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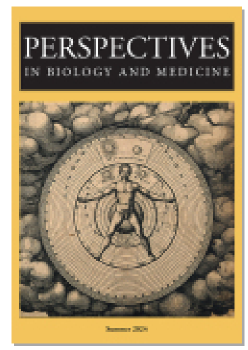
Biology as a Construct: Universals, Historicity, and the Postmodern Critique



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BIOLOGY AS A CONSTRUCT

universals, historicity, and the postmodern critique

HIPPOKRATIS KIARIS

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ABSTRACT The integration of postmodern thinking in the sciences, especially in biology, has been subject to harsh criticism. Contrary to Enlightenment ideals of objectivity and neutrality in the scientific method, the postmodern stance holds that truth is relative, not universal, and therefore progress is ambiguous. The effect of postmodern thought has ramifications that extend from the distrust of preexisting scientific conclusions to questions about the impact of progress in society. It also reflects skepticism about the scientific endeavor. Especially when postmodern ideas are considered to have gained traction, the anti-postmodern critique has become harsher. At stake is whether postmodern notions are indeed irrelevant, and—even more important—whether they compromise scientific progress. The conditional significance of universals in biology and the role of historicity in the evolutionary process makes biology different from the other natural sciences and subjects it to the postmodern critique. This article argues that rather than being viewed as a science that seeks universals, biology should be viewed as a construct, more relevant to a technology, aiming to attain functionalities. Such recognition may fuel progress and assist biology in attaining its ultimate goal, which is to address the most intricate questions about the living world.

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Inductive reasoning, formulated by Francis Bacon in 1620 in *Novum Organum* or *New Method*, is essential in scientific method. The appropriate evaluation of observations of the natural world, combined with experimentation, warrants the description of universal principles that do exist and remain to be unveiled (Cassan 2021). Besides the development of adequate and informative scientific methodology, this approach presupposes the existence of principles that apply to everything that relates to the corresponding scientific subject matter and is a prerequisite in moving forward, in a track that is perceived as progress.

Standing in opposition to inductive reasoning is postmodernism, an approach that is rooted in doubts about the validity of reason in understanding the world and that advocates for relativism and subjectivity—thereby implying the rejection of universals (Aylesworth 2015; Lyotard 1979). As such, postmodernism generally receives harsh criticism whenever the postmodern stance is thought to be adopted with regard to the sciences (Kuntz 2012; Polemics 1984; Whitfield 2008). This position is justifiable for natural sciences such as physics or chemistry, for which universal principles are thought to exist, are described mathematically, and apply irrespective of the specific setting. In biology, however, things may not be as straightforward, and the fertilization of biological sciences with concepts associated with postmodernism may be productive and valid (Kiaris 2023; Koonin 2009; Whitfield 2008). Furthermore, the recognition of these connections between biology and postmodern thought may provide a useful framework for a new biology in the postmodern era (Gilbert 1995).

The application of postmodern thinking to biology not only has implications for how we do or should live our lives as individuals and in groups, but also for the exact nature of the biological discipline and whether it is foreign to postmodern ideas. Among the natural sciences, biology possesses a unique position. On the one hand, it traditionally adopts empirical methodologies that are borrowed from physics, chemistry, geology, or astronomy, and then moves forward by applying principles of scientific method that are analogous to those of the rest of the natural sciences. On the other hand, it deviates substantially from these sciences in the role of context in explaining biological phenomena. Context in biology is associated with both modeling and experimentation and is also important in addressing the fundamental questions that biology is tasked to answer.

Context in the other sciences functions differently, if at all. For example, when the energy or the speed of particles is determined in physics, or when the reactions between compounds are described in chemistry, the limitations in results are linked to the existing model that is applied. Over time, through progress in the corresponding disciplines, the models become more and more accurate, and their predictive value increases in a unidirectional manner. The precision by which the measurements are obtained and the rigor of the experimental systems that are developed determine both the limits and the accuracy by which a physical phenomenon is interpreted. The context becomes irrelevant and can be defined if the definite factors that constitute it are reproduced. The application of the general laws is universal, and the conclusions of the inductive processes that are followed are readily applicable to various systems examined and interrogated. Empirical information accumulates and is integrated into the theoretical framework unconditionally, without exceptions and limitations.[1]

