The Biological Cell as a Living Symbol of a Natural Kind:
Bridging evolutionary process and material determination through dynamical wholism

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Abstract

This paper explores the foundational paradox between Newton's classical mechanics and Darwin's theory of evolution, focusing on their divergent conceptions of time—static determinism versus dynamic generation. Drawing on biosemiotics, a formal model of interacting biological cells is proposed that combines Newton's formal determinism and Darwin's agentic selection. In the model, individual cells are unified by genetic text into a community of mutual recognition through reciprocal signalling. The study introduces a relational ontology involving hypostatically mediated category differences, where genetic text serves as both a material index for the determination of particular individuals and a symbolic label for the communally enacted natural kind. By integrating the determination of lawful formation and the indetermination of communal resonance, the paper advances a novel framework, embedded in physical theory, for understanding biological formation, spatiotemporal continuity, and the semiotic logic of category theory.

Orientation to the Reader

This paper combines philosophy, biology, semiotics, and physics to propose a new way of understanding the underlying physics behind cell dynamics. The formal model presented is intentionally simple: it does not aim to predict biological outcomes but to exemplify how non-mechanistic formalism can reframe physical explanation. Readers should therefore focus less on the technical details of the model and more on the interpretive logic it illustrates. The central claim is that cells function as *living symbols of natural kinds*—entities that participate in communal semiosis and embody formal causes—so their dynamics are best understood as semiotic processes within physics rather than as reducible mechanisms. The contribution lies in this conceptual reframing of physics in relation to biology, not in the model itself. The underlying biosemiotic principles are applicable to more complex and experimentally relevant biological systems (Kull, Deacon et. al. 2009).

1. Introduction

Nothing changes; time is illusion. This is Newton in a nutshell. There is only change; time is universally real. This is Darwin in an instant. Taken in totality, these theoretical stances manifest an irreconcilable contradiction—a challenge not merely born of the difficult leap from simple physical systems to complex biological ones, but also of a deeper logical impasse. Newton's classical mechanics and Darwin's biological evolution become incommensurable theoretical frameworks when presented as universal or complete descriptions of the natural world. However, rather than seeking an elusive totality, I propose that we regard this contradiction as a paradox ripe for interpretation. In doing so, we ask: how might this paradox be understood, and what can it reveal to us about the nature of change in the natural world?

At first glance, the choice of Newton's and Darwin's theories as universal archetypes might seem counterintuitive, especially given that Newton's classical mechanics has been superseded by relativistic and quantum mechanics, and Darwin's concept of natural selection is often deemed incomplete without the specification of an underlying physical mechanism of molecular genetics as the determinative ground. Nevertheless, we select these theories precisely because their formal and ontological dimensions are comparatively simple and well defined. Furthermore, their iconic status as universal theoretical frameworks brings into focus the significance of the underlying logical paradox they present in relation—namely, the divergent conceptions of time. In our study, these archetypes are taken as interpretative contexts that might help frame the way in which change in the natural world is understood through scientific theory.

Central to our inquiry is the role of biosemiotics (Kull et. al. 2009) as a mediating theoretical framework that can relate the structural determinism of Newton's classical mechanics to the temporal unfolding of Darwin's directed generation (Rosen 1991). By recasting Newton's and Darwin's theories in biosemiotic terms, we illuminate how the apparent contradiction may serve as a window into a semiotic mediation that underlies formative processes in both physics and biology (Rogers unpublished).

2. Method

The present study adapts the methodology of analogical isomorphism as described by Tanev:

> Analogical isomorphism presupposes two sets of terms from two different systems of thought. It neither affirms nor denies similarity between the terms of one set and those of the other set, but it does assert that the network of relations in one set of terms is similar to the network of relations in the other set … Both sets are to be considered at once aiming at bringing to light an isomorphism or analogy of proportion that concentrates on the structural similarity of the two sets of terms moving away from the specific meaning of the terms within each of the sets. (Tanev 2017, p89).

The isomorphism of interest involves the relational categories of light, space and time in physics and those of sign, semiotic scaffolding and expression in biology. However, the form of the isomorphism is not delimited or determined by this investigation as a completed end state, rather it signifies the intended horizon towards which the logical development of the study proceeds.

The study unfolds in four interconnected movements. First, we examine the manner in which Newton's classical mechanics constructs time as a spatialized dimension in a predetermined structural order—a conceptualization that renders the open indeterminacy associated with the experience of time as an effective illusion. Second, we turn to Darwin's biological evolution, unpacking how its inherent logic demands that the indeterminacy of time be experienced as an openness to possibility, an openness that is essential for the emergence and transformation of life. Third, we explore a pathway of mediation between these two theoretical frameworks. This mediation is not an attempt to reconcile the seemingly disparate views of Newton and Darwin. Rather, we seek to discover a deeper, semiotic framework that formally distinguishes and determines relationally the qualitative characters of their primary theoretical categories. Finally, we discuss the results of the investigation with respect to ontological and interpretive commitments in physics and biology. In this way, our inquiry not only challenges conventional reductions in physics and biology but also opens a dialogue about the nature of interpretation itself in scientific understandings of the natural world.

3. The representation of exteriority

Newton's classical mechanics is grounded in the deep metaphor of *space* as the universal medium for all that exists, as the distinct container of what is real[1]. For Newton, space is omnipresence:

> Space is a disposition of being qua being. No being exists or can exist which is not related to space in some way. God is everywhere, created minds are somewhere, and body is in the space that it occupies; and whatever is neither everywhere nor anywhere does not exist. And hence it follows that space is an effect arising from the first existence of being, because when any being is postulated, space is postulated. (Isaac Newton in *De Gravitatione* as cited by Huggett 2002, 112).

