# Quantum semiotics

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> *…what we call matter is not completely dead, but is merely mind hidebound with habits. It still retains the element of diversification; and in that diversification there is life.*
>
> Charles Sanders Peirce, CP 6.158 (1931-1966)[1]

It has become fashionable, these days, to incorporate the word *quantum* into a title, whenever someone wants to sell a book or an article, on topics ranging from home cooking to auto repair. Far from entertaining such indulgences, in *quantum semiotics*, we are interested in the question of whether the principles of consciousness might somehow be relevant to the realm of the very small. This relates to *panpsychism*. To some, panpsychism is also a four-letter word that carries its own baggage. We need to move past this, with humility, and certainly at least in the spirit of brainstorming. There is "something" going on that now has some of our most enquiring minds contemplating whether we are not in fact just players in a matrix illusion, a kind of computer simulation. We don't need to resort to such conspiracy theories, just yet, but we do need to keep an open mind.

The word *quantum* relates to discreteness as opposed to continuum. Matter is comprised of discrete atoms and molecules and subatomic particles… electrons occupy energy levels in atoms in discrete jumps… we have the wave-particle duality of discrete photons as packets of energy… and thus we have Planck's constant that plays an integral part in the quantum narrative. The reason that we are interested in *quantum semiotics* is that we want to address the semiotic principles that might be playing out at the smallest, most indivisible levels… at the discrete atomic, molecular and subatomic levels, where we can assume perfect identicality of holons of any one group. Thus, say, one oxygen atom in its natural state is perfectly identical with (indistinguishable from) any other oxygen atom in its natural state, and we want to know how this identicality, with consistent properties that "just so" happen to be essential to life, comes about. DNA entanglement will be our principle focus in this conversation, because the DNA molecule is pivotal to the remarkable complexity that emerges in the lives of cells and other complex, multicellular organisms.

**The semiotic paradigm**

It is now widely understood that the infotech narrative, on which Neo-Darwinian biology is based, is problematic. We proffer an alternative theoretical framework that addresses the sorts of issues that Neo-Darwinism has not properly factored in. If we can no longer rely on the infotech narrative of Neo-Darwinism to describe the relationship between organisms and their DNA, is there an alternative interpretation that might be more compelling? In this regard, the nascent field of *biosemiotics* is introducing an alternative narrative into the life sciences. It is an interpretation that incorporates meaning into all life processes. *Semiotics*, as the study of signs and symbols, is the science of communication, language and meaning, most often associated with humans within the cultural domain. *Biosemiotics* takes the anthropocentric emphasis of *semiotics* and extends it to all living entities across all levels. From the level of words, language and memes in human cultures, biosemiotic principles extend down to the cellular level, where proteins, hormones and molecules play their part in the evolution of meaning within the cellular domain. Emmeche (1992)[2] outlines the most salient aspects of the biosemiotic paradigm:

> Biosemiotics proper deals with sign processes in nature in all dimensions, including (1) the emergence of semiosis in nature, which may coincide with or anticipate the emergence of living cells; (2) the natural history of signs; (3) the 'horizontal' aspects of semiosis in the ontogeny of organisms, in plant and animal communication, and in inner sign functions in the immune and nervous systems; and (4) the semiotics of cognition and language. Biosemiotics can be seen as a contribution to a general theory of evolution, involving a synthesis of different disciplines. It is a branch of general semiotics, but the existence of signs in its subject matter is not necessarily presupposed, insofar as the origin of semiosis in the universe is one of the riddles to be solved."
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> (Emmeche 1992: 78)

Biosemiotic theory introduces concepts from linguistics, with the idea of genes as signs, analogous to words in a language. In this context, proteins and enzymes can also be thought of as signs. With reference to the semiotics of Charles Sanders Peirce, Emmeche & Hoffmeyer (1991)[3] describe how a gene, as a sign, relates to the triadic scheme in the manufacture of proteins. The *sign vehicle* is the gene from the DNA molecule, the *object* is the protein molecule, and the *interpretant* is the cellular-biochemical network, as mediated in the process of RNA transcription. Molecules can also be signs. Within any organism, individual cells rely on tiny receptors to recognize sign molecules in their environment (Hoffmeyer, 1996)[4].