Such principles suffer in biology by a manner that is proportional to its progress. The more biology advances, the more we appreciate its limits and acknowledge that additional variables have to be introduced and taken into consideration in order to adequately define the experimental system. This is reflected in various domains that relate to biology—for example, in the ongoing debate between epidemiology and molecular biology, and whether the former can contribute to the identification of causality that the latter is seeking to obtain, sparing epidemiologists from becoming the "phlebotomists for molecular biologists" (Davey Smith 2019; Pearce 2007). Within the traditional frame of molecular biology itself, the concept of the gene and of its integration in biological phenomena has to be continuously redefined (Perbal 2015), while the stochastic phenomena that are associated with the fate of stem cells add further to the ambiguity (Theise 2006; Theise and Harris 2006). In evolution, advances in the field constantly call for drastically revisiting what was considered until now as factual: for example, in microbiology the incorporation of new information acquired from contemporary methodologies has fundamentally affected the reconstruction of the tree of life (Georgiades, Merhej, and Raoult 2011).

The experimental system in biology also has to be constantly redefined to include additional variables. For example, for experiments in the past involving rodents, it largely sufficed to know the animals' sex, rough age, and strain. This crude description of the system was not only due to the low precision of the information we wanted to extract, it was due to our lack of knowledge of the factors that can interfere in the experimental system's function as a model. This has changed over time, especially as the subject matter of biology has changed and we have become deeply immersed in the "omics" era that spans genomics, transcriptomics, proteomics, and metabolomics (Falus 2005). Such approaches underscore the complexity of the biological phenomena and advocate for a more holistic approach in understanding life, since a single approach is limited and restrictive, and such holism is inherent to the postmodern narrative (Ralston 2015; Theise and Kafatos 2013). Now we appreciate the role of social interactions in animal experiments, of their past experiences, of seasonality, and of other factors that were thought to be irrelevant and not taken into consideration. Whereas in other sciences the definition of identity is strict and tangible, in biology it is conditional and—importantly—it is relative.

[1]An exception may be quantum mechanics, for which many recognize a connection with postmodern thinking—for example, with regard to the controversy regarding the neutrality of the observer and its impact in the experiment (tracing back to Einstein and Bohr), or the concept of randomness as opposed to determinism (Skibba 2018).

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Thus, context is inherently associated with the biological phenomena that are examined, to the extent that it constitutes a component of the system: a biological system cannot be perceived independently from its context. In terms of modeling, this means that in order to extract meaningful conclusions, experimental biologists try to generate laboratory conditions that simulate the conditions of naturally occurring systems. The purpose of a biological experiment is not to test the universality of a law per se, but rather to reproduce certain components of it in a minimalistic manner, devoid of factors that are not considered relevant to the phenomenon that is examined. As such, context in its widest sense becomes of paramount significance in biology: it defines the limits of the observation and determines how representative this can be for the description of the natural phenomena. Observations in biology do not represent repetitions of the same events that happen in an identical manner, over and over. They are unique and unduplicated events that are characterized as generalities, and they can be seen as identical only if broader limits are set for their description. However, the broader the limits are, the more conditional our description of them must become, because more assumptions will be taken into consideration. Ultimately, though, fulfilling the demand for advancing biology as a natural science from the traditional point of view—delivering predictions with the highest level of accuracy and reproducibility—means that the experimental setting has to become too rigid and narrow, so that the conclusions relate to the laboratory conditions only. This deviates substantially from the primal goal of biology, which in understanding life as it is.

An additional consideration also relates to the concept of optimum and of the relativism it entails. In the physical sciences, "optimum" reflects the conditions that are associated with maximal efficiency of what the process under investigation is. But in biology, "optimum" is either what is considered as widely accepted, or something that knowingly deviates from naturally existing conditions but exaggerates the results of a hypothesis-driven study, dissociating purposely the role of the context and rendering the results largely irrelevant to what the naturally existing conditions are thought to be. For example, when we try to test if gene X is regulating gene Y, the experimental setting is adjusted so that the output in gene Y will be maximized, ignoring the true impact of this association in real life. In evolution, a genotype that emerged stochastically at random is selected only within a given context, and therefore its evolutionary value is related to the context itself. It is only selectable to the extent that the other genotypes with which it had to compete result in "worse" phenotypes in the given context. To that end, genotype A can be better than genotype B in context C, but in context D it can be worse. Thus, the value is dependent on the context and does not represent a universal feature. There is both a component of historicity (related to evolution) and a component of subjectivity (relating to how and under what conditions selection had occurred).