Yet space, and more specifically the Euclidean space of Newton's theoretical framework, is also a fixed structure or *timeless form*. While space mediates relations among physical bodies, it remains immutable and unaffected by such bodies. This immutability, for Newton, is taken to transcend all that exists. No longer metaphor, Newtonian space becomes an absolute entity—an embedding physical substance—even as it remains a definite mental concept—a formal Euclidean geometry. Taken as totality, the trope of Absolute space becomes the given and fixed theatre in which a Cartesian divide between the physical (ontic) and the intellectual (epistemic) has been enacted *a priori*, a divide that cuts the immediacy of phenomenal experience and rejoins the severed parts through formal systematic re-presentation (Levinas 2022). In effect, the open relationality of the deep metaphor becomes co-opted to serve as a closed and timeless form of *identity*. Absolute space is taken to be a completed system that exists *in-itself* and this *Self*-identity pre-structures and determines the identity of everything else that exists within the

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[1] For further context regarding the nature and limitations of the metaphor of deep space that are explored in this section, see *The proximity of light: a deconstruction of space* in Rogers (2022).

system, wherein existence is determined by way of reflected *Self*-images that are also timelessly formed.

We can get a handle on the workings of this trope by tracing some of the formal characteristics of Euclidean space. Specifically, Euclidean space is a structured system of fixed and completed relations. The straight line is the archetype of all possible relations in the system, a relational archetype of complete separation or division. Points become the horizons of such relations, the fixed form of the relata, of that which can be brought into relation by the system. The system is structured by lines, where lines are made of points, and where each point is distinct in-itself, without quality or character or *interiority*. The lines represent continuity. The points represent discontinuous stasis. The Euclidean system is like a structured dust, where the only whole—the whole system—is infinitely reducible to vanishingly small points that become fixed images of that whole—each formed *in-itself* just as the whole system is formed *in-itself*. The whole, writ large, and its parts, writ small, are fixed, immutable, unchangeable within the formal constraints of the relational system. The structured dust of Euclidean space is then taken to be infinitely dense—as the proximate relations of separation become proximate relations of local contiguity—and this dense earth becomes the Newtonian image of a continuous whole.

The imaginative leap of Newtonian mechanics is to consider this formal system to be identical to the form of the physical world. That is to say, the physical universe as a whole is likewise determined by relations of complete separation or division among vanishingly small physical elements that are featureless and timelessly formed[2]. In this way, the physical universe—represented as a theoretical system—closes in on itself, as if it were a complete manifestation of the fullness of physical being. Such closure comes about through absolutely completed simultaneity which is the defining characteristic of Newton's concept of Absolute time within Absolute space. Everything in the physical universe is taken to be present *all at once* in time within the containing matrix of all possible spatialized relations, relations whose character or aspect is *separateness*.

Within the embedding matrix of Absolute space, there is no possibility of a synthetic finite whole that can endure through time. Any circumscribable whole can always be reduced to its constituting parts and their relations of separation. Absolute space, in-itself, lacks an identity operator that can abstract or select a particular finite whole form as a synthetic whole that can be extracted from its context within the matrix of Absolute space. The only enduring whole is the total system of fixed relations, and the constituting elements of this whole are vanishingly small or *empty forms* whose identity principle—namely, existence in-itself—is an image of the identity principle of the embedding whole. This image of the whole is also absolutely simultaneous. Finite constructs within this embedding context reflect this image of the whole insofar as they exist all at once, in an instant of time, and are reducible to their constituting elements. All is timelessly formed in each instant of time.

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[2] The Cartesian divide between the physical (ontic) and the intellectual (epistemic) manifests in the elemental part in like manner to the way it manifests in the constituted whole of Absolute space, insofar as the postulated likeness of the imagined *infinite horizon* of a Euclidean point is taken to be not just like but, in fact, identical to an actualized real physical entity in the world.

The trope of Newtonian mechanics introduces the concept of time, into the static image of Absolute space as a continuous whole, by treating temporal relations *as if they were the same as spatial relations*. Thus, temporal relations are represented as Euclidean lines, whose symmetry principle is reversibility. The phenomenologically experienced irreversibility of time (e.g. the arrow of time), which would set temporal relations apart as qualitatively different from spatial relations, is excluded in the formal representation of the physical universe. And, within the theoretical framework, temporal relations take on the spatialized aspect of separateness, such that they are assumed to likewise reduce to a continuous succession of discrete and separate empty forms. Time does not flow or *process* according to the formal representation. Rather, in each irreducible instant of time, the whole universe is taken to exist all-at-once and it is re-iterated in the next instant without any continuity of identity that could support change within a finite, synthetic, enduring whole. *Nothing changes*. The resulting theoretical construct describes the image of a fully structured and determined "block universe" of timeless "point particles" within a four-dimensional space-time matrix that also has the form of Euclidean space. The background matrix of Absolute space-time, in which the elemental point particles are embedded, represents universal continuity as a static and infinitely dense dust with a determinate, fixed structure in space and "time".