The gene-as-sign has its analogy in human language, where the *sign vehicle* is the spoken (or written) word, the *object* is the item of interest defined by the word, and the *interpretant* is the context, as the catalogue of known possibilities that defines the item as relevant or meaningful. The "catalogue of known possibilities" relates to culture (its memes and language), and the cultural interpretations, based on historical experience. Or as another example, in the case of a fire, the *sign vehicle* is the smoke, the *object* is the fire, and the *interpretant* is the context that defines the fire, for example, in the mind of the observer. Having come thus far, it is tempting to conjecture how the triadic scheme should play out at the level of matter. This will be contingent on the context and the axiomatic framework that one is assuming. Sheldrake's *morphic resonance*, or Bohm's *implicate/explicate order*, or Schrodinger's *wave function*, or Young's *double-slit experiment*, or a chemical reaction between two different atoms, will, for example, posit different interpretations as to what constitutes the sign vehicle, the object and the interpretant. Perhaps further conjecture is an exercise best left until a clearer consensus on the strange world of quantum mechanics has been established. It is clear that molecules play an important role within the biosemiotic paradigm, particularly at the cellular level. And when we factor in their very precise, life-critical properties, this raises the question… are molecules and atoms, themselves, governed by semiotic principles? The semiotic paradigm might be integral to understanding what happens at the mind-matter juncture, and therefore of direct relevance to the mysteries of quantum mechanics.

**A theory of life throughout the universe**

*There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy.*

On the face of it, it would seem to be controversial to suggest that semiotic principles extend all the way down to subatomic particles. But consider recent research from the University of WA, establishing that the principles of conditioning (Pavlov's dog) apply also to plants.

Based on the work of Monica Gagliano and her team (2016)[5], there is now compelling evidence that plants also acquire habits by associative learning. By inference, it would thus seem that the Peircean-biosemiotic paradigm applies also to plants. And on Gagliano's Facebook account, I posted the comment, "Plants are the sorts of animals that evolve to take advantage of diffuse but reliable access to nutrients and energy... that is, soil and sun." Let us extend this rationale to atoms and molecules. Could it be that atoms and molecules are the sorts of animals that evolve to take advantage of the dynamic energy of a quantum void? As Robert Lanza observes (scienceandnonduality, 2011)[6], "Every now and then a very simple but radical idea shakes the foundations of knowledge [...] Biocentrism is turning the world upside down again with the seemingly simple idea that the universe arises from life, not the other way around."

If mind precedes matter, what then are the fundamental properties of Mind, and what are the implications? Semiotics is a good place to start looking, because it addresses the fundamental principles as they relate to, for example, motivation, associative learning, habituation and pragmatism (as outlined in my 2001 Semiotica article, The Law of Association of Habits). And the implications are far-reaching, as Lanza realizes. Ultimately the dumb dirt that we are familiar with in our lives, the same dirt that gets in our hair, under our nails and in our clothes, and the same dirt that plants rely on for their nutrients, is the same dumb dirt that more than likely exists throughout the cosmos. The incredible complexity within a living cell would not be possible were this dumb dirt not so smart. Perhaps we have our null and alternative hypotheses around the wrong way. It would make more sense for our default null hypothesis to be that life throughout the universe is the given, and it is up to the eccentrics among us, should they doggedly persist despite all reason, to prove otherwise.