Context does not only involve the multitude factors that interfere with the biological system that is under investigation. It also involves the unique history of each individual and group that can modulate the response that is examined. This also contributes to the unique in biology subjectivity, by which the output or a response is related not only to the input or the signal, but also to the past experiences of the individual cell, tissue, organism, or population. Our increasing understanding of epigenetics and of the inheritance of acquired characteristics increases our appreciation of the significance of past experiences and of their impact (Nadeau 2015). This memory factors in the role of "historicity" in biology, which is pertinent to the postmodern argument. Examples from immunology at the cellular and physiological level, past experiences at the level of the individual in behavioral sciences, or even collective memory of groups in our cultural evolution support these notions. Whatever happens in the domain of biology leaves an imprint, the scale of which we only now start appreciating at its true magnitude. This means that any two systems, regardless of how similar they look, are distinct, because their history and past are different.

Another striking difference between biology and the other natural sciences is in their ultimate goal—that is, related to their nature and the questions they seek to answer. The other sciences seek to identify universal laws that govern matter and energy, while biology seeks to describe the strategies that are adopted between different systems and that fulfil a mission. This objective means that the conclusions reached in biological inquiry and experimentation progressively lose their universality and become applicable to the specific system that is examined. Although in some instances the focus of a study may be sufficiently restricted to acquire a more universal knowledge of a particular process—for example, when the operation of a particular chemical reaction is observed—such studies deviate from the central subject matter of biology. There is a distinction between the acquisition of new knowledge and understanding, which signifies the transition between the different subject matters that constitute the different sciences (Lander 2010).

Additionally, in biology the concept of "function" and its integration in systems of different scales is inherent, while in the other natural sciences, function emerges only when the associated principles are utilized by us, something that is done unintentionally through evolutionary processes, or intentionally when we develop technologies to attain specific outcomes. In either case, what is perceived as biological must eventually be associated with some function, otherwise it remains only chemical. The analytical approach aims to reduce biology to chemistry, yet the integration of function has to operate synthetically and elevates the subject matter from chemistry to biology. The emergence of system biology as a distinct discipline makes this distinction increasingly apparent, with the substitution of the double helix—the cultural icon of biology—by the hairball of systems biology (Lander 2010).

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Function can be described in evolutionary terms, in developmental terms, or in any other terms that answer "why" questions. In the other natural sciences, the answer is often trivial, while in biology it can become ambiguous. This constitutes a signifying difference between biology and the rest of the traditional natural sciences: the subject matter of biology entails notions of strategy and success. At the evolutionary level, at which functions are attained unintentionally—without any conscious decision on the part of the individual—different cell types utilize different types of sugars as energy source, not because they are better but rather because by doing so the overall strategy is efficient. Alternatively, different species chose to produce more offspring than others but did not invest much in their survival, while other species chose to have fewer offspring but invest more in them; neither of these strategies can be viewed as better than the other, but both are equally efficient. This diversity of different strategies that have persisted over time, and their validity without one being better than the other, is an underlying principle of the diversity we recognize in the biological phenomena, and it is also inherent to the postmodern stance. As Perbal (2015) puts it: "Postgenomics is partly the product of postmodern culture that extends into science: The philosophy of difference takes precedence over universality" (780).

The same scheme applies at the level of the intentional development of technologies, in which we consciously develop constructs to attain functions with variable degree of efficiency that are also the subject of selection within the context of our cultural evolution. For example, we develop machines to make our lives easier, but at the same time we recognize their cost to our environment and also question whether their existence per se contributes to our overall happiness and well-being. To that end their utility becomes just a strategy, one among many.

