processes rather than out of elementary particles (von Neumann, 1966). In essence, processes from the process-perspective are considered to be primary over objects to be specified by their state attributes, the latter of which are seen merely as derivative products of the processes. The issue of the origins of life now comes to address how the process-perspective could have taken over the state-perspective and on what ground.

What is unique to the state-perspective is the priority of inexorable dynamical laws that can further be supplemented by the external boundary conditions assuming the auxiliary secondary role at best (Polanyi, 1968). In contrast, the process-perspective is peculiar in internalizing the notion of boundary conditions into the processes themselves (Pattee, 1969). Despite that, conceiving of both dynamical laws and the associated boundary conditions on an equal par would raise a formidable problem of how could it be possible to incorporate the descriptive attributes of the boundary conditions into the dynamical processes themselves. Although the boundary conditions can be taken as a theoretical artifact to

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arbitrarily be imposed if they are regarded as being external to the dynamics in focus, the situation would be made totally upside down once they are taken to be internal to the dynamics. In fact, the boundary conditions must be internalized into the dynamics unless the anthropocentric intervention is forcibly allowed to participate in. The pressing agenda would now become how the dynamics in the natural setting could come to internalize the descriptive attributes that seem quite anthropocentric at least in their outlook.

In particular, any descriptive attribute appearing in natural dynamics is an abstraction because of its implicit appraisal of the abstraction adopted for addressing the relational activity of predication. Relating something to something else is an activity of abstraction since the underlying relational activity does not assume an exhaustive specification of those material objects in focus. The underlying problem is how one can approach a concrete implication of the natural dynamics as starting from those descriptive attributes that are already an abstraction.

The difficulty rests upon the self-referential complications of how the description of the dynamics could be described within the dynamics itself. Linguistic predication of such self-referential complications, if attempted without seeking the help of material and natural dynamics, would remain necessarily unsatisfactory and eventually end up with vicious circles or what may be called impredicativities (Rosen, 1991; Igamberdiev, 2012). If there is any hope for making an access to the likelihood of the process-perspective, it would be required to re-examine the extent to which the functional capability of each atom and molecule could be made descriptively accessible. At issue here will be how one can meet the material activity that could be assimilated with the act of an abstraction that may be done without the anthropocentric intervention. This will be an agenda to be explored in the present article.

One prospective clue to addressing the functional capability of an elementary particle is found in the occurrence of the identity of such particle in isolation. The state-perspective being at home with inexorable dynamical laws takes the identity of an elementary particle for granted. Each elementary particle is taken as a functional unit keeping its own identity intact throughout there. However, this observation does not exclude the possibility of the occurrence of the material body whose identity could not reduce to a mere collection of the identities of elementary atoms and molecules in isolation. Consider, for instance, any of a biological organism. It can maintain its identity for some time even if its component particles are constantly exchanged with the new ones coming from the outside. Biology is full of such organisms maintaining their identities through the exchange of materials. That is a metabolism. This simple observation suggests to us that the process-perspective may establish its legitimate status even if the identity of an elementary particle appreciated solely from the state-perspective happens to be replaced by another type of the material identity maintained by the constant exchange of the participating elementary particles.[1]

The real issue is whether the occurrence of those material bodies or vehicles whose identities may be kept through the exchange of the participating elementary particles could be likely even before the onset of biology. Only when such a takeover of the state-perspective by the process-perspective could be likely prior to the onset of biology, there may be a hope for expecting the occurrence of biology running on the process-perspective. This issue must be settled empirically or experimentally, more than anything else, since the linguistic difficulties intrinsic in predicating the self-referential complications cannot be theoretically settled on the linguistic basis alone. One likely candidate for this type of endeavor could be to experimentally examine in a prebiotic setting the possibility of raising and supporting the material body whose identity may be kept through the exchange of the component material elements.

## 2. Running the citric acid cycle

One of the most ubiquitous material bodies supporting their identities through the exchange of the constituent material elements in biology is the oxidative citric acid cycle found in mitochondria in charge of the downstream part of glycolysis while extracting the energy and releasing carbon dioxide molecules from the participating carboxylic acid molecules. The citric acid cycle in mitochondria extracts the energy ultimately stored in pyruvate for the synthesis of ATP is heavily armored with highly sophisticated enzymes. The carbon atoms in the citric acid cycle are constantly alternated by the new ones supplied from pyruvate $CH_3$—CO—COO− through the vehicle of the acetyl group $CH_3$—CO− and are eventually released from the cycle in the form of carbon dioxide molecules.

Then, a serious question arises with regard to whether or not the presence of highly sophisticated biological enzymes mediating dehydrogenation and decarboxylation of the participating carboxylic acid molecules is prerequisite to the operation of the citric acid cycle. If these biological enzymes are prerequisite to the operation of the citric acid cycle, the likelihood of the cycle as a material unit processing the constant exchange of carbon atoms may be taken as a derivative of biology. However, if the cycle can run even in the absence of such biological enzymes under the conditions simulating the ones conceivable on the primitive Earth, the likelihood would come up to the surface such that the onset of the reaction cycle whose identity may be kept through the exchange of carbon atoms could have been prior to the onset of biology. This will be an experimental issue to be settled before entering into a theoretical speculation of how to make a descriptive access to the material body whose identity can be maintained through the exchange of materials. A key question to be settled experimentally at this point will be whether the occurrence of the exchange of materials could be prior or posterior to the onset of biology.

The oxidative citric acid cycle is a reaction cycle maintained by the carbon flow circulating in the direction as depicted in the scheme: oxaloacetate(4) → citrate(6) → isocitrate(6) → alpha-ketoglutarate(5) → succinate(4) → fumarate(4) → malate(4) → oxaloacetate(4), in which the number in the parenthesis attached to each carboxylic acid molecule is the number of carbon atoms included in that molecule.[2] The source of the carbon flow is pyruvate(3) which supplies the acetyl group (2) right in the middle of the pathway of oxaloacetate(4) → citrate(6) from the outside of the cycle. There is also a reaction pathway for synthesizing oxaloacetate(4) from pyruvate(3) and carbon dioxide(1). In addition, carbon dioxide(1) is released from the pathway of isocitrate(6) → alpha-ketoglutarate(5) and also from the pathway of alpha-ketoglutarate(5) → succinate(4) in the second and the fourth round of the reaction cycle one by one. All of the carbon atoms

[1] If we try to associate Rosen's internal principle of organizational invariance on being closed to efficient causation with the sought-after identity of material origin, it would beg the further question of how the internal principle could be vindicated and on what ground. In fact, the organizational invariance comes with the efficient causation in the form of the constant replacement of the participating elements. The underlying question will be whether the process of replacing the elements could be conceived of independently of the internal principle of organizational invariance as Rosen originally formulated.

[2] Although aconitate(6) may intervene in the middle of the pathway of citrate(6) → isocitrate(6) through dehydration and hydration, it is not explicitly displayed in the scheme because of the relative ease with its synthesis and transformation.