## Stem cells and DNA

Within the context of the biosemiotic paradigm, *stem cells* play a crucial role in life processes, because they are the precursor cells that transform into useful organ cells essential to sustaining life. It is at the transition from an undifferentiated stem cell without a purpose to a productive cell with a very specific role that brings our focus onto the most essential principles that we want to explore. In explaining the role of stem cells, the established narrative in biology persists with the mechanistic infotech metaphor, typically along the following lines:

> While differentiating, the cell usually goes through several stages, becoming more specialized at each step. Scientists are just beginning to understand the signals inside and outside cells that trigger each step of the differentiation process. The internal **signals** are controlled by a cell's **genes**, which are interspersed across long strands of DNA and carry coded instructions for all cellular structures and functions. The external signals for cell differentiation include chemicals secreted by other cells, physical contact with neighboring cells, and certain molecules in the **microenvironment**. The interaction of signals during differentiation causes the cell's DNA to acquire **epigenetic** marks that restrict DNA expression in the cell and can be passed on through cell division.
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> Bethesda, MD: National Institutes of Health, U.S. (2016)[7]

What we have here is much detail, but no explanation. This kind of narrative sheds no light whatsoever on the principles that come together to explain biological systems. A linear narrative, along these lines, might explain the workings of a car engine by describing the motion of the pistons, the flow of air through the carburetor, the injection and ignition of fuel, etc. But we know how engines come about... they are designed by engineers and manufactured in factories. By contrast, cells are not manufactured in factories or laboratories... cells are participants in biological systems, or colonies, and they make themselves (systems theory, *autopoiesis*). The above referenced passage provides no synthesis, no integration of insights into a compelling paradigm to explain the inevitability of life processes. The topic of stem cells remains just another pigeon-hole into which another category of detail can be slotted. As we see in the above passage from the website of National Institutes of Health (NIH), the established narrative is one grounded in concepts from information technology… concepts that we also associate with data and computers, like *coding*, or *information*, with the usual conflation of *genes* with *data*. Consistent with this genocentric narrative, DNA provides the blueprint that determines form, behaviour and instinct… hence the term *genocentrism*. References to stem cells are typically made within this same genocentric context, and in this we lose the opportunity for real insights as to what might be taking place in any living system. There is much more to stem cells than merely another stage in an organism's development, particularly when we factor in insights from the biosemiotic paradigm.

## Synthesis with quantum mechanics and systems theory

In his theory of morphic resonance, Rupert Sheldrake (1987)[8] provides an analogy that compares the role of an organism's genes to that of a television antenna delivering a television program through the television picture tube. That is, according to this analogy, an organism's genes enable the organism to "tune in" to other organisms that share its genotype (and phenotype). In this way, an embryo can develop along established lines without having to have all the information encoded in its genes. Genes and DNA are molecules. It is now fairly well established that the principles of quantum mechanics apply to atoms and molecules just as they do to subatomic particles, such as photons and electrons. Might Sheldrake's theory of formative causation be better understood from the perspective of entanglement? Entanglement between DNA molecules is an appropriate place to start looking.

Narratives from systems theory, associated with the likes of Ludwig von Bertalanffy, Humberto Maturana and Francisco Varela, are assumed throughout this chapter, and are directly applicable here. Within the context of systems theory, a cell is a participant in a colony. It makes choices from its colony and conforms to the rules that enable the colony to survive. With its interdependencies, the relationship between a cell and its colony is played out at different levels, such as ants in an ant colony or people in culture. But ants, bees, meerkats and people are mind-bodies, comprised of many cells, and they take their cues for behavior via their senses. What are the mechanisms by which a single cell might take its cues? Perhaps an important part of the answer lies in DNA entanglement. Let us take a look at the developmental trajectory of embryonic stem cells, to see how this might play out.

**The known versus the unknown of reproduction**

Among sexually reproducing organisms, before a stem cell can come into existence, a fusion has to take place between a male and a female gamete (sperm and egg). It is no accident that male and female sex and gender roles (sexual dimorphism) are manifestations of the very dynamics that play out between gametes in the course of reproduction. In human cultures, competition between active males establishes the hierarchies that determine access to females and thus, to reproduction. It is to this fundamental competition between males, with females controlling sexual supply, that the history of humanity owes the emergence of gender roles in culture. Similarly, at the level of gametes, many swimming sperm must compete for access to a single, stationary, receptive egg, before a zygote is formed and an embryo can commence. The parallel between the social behavior of men and women in culture and the reproductive behavior of sperm and egg in the womb is most remarkable when you think about it. It suggests a fundamental relationship between the known and the unknown that is as important at the level of culture as it is at the level of the cell. A stem cell, as a product of the union of sperm and egg, must also contend with the unknown… it too needs to learn the rules of survival. It must *know how to be*, so that it can transform into a differentiated cell within a productive, functioning organ.