But when we say *nothing changes*, we actually mean no physically enduring thing changes within the context of the represented formal system[3]. As long as we distinguish the representation of the theoretical model from the actuality of the physical world, we can avoid contradiction. The foundational forms of Newton's classical mechanics are timeless and do not change; they become a system of featureless signs (i.e. symbols) that represent the constituting physical elements and their governing laws. Newton's theoretical framework then applies whenever systems in the physical world actualize such timelessly formed governing laws among physical constituents that can be taken as discrete and featureless elements of the system. The theoretical framework refers to an *ordered structure of relations* among featureless elements, where the featureless elements represent physical entities in the world whose particularity, interiority and changeability are not significant for modelling the physical phenomena of interest.

However, if we try to generalize Newton's theoretical framework of timelessly formed laws governing timeless elements so that it applies to all of nature *in totality*, we encounter the problem of broken symmetry. Absolute space presents as a continuous formal matrix of all possible locations for physical entities. The possible locations are distinct, featureless and indistinguishable Euclidean points. But in order to be located, an actual physical entity must break this formal symmetry. Because an actual physical entity is *particular*, it must be located at a unique place within Absolute space. Absolute space, in-itself, provides no means to distinguish such a particular place because its constituting Euclidean points are purely formal, general, and indistinguishable. The breaking of the symmetry of Absolute space involves the selection of a particular actual place from among an indistinguishable set of identical formal possibilities.

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[3] The only change represented in Newton's theoretical framework is movement through space of fixed and immutable physical elements. Thus, the physical things do not change in themselves; rather, it is their spatial relations that change within the matrix of possibility that is Absolute space. But then, through Absolute time, even these changes in spatial relations can be embedded in a larger four dimensional Euclidean "space" representing space and time as a Euclidean structure. Within this larger space, even the spacetime relations are fixed and fully determined.

Within the theoretical framework of Newtonian mechanics, *selection happens from beyond the theoretical framework,* by way of arbitrary boundary conditions that must be specified (by the theorist) in addition to the formal laws, such as initial conditions. Once selection has happened, the complete dynamics of the system are formally determined for all time by the governing laws. Time becomes a universal succession of discrete and separate instances, each completely present in itself without reference to past or future.

The concept of broken symmetry can allow us to probe more deeply into the trope of time in Newton's theoretical framework. Each finite region within Absolute space exists in relation to the whole system. This directed relation, like intentionality, points from within the interior of the region to the exterior of that same region. Suppose, along with Newton, that massive particles are like Euclidean points except that they have extension in space[4]. Then, a finite and extended mass—a massive particle—located within a particular region of Absolute space would be likewise intentionally related to other particular finite masses located externally to that region within the system of Absolute space. However, the directedness of the relation is an excluded initiative of Absolute space because the orientational symmetry of Absolute space precludes the capacity to distinguish the orientation of directed relations. Absolute space, in-itself, provides no mechanism to break orientational symmetry within. It is as if an extended mass within the system of Absolute space would have the freedom to select its own direction of intention.

In Newton's theoretical framework, this freedom to select is given over to the whole collection of massive particles that make up the universe through the law of inertia. This law states that, in-itself and without reference to any other massive particle, a particular massive particle will continue to act in the future as it has acted in the past. It is as if, in each instant of time, each extended massive particle sublimates its inner capacity to act *differently*. As a result of this kenosis of interior freedom of each particular massive particle, the only way that change can happen is by the external action of other massive particles. Moreover, the kenosis or pure *receptivity* of matter is what allows massive particles to be represented through the likeness of featureless Euclidean points that lack extension. That is to say, kenosis gives the massive particles their determinate (but empty) form that is receptive to other massive particles that make up the universe as a completed system embedded within Absolute space[5]. This determinate receptive form comes about because of the sublimation of interior freedom to select; without the

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[4] The crux of the problem of broken symmetry rests in the fact that Euclidean points are formal horizons or limits without extension within a matrix of possibility, while massive bodies are effective, actual and extended in space. When massive particles are taken to be "like" Euclidean points, the likeness involves rendering possibility and actuality as indistinguishable. It also involves rendering the categories of exteriority and interiority as indistinguishable.

[5] Within Absolute space, massive particles are featureless and have no categorically distinguishable interiority. In order to bring into view the way in which broken symmetry affects the parts of the whole, we are postulating an extended mass which has a categorically distinguishable interior by which it can be said to act. But then we are reducing that interior back to a vanishing infinitesimal as it must be within Absolute space. This imaginative movement brings into view the possibility that a massive particle may have the capacity for an interior action of selection, a possibility that becomes excluded by the construct of Absolute space in which selection has already happened (which is the signature of the determinate mechanism of Newton's theoretical framework). The possibility of selection we are calling receptivity. For an exploration of how receptivity can open up the totalizing construct of Absolute space, see *On the embodiment of space and time: triadic logic, quantum indeterminacy and the metaphysics of relativity* in Rogers (2022).

sublimation of interior freedom, mass has no form according to the theoretical framework. If Absolute space were truly total or complete *in a physical sense*, it would not even make sense to speak of sublimation because interior freedom *must* be sublimated in order for matter to exist within Absolute space. But Absolute space, as a metaphor for physical presence, is not total or complete in a physical sense. For instance, in physical space the symmetry of chirality (or handedness) is broken and this suggests that physical space, represented as a formal Euclidean system, is intentionally related to something beyond itself, namely, its duality. The breaking of chiral symmetry is related to the breaking of the symmetry of temporal relations and also to the breaking of the symmetry of directed intention (e.g. orientation along a line of reciprocal separation)[6].