The subjectivity of universality becomes even more strikingly apparent in evolutionary terms. What is viewed as universal (genetic codes, genetic material, basic structure of cells) is universal just because no other plausible alternative has happened—or if it did happen, it did not persist. A plausible alternative may still happen in the future, and if this occurs and is efficient, it may become the new universal. Such alternatives may also happen or have happened at different locations in the universe, and the resulting construct may be similar or very different from what we now know as life. Even more intriguing is the fact that life as such, formally, is the result of some peculiar coincidences that might not have occurred. Thus, seeking for universals in biology does not depend on the admission for the existence of principles that will be stable over time and across space. It just reflects the description of principles that are currently experienced as universals, because they originate from a single coincidence that resulted in life as we experience it today.

For example, the genetic code and the central dogma of DNA↔RNA↔protein is perceived as a universal because the biological subject matter—life as we perceive it today—was established after this dogma has been founded, guiding future evolutionary events and setting a reference point that had to be taken into account when subsequent evolution occurred. Therefore, a historicity is established. Of course, the notion that the whole universe is evolving and should be considered as a unity in which informational value, and thus historicity, is extended beyond the organic beings, exists (Caldwell 1999). To that end, the concept of (the lack of) universality of principles applies not only to biology but to the other natural sciences as well, and this in turn advocates for a connection with postmodernism of the other sciences.

From a universalists' perspective, the limitations of biology when treated as a natural science are reflected in biology's inability to deliver predictions with accuracy, especially when biological systems become more complex. For example, when our attention progressively transitions from the study of biochemical reactions to the study of cells, organisms, and populations, our predictive power decreases. This is not simply because the more complex systems, by definition, have more variables, but rather because the system becomes more pertinent to the subject matter of biology than that of, say, chemistry. While we can accurately predict the orbit of planets, the weather, or the products of chemical reactions, and express them in mathematical equations, we cannot predict outcomes of biological processes unless we integrate probabilistic approaches. The complexity of living systems usually is thought to be the cause of such deficiencies, yet it is even more likely a consequence of our inability to capture biological phenomena by traditional inductive reasoning. Such phenomena unfold within an actual context that is different from what we define as context when we reproduce them in the laboratory setting. This limitation also reflects that in biology we, as living beings, have to operate both as the observer and the object of the relevant subject matter, while in the other physical sciences we can maintain a conceptual distance from the subject matter we focus on.

Statistical approaches are essential in natural sciences. They are used to offset our current limitations in performing complex calculations in highly convoluted systems, and their predictions are aligned with quantitative models at which deviation is consistent with experimental error.[2] As systems, though, they can be decomposed to their elements, and their complexity is only due to the magnitude and the multitude of factors involved. Two identical atmospheric settings would result in the same storm if all conditions remained identical. Moreover, we could make precise predictions if we had all available data at hand and calculating power available. In biology things are different, because the system cannot be deconstructed the way a natural phenomenon can. Furthermore, in addition to limitations in the calculations and data is the fact that among different plausible

[2]Again, such notions are not applicable in quantum mechanics, because of the inherent existence of randomness and the inability to define the properties of a system unless we measure them (Marinescu and Marinescu 2012).

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outcomes only one has happened. From an evolutionary perspective, for example, even if all conditions remained identical, different evolutionary paths could have been taken, signifying different historicity in the resulting processes, and developing into different and distinct contexts. The astonishing diversity we see in the biological world is a result of variation not only in forms and functions, but more strikingly in strategies, which constitutes the essence of what we perceive as biological, as opposed to biochemical or chemical. If we projected this on to the evolution of our species, by applying the "universality principle" of the other natural sciences—which presupposes linearity of events and determinism—we would have to assume that the appearance of *H. sapiens* was unavoidable and somehow predestined, a notion about which most biologists would not agree. Of course, irrespective of its perceived determinism, whether the emergence of *H. sapiens* denotes an ending point of our evolutionary process as an outcome of selection represents a completely different question, one that implies that different paths could have reached the same end-point (Kiaris 2022).