**A stem cell's destiny and purpose**

Established theory as it relates to stem cells can be summarized as follows:

- Embryonic stem cells are derived from the undifferentiated inner mass cells of a blastocyst, and they go on to form the embryo;

- Every differentiated cell in every organ in the human body ultimately owes its existence to the undifferentiated stem cells of the embryo;
- A stem cell learns its role from its location within an organ. It stops being a stem cell when it differentiates, to become a specialized cell that fulfils the role defined by its location in an organ;
- We might interpret a stem cell's development to a specialized cell in the context of *knowing how to be*. It is analogous to how people learn their roles from their culture. For example, people growing up in working-class or middle-class suburbs are more likely to *know how to be* tradesmen, shopkeepers, nurses, police or the unemployed, while people growing up in upper-class suburbs are more likely to *know how to be* professionals, investors, office-workers or, simply, the idle rich;
- Nothing thus far in our list above is new, in principle, as it relates to well-established systems and complexity theory. Emphasis is on autopoiesis. The process is bi-directional, with principles of organization coming from the top-down and the bottom-up. However *knowing how to be* brings a fresh perspective with important implications for how systems/complexity theory might be interpreted;
- In its crudest form, *knowing how to be* might loosely be defined as imitation. But this description is inadequate, because *knowing how to be* has to factor in other nuances that address how an entity defines the things that matter. This brings us to established theory in biosemiotics and the semiotics of Charles Sanders Peirce, on the topic of *pragmatism*;
- Pragmatism is an important concept in semiotic/biosemiotic theory. Peirce originally defined pragmatism in the context of scientific methodology for research and analysis... how a researcher goes about defining the things that matter. In Peircean biosemiotics, this is expanded to a more general, phenomenological context. Thus from the perspective of biosemiotic theory, pragmatism is concerned with how any organism, from cells and insects to whales and humans, defines the things that matter. The mind-body unity is central to biosemiotic pragmatism, because it is the body that provides the predispositions to interface with what the neuroplastic Mind defines to matter. Similarly, the mind-body unity of the stem cell predisposes it to the sorts of choices that lead first to its differentiation, to progress ultimately to its useful purpose in an organ.

Let us take a closer look at our assumptions regarding organization from the bottom up:

- Every cell in any living body houses an identical suite of DNA molecules and chromosomes in its nucleus;
- Within the context of the established genocentric narrative is the infotech metaphor of "data" encoded into the DNA. This metaphor suggests the presence of software to be "computed," yet there is no sign anywhere of any computer to process it;

- Given the comprehensive, complex manner in which any DNA molecule replicates, it is logical to infer interaction and thus possible quantum entanglement between the two subsequent daughter molecules that result. And given that all the DNA within a multi-celled organism has its origins in the DNA of the zygote that was its beginning, it is logical to infer that all the DNA in the organism are entangled together. This has implications for the "binding problem" and the unity of the organism as a single entity;

- A reasonable conjecture upon which to commence discussion, in a semiotic context, is that this entanglement between identical DNA molecules predisposes any stem cell to making choices appropriate to the cues that it receives from its location within an organ. The cell is not "instructed" what to do but rather, "knows" the things that matter, in the spirit of pragmatism, and responds accordingly;

- Let us draw on Sheldrake's metaphor of DNA as antennae receiving signals. The suggestion is that the entangled DNA molecules enable the body's cells to access the shared mind-body condition, to be informed by it. In this way, *DNA entanglement* plays a crucial role in *knowing how to be*. This would be analogous to how our telecommunication technologies provide every person in a city with immediate access to the city's options, to inform its people on *how to be*. And in this we have the now familiar metaphor, first introduced by Rupert Sheldrake, of an antenna that receives transmissions from a television broadcast.