As a totalizing formal concept, Absolute space structures time in its own likeness. In each instant of time, each timeless and immutable elementary particle, represented by the likeness of an actualized Euclidean point, processes to the next instant of time according to the law of inertia. But its projected motion to the next instant of time is synchronously communicated to every other elementary particle through the oppositional duality of action-reaction which states that for each action there is an equal and opposite reaction. The relational reciprocity is resonantly distributed throughout the whole universal system in the momentary instant of time and impacts back on each elementary particle as a generalized *external* force that effectively causes a change in its inertia[7]. The key trope that allows time to be treated in this manner is the principle of absolute simultaneity and this principle is dependent upon the postulation that elementary particles possess no changeable interiority (e.g. their mass is invariant and they do not break chiral symmetry). All aspects of the system can then be externally represented and any change from one instant of time to the next instant is determined by the state of the system in that instant. Instants of time decouple into distinct and fully completed states of the totalized system, just as elementary particles decouple in space as distinct and fully completed point masses.

Thus, when the deep metaphor of space as transcendental presence is turned into a totalizing formal concept through Newton's theoretical framework of Absolute space, the physical world disintegrates into dust, there are no changing entities, time reduces to universally completed instances, intentionality and freedom are excluded *a priori*, and the actual becomes the only possible. Everything is taken to be nothing more than a fully determinate and structured formal representation of exteriority. This picture of the physical universe rests precariously upon the paradox of categorical duality as a form of broken symmetry (Rogers unpublished).

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[6] For further context on the relation between these broken symmetries, see *Spacetime as a formal semiotic process* in Rogers (2022).

[7] It is the *relation* among actions that is considered to be reciprocal and this fixes the resonant structure of the whole universe of elementary particles within the rigidity of Absolute space (similar to the mean field theory approximation of critical phenomena in condensed matter physics). It also allows temporal relations to be reduced to spatial relations. For further context on the role of reciprocity in the representation of spacetime, see *An introduction to the meta-physics of relation with application to the physics of quantum mechanics and relativity theory* in Rogers (2022).

4. The expression of interiority

Darwin's theory of evolution through directed generation is grounded in the deep metaphor of *Nature acting in time* (Da Silva Oliveira 2022). Unlike Newton's metaphor of the present whole as structured according to the passive container of Absolute space, Darwin's metaphor posits the present whole, labelled as Nature, as an active agent. According to Darwin (Gould 2002), Nature *selects* particular constituents based upon their suitability or fitness in the present moment. The constituents, upon which selection is enacted by the whole, are biological organisms. The metaphorical relation between the whole and the part involves the directed relation of *intentionality* that is excluded in Newton's theoretical framework (Hoffmeyer 2003). This intentionality is reflected as an image in the part by postulating that organisms *are driven to act in order to endure through time*. Thus, Darwin's theoretical framework differs from Newton's with respect to the primary categories of wholeness[8]. Newton's externally represented whole is passive and incapable of internal selection because selection requires the *particular* freedom of agency to break the formal symmetries of the whole. Moreover, the (infinitesimal) internal parts of Newton's whole are immutable and timeless; they pass through time without change independently of their action and they can neither be created nor destroyed by the whole. Foundationally, Newton's theoretical framework of temporally determinate mechanism within Absolute space presents as logically inconsistent with Darwin's theoretical framework of temporal contingency and mutability within an acting whole.

If Darwin's theory is not grounded in Newton's classical mechanics, how then does it *work*? What is the appropriate logical form of the overarching theoretical framework when considered on its own terms? How can we understand Darwin's theoretical framework without presupposing it is determinatively grounded in the classical mechanics of Newton's theoretical framework?

The fundamental constituents of Darwin's theory are biological organisms whose wholeness comes from agency or participation. Unlike Newton's elementary particles that are represented by timeless forms, Darwin's organisms process in time and this procession—represented as the drive to endure in time—is finite and contingent. Organisms grow, reproduce and eventually come to an end in time. However, through reproduction, a particular organism passes on to its offspring something of itself, such that each generation is in the *likeness* of the preceding one. Yet likeness is not identity. In the jump-discontinuity of generation, the offspring are also different from their generating parents; it is this difference that allows for changes in hereditary lines through time that adapt to changes in the environment. That is to say, Darwin's directed generation involves the duration through time of *dynamical forms* in a context where the particular material constituents (the actual physical organisms) are temporally contingent and do not survive the passage of time. It is as if there are two different timescales at play in directed generation: the shorter timescale in which *particular* physical organisms are generated, reproduce and die; and the longer timescale in which *general* dynamical forms endure from generation to generation.

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[8] For further context on the way in which Darwin's theory of evolution differs categorically from Newton's theoretical framework of classical mechanics, see *Towards the case against reductionist theories of evolution* in Rogers (2022)

Natural selection is the process that governs the temporal evolution of organisms according to the longer timescale in Darwin's theory (Gould 2002). Particular physical organisms generate offspring, often in larger numbers than the environment can sustain. Nature—metaphorically representing an intentional agency related to the environment—selects the fittest organisms to survive and generate their own offspring, while the less fit organisms die off more quickly with fewer generated offspring. In this way, differences in form that occur during reproduction are passed on through subsequent generations based on the selective advantage they impart to the organisms within the context of the environment.