A counterargument could be that the mutations that drive evolution are actually chemical reactions that could be modeled by having tremendous calculating power at hand. Therefore, by extrapolation, even evolution could have been modeled and predicted, abolishing the component of randomness. Yet even in that case the component of historicity would remain, and deconstruction of the system would be impossible because all previous steps should have been recapitulated. In that case we would conclude that our current *being in time*—to paraphrase Heidegger's (1927) famous title—is unique and unduplicable. Acknowledging this constitutes a major difference from the traditional natural sciences and underlines what is perceived as subjectivity in biology. Issues emerging from the modern synthesis in biology, such as the horizontal gene transfer seen in bacteria or symbiosis, can be resolved by the introduction of an inclusive biological synthesis, one that views evolution as a historical process that addresses the "challenge of earning a living in a given environmental context" (Corning 2020, 9).

Of course, the inability of biology to deliver universals and render predictions does not detract from the magnitude of the achievements we have made in biological technologies or our unprecedented capacities to interfere with the functions of life. This reflects an additional contradiction in biology compared to the other physical sciences. In the other natural sciences, we have identified universals but we cannot interfere with them and alter them, precisely because they *are* universals. In biology, though, we can drastically change functionalities and alter processes through drug development, the manipulation of genomes, or through the performance of surgeries. It is plausible that by producing chemically new, artificial tRNAs and amino acids, we may also be able to generate new genetic codes for which the unit will be a doublet or quartet. Such genetic codes establish new universals.

Probably this constitutes an additional argument in favor of the nonexistence of universals, and of the malleable nature of the subject matter of biology that makes it distinct from the other natural sciences. Biological phenomena evolved over time and continue to do without having to do so, relying on principles of other natural sciences that set the frame of the universal principles, maintaining the historicity in the form of biological evolution. From the point that the biological phenomena emerged and started to be seen independently of the natural processes, this universal frame was abandoned. A biochemical reaction is a chemical reaction that obeys the same principles with the other chemical reactions, irrespective of whether they occur within a cell or outside of it, but the integration of this chemical reaction into a biological process became a strategy that abolishes universal validity and attains a function. The same chemical reaction may occur in different biological contexts and perform different functions. Thus, principles relevant to biology abolish their universality at the point at which functionality emerges and integrates into the system.

To that end, the subject matter of biology is more pertinent to an invention: it becomes a *technology* instead of a *science*, since it refers to something that came into being at a certain point and because its existence carries principles and truths that are not universal beyond the existing time and context. Truths and principles in other natural sciences did not come into being at a certain point but exist irrespectively of their context; essentially, they exist even without the objects that make them apparent and tangible. Gravity exists without the apple that falls, but the evolution of *H. sapiens* is inconceivable without the *H. sapiens* itself. Since the universal principle depends on its actual outcome, it cannot be perceived as either universal or as principle. The efficiency by which innovations in biology occurred, even early in our history with the agricultural revolution and animal domestication, reflects this and relies on the plasticity of the biological doctrines. It also demonstrates the inherent link between technological processes and whatever relates to the biological subject matter.

Perhaps we should start viewing biology not as a science that aims to identify universal rules and principles and to render predictions, but rather as a construct for which the subject matter is the attainment of certain functionalities. From this stance, biology constitutes a technology that depends on the scale and the intentionality by which it was developed. When life itself first appeared, it did so by utilizing existing principles of other natural sciences to attain the most primitive biological function, that of self-replication and propagation. This system was a technological construct per se that—irrespective of whether it was created randomly or not—had to fulfil a certain function with a certain degree of efficiency. Over time, more complex functions were attained, with variable degrees of efficiency, fueling biological evolution and maintaining their relationship with the most primitive functions as they originally emerged and from which they originate from. This scheme persists today with humans, when we (intentionally

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or unintentionally) utilize existing principles to fulfil more complex functions and develop technologies. Thus, everything that emerges in the domain of biology, from the species and the biological processes to the products of human creativity, acquires a transiently universal character that eventually is abolished and can be integrated differentially in consequent processes. This universality is associated with the persistence of the functions they fulfil.

By seeing the biological subject matter as a construct and by relieving ourselves from the burden of universality, we may start seeing marginal truths, conditionally applicable, that are context-dependent, and we may then be able to acknowledge that this is not a limitation but rather the actual essence of biology. But this will require establishing a methodological distance from the other natural sciences and infusing biology with ideas that typically predominate in postmodern thought.

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