There are a number of truths here that must be taken seriously. These are truths that must be addressed with due rigor, in the spirit of falsifiability and the scientific method. They provide bottle-necks that bear directly upon the possibilities that can manifest:

- The absence of a mechanism, or computer, which "processes" the "data" in the DNA molecule is non-trivial. If there is no "computer" in evidence, then it is bad science to persist with a metaphor that assumes a computer to be a given. There is no crossing this Rubicon, if one bases their reasoning on the current established narrative. Genes as data but no computer? Then you have no paradigm;

- One objection to the preceding point is the suggestion that the complexity of a computer that cannot be found is somehow bound into the molecular sequences and structures around which all reactions and operations take place. But the suggestion that atoms and molecules – oxygen, water, carbon, minerals, etc. - have all the complex properties that just so happen to be essential to the life processes that come together to create hearts, muscles, eyes and brains, is itself problematic and opens a whole new can of worms. This line of reasoning is devoid of the specifics that are integral to falsifiable methodology. The video clip, Inner Life of the Cell (MoreThinking, 2013), dramatically illustrates the scale of the complexity within a cell that is so exquisitely and precisely choreographed;

- Or, following on from the preceding objection, if no computer has been identified to process genetic data, then the suggestion seems to be that said computer exists in some kind of data form, sharing the volume of the egg's nucleus with the data for the organism's genetic blueprint. But is this realistic? Can the genetic code account for the mechanism of its own interpretation? That is, can the computer that *processes* the genetic code be built *from* the genetic code?

- Given the established narrative's metaphor rendering data as the basis for some kind of blueprint, or some kind of indicator of complexity or sophistication, consider that the Human Genome Project has estimated that there are 20,000 to 25,000 protein-coding genes in the human genome. For comparison, the number of genes in some less "complex" organisms play out as follows (Kimball, 2016)[9]:

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|---|---|
| Naegleria gruberi (unicellular amoeba): | 15,727 |
| Fruit fly: | 17,000 |
| Humans: | 21,000 |
| Caenorhabditis elegans (nematode roundworm): | 21,733 |
| Mouse: | 23,000 |
| Pufferfish: | 27,918 |
| Picea abies (Norway spruce conifer): | 28,354 |

  Is it conceivable that we humans have been bested by worms, mice, pufferfish and conifers? Clearly, the number of genes comprising an organism's genome provides little utility as a measure of complexity or development;

- The haploid human genome is estimated to be of the order of 3.2 billion bases long. For comparison, the now unremarkable Western Digital external hard drive sitting on my desk comprises 2 terrabytes, or 2,000 billion bytes. And if we interpret our 3.2 billion bases in the context of bytes, then the justification to interpret DNA in the context of the infotech narrative becomes even more preposterous. The four nucleobases that comprise the base-pair building blocks of the DNA molecule are cytosine, guanine, adenine and thymine (DNA), abbreviated as C, G, A and T, respectively. There are four base-pair combinations that manifest as the rungs along the length of the DNA spiral, namely, C-G, G-C, A-T, T-A. If we interpret the four base-pairs that are possible as comprising one "byte" of data, then 3.2 billion bases would translate to a measley 800 Mb of data.

Given these very serious limitations, we can only conclude that the established narrative is unrealistic. Indeed, worse than simply being unrealistic, it encourages the persistence of narratives that hinder our capacity to apprehend the true nature of things. A false narrative obscures from our view other potentially more salient possibilities. What possibilities are we left with? Perhaps we should introduce *quantum mechanics* into our narrative and take seriously its implications for *DNA entanglement*.