However, while necessary, natural selection is not a sufficient condition for Darwin's theoretical framework. That is because natural selection acts on *particular* organisms. Without reference to a matrix of *general* possibilities, selection becomes determination[9]. A circular argument ensues: nature selects particular organisms according to their fitness, but their particular fitness is defined by virtue of having been selected by nature[10] (Fodor and Piatelli-Palmarini 2010). In order to break the definitional circularity, the concept of species or *natural kind* is required by the theory. The species is the contingent dynamical form that connects particular, actual organisms with general, formal possibilities. Moreover, the species is the formal bio-semiotic context for reproduction or directed generation (Kull 2016, Hoffmeyer 2003). Natural selection picks out *particular* instances of difference from within an overarching context of *general* formal sameness (the species) on a shorter timescale, and then the amplification of these particular differences through multiple generations can change the overall conditions of general formal sameness (evolution of species) on a longer timescale.

But in order to stabilize change in general form over longer timescales, there must be continuity of form in directed generation over the shorter timescale. The way in which the continuity of biological form is stabilized over shorter timescales was not known when Darwin put forth his theoretical framework. It involves *text*. The general dynamical form of the species is encoded in genetic text and it is this genetic text that is passed from parent to offspring during directed generation. Continuity over time occurs because text is a static ordered pattern of relations in which the whole pattern is a form that supervenes on particular material constituents but is not identical with the material constituents. The material constituents become empty forms (symbolic letters) that bear the pattern, although the pattern could equally well be borne by a different set of particular material constituents as long as the whole pattern of relations among symbolic letters remains the same. It is such *patterns* that are passed from parent to offspring during directed generation.

Because text is a *static* pattern, it has the remarkable property that it can endure through time and space despite changes in the particular material constituents of which it is composed, as long as the symbolic letters represented by the particular constituents retain their relational form as a whole (Gadamer 2004). Thus, genetic text can continuously connect particular biological organisms that are discontinuously separated in space (different organisms within a community)

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[9] The problem of natural selection is formally like the problem of measurement in quantum physics. As discussed by Pattee, "a measurement is a mapping from a physical system to a symbol" (1982).

[10] The circularity of the argument involves a category error in that the notion of selection requires general kinds and therefore involves a different category of distinguishing than determinism which only offers the distinction of particular instances.

and/or time (different generations of organisms). In the modern synthesis of Darwin's theory of evolution (Gould 2002), genetic text identifies the dynamical form of species. Unlike Newton's theoretical framework where the foundational relation is space-like *separation*, in Darwin's theoretical framework the foundational relation is time-like *procession*. As iconically exemplified in the directed generation of offspring from their parents, time-like procession involves *the directed communication of patterns* from the past to the future. Therefore, the continuity of time for biological organisms within a species is contingent upon the continuity of pattern transfer. Time-like procession, involving pattern transfer, can create non-local relations of resonance among relata in space and time insofar as the pattern or form, as a relation of relations, remains invariant or isomorphic throughout the material process[11].

The other key property of genetic text, as the seat for self-referential activity (Hoffmeyer 2006), is that it forms an indexical origin for the dynamical formation of interior patterns within the cell. That is to say, the interior dynamical processes of the organism, understood as dynamical pattern formation, are governed by the static genetic code to which interior dynamical patterns are indexed. In this way, the genetic text constrains the interior processes of the organisms of a given species such that they follow common, overarching dynamical patterns. Particular dynamical patterns are selected, by each particular organism, from the formal possibilities that are determined by the genetic code and these dynamical patterns emerge from the collective synchrony of the cell as a whole. However, the selected dynamical patterns do not fully determine the interior processes (as would be the case with the determinate mechanism of Newton's classical mechanics) because they are *general* forms, while interior processes are *particular* actions. Rather, the genetic text becomes the identity operator (e.g. label or name) for the *symbol* of the species and this collective symbol is *enacted* by each particular member of the species insofar as the genetic code is the static index or origin for the dynamical processes of pattern formation within the individual organism. The genetic text codes the matrix of possibilities for those interior processes within the organism that follow the general dynamical patterns of the species and these interior processes, as dynamical forms, determine the formation of the organism. The formation is dynamical and involves some degree of arbitrariness or randomness related to *particular* aspects of interior processes that do not follow the *general* dynamical forms encoded by the genetic text.

Therefore, the concept of species in Darwin's theory refers to an overarching system of general formal possibilities, encoded in genetic text, that are enacted by particular individuals. But, whereas the particular actions belong to individuals, the general possibilities are communally shared. As a result, in their individual actions, organisms dynamically form patterns that have the potential to reference dynamically formed patterns of other members of the species because the dynamically formed patterns of all members of the species are indexed to the same genetic code and form the same matrix of possibilities[12].

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[11] For further context on the role of text in generating nonlocal relations see *On the relationship between the concept of text in Gadamer's theory of hermeneutics and the concept of light in Einstein's theory of relativity: towards a fusion of horizons* in Rogers (2022).

[12] For example, an individual cell forms a cognitive learning system that can reference external patterns in the environment to internal processes and in this way attribute a semantic content or meaning to the external patterns based on interior functional processes (Rogers 2024). From among the external patterns that the cell can reference, we are particularly concerned with those patterns that reference another cell of the same "species".

Therefore, in addition to mediating continuity of temporal relations through directed generation, genetic text can also mediate spatial relations as *resonant formal structures*. A given biological species, as a whole, becomes a formal model, enacted by its constituent organisms, that represents the way in which constituent organisms, as contingent dynamical individuals, *mutually interact* through spatially resonant structures to form an integrative biological whole (the communal species) that endures through time and governs the individual constituents.

For the purpose of exemplifying how such a formal semiotic model of speciation works in Darwin's theoretical framework, consider the hypothetical case of a "species" of single-celled organisms that reproduce asexually[13]. By species we mean a communally enacted general type or *natural kind* that is common to all members of the type. While this notion of species as natural kind is more general than Darwin's notion of species that applies to multicellular organisms, it will allow us to focus specifically on the role of genetic text as an identity operator for natural kind formation within an evolutionary framework.

Each cell possesses an interior that is qualitatively and categorically different from the environment in which it is embedded. Through its actions, the cell expresses aspects of this interiority as outwardly manifested dynamical forms or patterns. Other co-present cells of the same species can detect the outwardly manifested patterns as inputs and respond by interiorly processing the inputs and outwardly expressing this interior processing. In this way, cells forming a natural kind have some degree of individual interior agency through their response to external inputs, as well as some degree of collective governance through the mutual transfer of outwardly expressed patterns that reference interior processes (Rogers 2024).

The lynchpin of species as natural kind formation is genetic text. The genetic text—a static pattern within the individual cell—is the indexical origin for the dynamical formation of patterns within the cell interior as a particular cell develops and responds to its environment. The genetic text, as code, *identifies* the general formal possibilities of the species as natural kind that can be actualized by a particular constituent cell in space and time. However, in order to actualize formal possibilities, the particular cell must break the symmetry of general form by selecting from among a fixed range of formally equivalent possibilities. This selection process is constrained by the general formal possibilities encoded in the text to a certain degree and yet also involves semiotic freedom to choose from within the limitations of the constraints. Thus, the interior processing of a particular cell is governed by patterns of selecting patterns and this governance is indexed to the genetic text as a fixed and static pattern. Any interior action of a cell as a synchronous whole involves selection according to the constraints of the indexing code. Because of semiotic freedom, a given particular cell will have its own unique temporal evolution that is orchestrated by the possible patterns of forming patterns which are determined by the genetic code. The unique temporal evolution is characterized by the particular temporal synchronicity of pattern formation that depends on the specific inputs the cell receives through time from its exterior environment (Rogers 2024). A different cell will have a different

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[13] In developing this formal model, we are intentionally ignoring some significant issues related to the biological definition of species for single-celled organisms. The method we are using to bring the formal model into view is like the method of "thought experiments" in physics. For further context on modelling the cell as an evolving symbol-matter system, see Pattee (1982) and Rogers (2024).

synchronicity of pattern formation because the specific inputs will be different and the particular symmetry breaking actions will be different. However, if the two cells belong to the same natural kind and therefore share the same indexing genetic text, then there is an inherent correlation of the *pattern of forming patterns* between the two cells because these dynamical forms are governed by the same indexical genetic code. This correlation creates a condition of possibility for resonant inter-actions among particular cells of the same natural kind that are separated in space.

More specifically, the genetic code (in part) represents the general conditions of possibility for interior processing by *particular* individual cells that will result in the outward expression of *generalized* patterns that can impress back upon other particular individual cells who are members of the same natural kind as viable inputs for their internal responsive processes. Thus, the genetic code mediates mutual recognition (e.g. expression by one particular cell followed by impression by another particular cell and vice versa) of generalized patterns of action among individual members of the species as natural kind. And in their actions, particular individual cells function as icons for other particular cells, with whom they are in communion, of the general formal conditions of communicable possibility of the species as natural kind[14].

If the genetic code were an immutable static pattern representing the general conditions of possibility for particular cells of the species as natural kind for all time, then the theoretical framework of Darwin's theory would be like Newton's theoretical framework insofar as the constituents of the genome would play the role of unchanging constituent elements of the deterministic kind as a whole structured and timeless system. There would be no evolution of species as natural kind because the kind becomes the defining timeless structure that is the determinate form of the matrix of possibilities for the expression of the genetic code. However, this is not how our formal model of Darwin's theory works.

Rather, precisely because there is a categorical difference between interior processing by particular cells (Rogers 2024) and outward expression of general communicable form, *the species as a natural kind is never formally completed*. What comes into external representation for the particular individual cells of the species as a natural kind are general modes of action that present as dynamical patterns. These modes of action become unified into a system of communication through the fusion of horizons[15] of particular individual cells insofar as each cell is an icon of the natural kind for the other cells in the species. A fusion of horizons happens because, as an indexical origin, the genetic text determines the dynamical patterns of interior processing that belong to the synchronicity of a particular cell. But some of these dynamical patterns are also externally expressed in a way that can be recognized and internally processed by other cells within different contexts of synchronicity. The external process of communicating externally expressed patterns among particular cells overlays, upon the internal dynamics of each cell, a categorically different *external* temporality that belongs the whole community of interacting cells and this overlayed temporal order, as a generalized system, impresses back upon

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[14] The conditions of communicable possibility of the species as kind form a restricted subset of the much larger set of conditions of possibility for each particular cell within the species as kind as described by Rogers (2024).

[15] For further context on the fusion of horizons, see *On the relationship between the concept of text in Gadamer's theory of hermeneutics and the concept of light in Einstein's theory of relativity: towards a fusion of horizons* in Rogers (2022).

the particular individual cells to synchronize aspects of their internal temporal modes of action. No longer are the interiors of the cells completely separated from one another as unique temporal systems. There is a governing system of externally communicated dynamical forms, called a semiotic scaffolding (Favareau 2015), that draws the mutually interacting cells into collective modes of action belonging to the *natural kind.*

The fusion of horizons is a form of communal resonance that occurs because the genetic text identifies the natural kind as an *enacted symbol*, where an enacted symbol is a dynamical whole that manifests through communal participation of its constituents. The species as natural kind functions as a *final cause* that draws constituent cells towards the expression of generalized communicable forms because such expressions bind the individual constituents together, allowing for collective duration through time and resonantly creative interactions in proximal space. As the genetic text is passed from generation to generation, there is a synergetic "pressure" or "guidance" to stabilize those communicable forms that respond well to the current environment. However, as the environment changes, the genetic code can also change. Additionally, there is a pressure or guidance with respect to the expression of genetic text that can impact the way in which individual cells interiorly process genetic text, for example by privileging certain modes of expression that are collectively advantageous to the continuance of the mutually interacting system of cells of the same natural kind.