**DNA entanglement**

The introduction of quantum physics into the narrative of the biological sciences is certainly not new. It has been implicated in photosynthesis and avian navigation. And the Orch-OR hypothesis of Stuart Hameroff and Roger Penrose attributes a crucial role for entanglement to microtubules as the basis for consciousness. However, at the heart of many of these interpretations there continues to be a reductionist, or deterministic, linear emphasis. Frequently, entanglement/nonlocality is interpreted in the context of the mechanistic narrative, and entanglement becomes just another part in a complex linear mechanism of cause-and-effect, not unlike that introduced in the above passage on stem cells, by the Bethesda National Institutes of Health. The problem with this kind of linear emphasis is that it fails to resonate with the axiomatic, integrative thinking that we might recognize, for example, in Isaac Newton's contributions to physics. A linear, mechanistic sequence of cause-and-effect fails to account for the inevitability of life… the ability of life to persist across time. The motivation behind our conjecture, therefore, is that there is something about entanglement that relates to a more central role, in the context of an axiomatic framework of principles for the life sciences. There is something about entanglement that seems to suggests a unifying principle that is integral to all life processes… something more central than just part of a mechanistic, linear sequence of cause-and-effect. DNA entanglement therefore provides an ideal focal point around which our conjecture might be further explored.

The usual objection to DNA entanglement is decoherence. That is, coherence is very fragile and difficult to maintain, and decoherence is inevitable when an entangled system is exposed to the environment. In response, it is suggested that this assumption of decoherence might not be an accurate representation. Perhaps our assumptions are incomplete, and a more compelling possibility is being overlooked. Contemporary research is increasingly addressing the notion of *coherence freezing* – that is, the freezing of quantum correlations. With reference to the work of Cianciaruso et al (2015)[10], Zyga (2015)[11] discusses the ability of some quantum correlations to persist, despite the noise associated with decoherence. The researchers have shown that the freezing of quantum correlations is universal. Quoting Lo Franco, from the Cianciaruso et al team, Zyga reports, "The greatest significance of the work is to show that a general form of quantum correlations must remain frozen and protected in the presence of some, usually detrimental, decoherence effects." The researchers have also found that under certain circumstances, it may be possible to not just prevent but also reverse the effects of decoherence. Building on the insights from Cianciaruso et al, Silva et al (2016)[12] demonstrate the extreme resilience of coherence. Quoting Adesso, from the Silva et al team, Zyga (2016)[13] reports:

> Quantum properties can be exploited for disruptive technologies but are typically very fragile... Here we report an experiment which shows for the first time that quantum coherence in a large ensemble of nuclear spins can be naturally preserved ('frozen') under exposure to strong dephasing noise at room temperature, without external control, and for timescales as long as a second and beyond.

These conclusions are important in our analysis, because they suggest that quantum decoherence is not the insurmountable problem that people have been assuming it to be. Quantum coherence is contingent on a number of variables, how we define it, and what kind of system or subsystem one is considering. Our researchers' observations raise concerns about how much we really know about coherence and what it is. Have we clearly defined what we are looking for, and what our axiomatic assumptions should be? And so into this vacuum we proffer a possibility to explore, one whose motivations are inspired in the axiomatic imperative. At some level, should we not be asking how atoms and molecules "know" their properties? Within the context of the Peircean biosemiotic paradigm and Peirce's pragmatic maxim, do atoms and molecules also have to *know how to be*?

## Redefining decoherence as recoherence

The topic of recoherence appears to be a fairly recent entry into the field of quantum mechanics, and it has its parallels with what I intended it to mean when I first coined the term myself (as a lay researcher operating outside of the physical sciences). That is to say, the accepted definition suggests that decoherence can be followed by recoherence, as a system re-establishes a cohered configuration. Such recoherence is demonstrated in a paper by Bouchard et al (2015)[14], whose experiment showed that "… propagation-induced decoherence can be reversed to recover lost information, provided that a judicious choice of imaging optics is made by the experimenter." Nonetheless, there are differences in our interpretations, and that which I bring to bear is inspired first by the semiotic narrative. We are particularly interested in the relevance of recoherence to the properties that manifest in matter. By way of thought experiment, we step outside the box and redefine decoherence as recoherence. In the spirit of this thought experiment, the suggestion is that entanglement is the default condition for any non-virtual particle, and that atoms and molecules "know" their properties through entanglement with others of their kind... entanglement is what distinguishes them from the fleeting, virtual particles of the quantum void that have no properties to sustain.