The formal model appears to involve logical circularity: the genetic text determines the expression of communicable forms and the impression of communicable forms determines the genetic text. However, this logical circularity is neither self-contradicting nor tautological because *two different categories of determination* are involved. The determination of the genetic text *as expressions* belongs to the interiority of the cell; the determination of communicable forms *as impressions* belongs to the exteriority of the cell. Correspondingly, two different forms of synchronization (internal cell processes and external intercellular communication) result in two different categories of time (belonging to individuals and to the collective, respectively). Particular individual cells are governed by the genetic code which synchronizes the interior of the cell by way of generalizable dynamical modes of expression. This synchronization establishes the shorter timescale of the life cycle of individual cells. Overlapping with this timescale, the externally mediated communal interaction of the members of the species as natural kind governs the establishment of new generalizable patterns that offer survival advantage *for the natural kind as a whole* by becoming preferentially expressed or systematically encoded into the genetic text. This collective synchronization of significant patterns occurs over the longer timescale of species evolution.

The formal model is also logically incomplete. The genetic text identifies the natural kind as an enacted symbol. But that which the enacted symbol represents is a final cause that can never be determined by any formal system. The species as natural kind belongs to the category of interiority yet it only manifests through exterior expression. What is expressed exteriorly are generalized communicable forms. While the generalized communicable forms converge towards the fusion of horizons for each particular cell of the species as natural kind, this fusion is never made actual in space and time. The particularity of each individual member as an acting agent always transcends any system of generalized forms and it is this transcendence that provides the principle of unity for directed generation. It is the principle that actual physical entities, by virtue of their actuality as experiential agents in the world, transcend in their particularity any completed formal representation. What transcends any completed formal representation is *the particular agency of semiotic freedom to select* from among a given system of formal possibilities.

Within this formal model there is continual *differential change* of genetic text. Individual cells can generate changes in genetic code during the process of directed generation (for example, through mutation). These differential changes can become amplified and systematically incorporated into the species as a whole, such that over the timescale of the species the genetic text changes. Continuity is maintained through differential change as long as the particular differential changes do not comprise the processual synchronicity of individuals or of the whole species as a system. What holds the formal system in unity is the identity relation of mutual recognition whereby a given particular cell expresses a form that impresses upon another cell but that cell processes the impression to then expresses *the same form* back to the given cell to create an indeterminately resonant relation of mutuality. The resonantly exchanged dynamical forms *are* the enactment of the symbol, and the constituting cells thereby enact a temporal synchronicity that belongs to the whole community of interacting cells as a natural kind.

However, it should be noted that cells do not form species in the same sense that multicellular organisms form species. The formal model describes the way in which cells are living symbols of a general type or natural kind that is identified by genetic text. The model demonstrates how it becomes possible for a community of cells of the same natural kind to impress back upon the genetic text through intercellular communication channels and this relation of *Return* can become the origin of more complex forms of processing genetic text (patterns of forming patterns), such as differential genetic expression and formation of multicellular organisms. Return relates the two formally distinct categories of interiority and exteriority such that the emergent forms of processing genetic text are not mechanistically determined as would be the case within Newton's theoretical framework, rather significant patterns of expression are amplified because of their significance for the whole community of cells acting within their environmental context. While this simplistic model only offers a rudimentary theoretical framework for understanding the genetic foundation of inter-cellular semiosis, the underling principles can be expanded to the more complex forms of heterogeneous cellular communication that characterized biological systems. Thus, the model exemplifies a non-mechanistic theoretical framework in which meaningful cellular behavior emerges and evolves in communal systems where shared genetic text enables mutual interpretation.

Darwin's theory of evolution involves the process of natural selection which is the excluded initiative of Newton's theoretical framework. In our formal model, the whole species as natural kind selects constituent cells based upon a communal form of belonging within the environment at any given time and place. In addition to the particular selection of individual cells, selection also happens through the external expression of patterns or forms by cells that then impress back upon other cells of the same natural kind within the unifying context of mutual recognition. Selection is not deterministic in the way that Newtonian classical mechanics is deterministic. Within the overarching dynamical forms of the species as natural kind, each particular cell has a degree of internal semiotic freedom as it processes inputs. These variations allow the cell to dynamically respond to its changing environment over the shorter timescale of its lifespan

(Rogers 2024). Likewise, the transfer of genetic text involves a certain degree of freedom for change that allows the species as natural kind to adapt to environmental changes over the longer timescale of species evolution. Two different categories of order with two different categories of temporal synchronicity become dialectically synchronized by the generative order of genetic text (Rogers unpublished).

5. The mediation of hypostasis

Newton's theoretical framework focuses on external systems as fixed structures of relations that fully determine featureless elements and their interactions through represented forms. Darwin's theoretical framework focuses on interior procession whereby individual agency is expressed and maintained through communally enacted forms or patterns of likeness. For Newton, time is categorically external, like space. It is represented as a *fully completed relation*: a moment in a nutshell. For Darwin, time also belongs to the interiority of an organic whole. It is represented through *incomplete relations* insofar as patterns from one context are passed on to new contexts: layers of synchrony of unfolding forms in the process of becoming real.