By contrast, physicists' references to entanglement generally assume entanglement which is imposed artificially in a laboratory (e.g., Alain Aspect's pioneering experiment), where a deviation from "normal" atomic/particle "behavior" is typically imposed on pairs of subatomic particles by way of, say, spin state. This latter form of imposed entanglement will thus be an unstable condition that is easily disrupted in warm, wet environments, in the now familiar narrative of decoherence. But maybe this disruption is better thought of as recoherence, not decoherence... as the pair of particles return to familiar conditions that define their usual, replicable properties. There are several motivations for this line of reasoning, particularly from the perspective of entropy. Recohered entanglement would be the most stable condition at which subatomic, atomic and molecular entities can possibly persist across time. Think of it as "rest state" coherence… the coherence that manifests when all other instabilities have expired. This relates to entropy, and is analogous to thermal equilibrium, like a hot jug of water that resumes room temperature after a couple of hours have transpired. The following line of narrative, taken from an informal forum conversation that I was part of, illustrates the significance of this reinterpretation, and why it might be relevant to pragmatism applied to the realm of subatomic, atomic and molecular entities:

> The metaphor that I apply is human relationships within the context of human culture. When two people undergo an intense bonding experience, they identify with one another, they become dependent on one another, and they develop a shared understanding of what reality is. When the intense bond is torn asunder, they must part company. They must learn to live without each other, and they re-assimilate with their cultural whole. The two soon adjust to their new, "normal" relationships, and they forget about each other and their special bond that they shared. As they increasingly interact with "normal" people from a "normal" culture again, they become more "objective" and "sensible" again, and they have thus "recohered" with their cultural norms.

> Could this re-assimilation with the whole be what is taking place with "recoherence" at the subatomic level? Thus what manifests at first glance as decoherence, actually culminates in the very opposite. That is, a pair of particles begins by "decohering" following an intense bonding experience within a laboratory crystal, but they culminate in recohering with their collective "norm" throughout the rest of the universe. The particles are re-assimilating with the normal behavior that is expected of them outside of the artificial laboratory conditions in which they bonded. Maybe we can call it "re-entangling" but ultimately, all it amounts to is renegade laboratory particles, say hydrogen atoms, re-assimilating with normal hydrogen behavior, after being freed of the stifling, artificial laboratory conditions.

So what might the basis for *stable* entanglement be? More specifically, if, in the context of experiments such as those pioneered by Alain Aspect, fragile and unstable entanglement is artificially imposed on interacting particles in a laboratory, what might be the basis for the stable entanglement that accounts for the familiar, persistent properties of atoms and molecules in their natural state? On what basis might laboratory-entangled particles revert (recohere) to their stable, persistent forms? In this context, the notion of *identicality* seems logical. In simple terms, if it can be suggested that any two entities are absolutely identical (this might be inferred at the subatomic, atomic and molecular levels), it is not unreasonable to suggest that they might be entangled. This is the line of reasoning pursued by Gefter (2015)[15]. The matter of identicality at the subatomic, atomic and molecular realm has far-reaching implications for the assumptions that we make, and how we interpret even space itself.

## Identicality, de Broglie hypothesis, quantum eraser

The subject of identicality between particles and its relevance to quantum mechanics is appreciated throughout the physics literature. In said literature, *identical particles* are also defined as *indistinguishable* or *indiscernible* particles. There are two main categories of identical particles, bosons and fermions. Bosons can share quantum states, and fermions cannot share quantum states due to the Pauli exclusion principle. But the narrative in the wider literature is usually along different lines, with emphasis on, for example, statistical mechanics and Gibbs paradox, and not in the context that we wish to bring to bear in this chapter. This is not to say that our two lines of thought are inconsistent, but more detailed discussion of the general literature is beyond the purpose of this section. Here, our emphasis is on the suggestion that identicality relates to *knowing how to be* and *pragmatism*. This incorporates the *semiotics* and *pragmatism* of C.S. Peirce, and the idea that particles, like living organisms, also need to "know" the rules that matter… the rules that define their "behaviour" (properties). These are the rules that distinguish real particles that persist through time with predictable properties from the virtual particles that flicker into and out of existence in the quantum void. This brings us to Schrodinger's wave equation, the relevance of all the possibilities that are implied in the wave function, and how entangled particles might arrive at the consensus that results in the collapse of the wave function.