Newton's theoretical framework cannot ground Darwin's theory of directed generation because the process of coming into determination through the logical ambiguity of natural selection cannot be formally represented by determinate mechanism. However, Newton's framework may provide important insight into the nature of mutual recognition, or *resonance*, through formal systems which, according to our formal model, appears to underwrite Darwin's necessary concept of species as natural kind.

Within our formal model of Darwin's theoretical framework, time references incomplete relations, where completion belongs to the final cause that is inexpressible through formal representation. Therefore, by way of their temporal contingency, all entities in nature are considered incomplete. Incompleteness manifests in the formal model through a relational ontology in which formally represented physical organisms do not have a determinate form in themselves (as would be the case in Newtonian's classical ontology), rather they come into formation by way of their relations with other physical organisms.

A relational ontology[16] involves hypostases as contingent dynamical forms of wholeness. Hypostases exist in relation to other hypostases with which they form a nodal network. In our formal model of directed generation, a biological cell is represented as a hypostasis. The communal interaction of a community of cells belonging to the same natural kind is represented as a nodal network of interacting hypostases. Unlike the immutable elements of Newton's classical ontology, a hypostasis possesses an interior that is categorically different from its exterior. Hypostases are characterized by temporal procession whereby aspects of the interior are intentionally externalized as outputs. The outputs can be communicated to other hypostases as

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[16] For further context regarding the formal representation of relational ontologies, see Rogers (unpublished). In the context of this paper, the interior ordering of the cell belongs to the implicate order, the exterior communication among cells belongs to the explicative order and the genetic text belongs to the generative order.

inputs that they can process. In the act of processing inputs, hypostases generate new outputs that are available for communication.

Hypostases simultaneously participate in two different categories of order. For our formal model of biological cells, interior processing belongs to the category of implicate order and exterior communication of form belongs to the category of explicative order. The genetic text is the generative order that brings the implicate and explicative orders into dialectical relation (Rogers unpublished). It is the indexing origin for the implicate order; it constrains internal actions by way of the dynamical patterns that are encoded by the text. However, the constrains are partial, such that the cell has a degree of semiotic freedom to act within the limitations of the constraints. The internal actions are outwardly expressed and this outward expression can be communicated to other cells within the community. Outward expression involves the transfer of matter and energy that is temporally patterned into a signal according to the internal actions of a given cell (Rogers unpublished). The intercellular communication system belongs to the explicative order.

For the most part, the transferred matter and energy are dissipated into the environment. However, for some specific modes of internal processing, the transferred matter and energy form a spatiotemporal pattern that can be received by another cell because that cell has an internal mode of action that matches the same spatiotemporal pattern. In this case, the internal mode of action of the second cell has a relation of reference to the internal mode of action of the first cell. These relations of reference form a resonant system of communication—a semiotic scaffolding—that is indexed to the genetic text insofar as the internal modes of action of the cells belonging to the same kind are informed by the same genetic text.

However, in order for the communication system to remain intact, the external environment must amplify the patterns of matter and energy transfer that match internal modes of action of the community of cells above the background noise of dissipative transfer to the environment. This amplification involves the formation of resonant structures for mutual matter and energy exchange between cells. That is to say the environment must create communication channels for the mutual exchange of patterned matter and energy (i.e. signals) that allow cells to reference one another in their internal modes of action.

As a result, there is a duality in play. The individual cells privilege certain modes of action according to their indexing genetic code. These modes of action create external patterns of matter and energy exchange that are mediated by the environment through communication channels. But the environment can also affect the individual cells by privileging specific communication channels, thereby exerting pressure or guidance on the cells to select specific internal modes that resonate with such channels. Natural selection happens by way of this duality.

Thus, the species as natural kind forms a communication system of external formal representation—a semiotic scaffolding—that is indexed by the genetic text and governed by the natural environment. And Newton's theoretical framework provides the logical foundation for understanding how a formal system of representation governs its resonant constituent elements through lawful regularity[17].

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[17] For example, as discussed by Pattee (1982), "symbols are processed by syntactic rules" and "syntactic rules are rate independent, that is, the rate of executing the rule is irrelevant". Thus, the time-independent laws of Newton's

6. Conclusion

The mediating framework of biosemiotics allows us to consider the relation between Newton's and Darwin's theoretical frameworks as an iconic example of the categorical duality between interiority and exteriority in natural systems. This duality is reflected in the ontological priority of external spatial representation (structuralism) in physics versus the ontological priority of internal temporal processes (agency) in biology. The biosemiotic framework is both deterministic according to the generalized modes of action and semiotically free according to the particular agency to select from among a fixed system of general possibilities. It can be formally represented as a relational ontology in which hypostases—as communally interacting images of the whole system—interpret their particular conditions of actuality within the present environment in order for the whole system to endure through time thus sustaining the temporal continuity of the individual hypostases. The impetus of life might thereby be interpreted through self-giving aspects like belonging, growth and love rather than through currently privileged self-isolating aspects like force, conflict and death.

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classical determinism might be seen as a sufficient condition for a functional syntactical system as a grammar of possibilities involving symbols at one level of order that, in turn, are emergent explicative forms generated from an underlying implicate level order. For further context, see Rogers (unpublished).

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