In this regard, the question of *self* and identicality is most relevant, particularly in the context of the famous quantum eraser experiment (for example). Within such a double-slit experimental setup, does it make sense to regard a pair of entangled photons not as two separate entities each going their own way, but as somehow two manifestations of a single self? If a pair of photons are, in fact, more accurately thought of as a single "self," then the question of distance travelled (to their respective detectors) and time elapsed need to be factored into the possibilities that are implied in the wave function, and what kinds of options that a pair of entangled photons have available to them. The illusions of space and time that are available to a human observer are not the same illusions that will be entertained at the subatomic level. From the available literature on the quantum eraser experiment, for example, it seems that researchers are factoring in assumptions about the speed of light (when configuring the detection windows on their coincidence counters), when in fact in certain contexts, the speed of light might be instantaneous... it may well be that the photon arriving at the more distant detector is not arriving later, but at exactly the same time as its twin photon at the nearer detector.

> [From the literature that I have been able to access on the quantum eraser experiment, it seems that the speed of light, c, was assumed as given, and the coincidence counters set up accordingly… but instantaneous arrivals would also have been detected and registered by the coincidence counter. It seems that this remains something that needs to be addressed by researchers, so as to properly account for the time paradox that has them scratching their heads. Maybe there is no time paradox at all]

**Entangled heavy molecules**

It is now confirmed that the principles of coherence are not confined to the lightest subatomic particles. More complex, heavier holons, such as atoms and molecules, also exhibit de Broglie wave properties. Given that this is currently an area of focused research, let us review the most recent state of play and the lead-up to it. In 1999, De Broglie wave interference was achieved by experiment, in massive C60 molecules, also known as buckey balls (Arndt, et al., 1999)[16]. And by 2003, clear experimental evidence was obtained of the de Broglie wave nature of meso-tetraphenylporphyrin (TPP) and of the organic molecule fluorofullerene C60F48 (Hackermüller, et al., 2003)[17]. As with DNA, porphyrins (TPP) are of low symmetry, and they are abundant in organic systems. Hackermüller et al were able to conclude that their experimental results were consistent with the theoretically expected relationship between interference patterns and the de Broglie wavelength. C60F48 (1632 gmol/1) was the heaviest, most complex molecule for which Hackermüller et al were able to demonstrate interference of matter waves. Gerlich et al (2011)[18] investigated the wave nature of organic compounds comprised of up to 430 atoms, with a maximal size of up to 60 Å, and masses up to m = 6,910 AMU. They conclude:

> ... our experiments reveal the quantum wave nature of tailor-made organic molecules in an unprecedented mass and size domain. They open a new window for quantum experiments with nanoparticles in a complexity class comparable to that of small proteins, and they demonstrate that it is feasible to create and maintain high quantum coherence with initially thermal systems consisting of more than 1,000 internal degrees of freedom.

In the 2012 Colloquium on *Quantum interference of clusters and molecules*, Hornberger et al (2012)[19] review the evolution of research on coherence in molecules and nanoparticles. Wave properties have been confirmed for nano-sized particles, and Hornberger et al are of the opinion that

> *... to date, there has been no experimental indication that the quantum superposition principle may fail at any mass or length scale.*

Given these consistent developments, it would seem reasonable to conclude that DNA molecules will be subject to the same de Broglie wave properties. But what might this imply for entanglement?

**Coherence and entanglement equivalence**

Coherence and entanglement are based on the same superposition principle, and so it would seem that coherence and entanglement are related. Along these lines, Streltsov et al (2015)[20] were able to establish that coherence and entanglement are quantitatively, or operationally, equivalent. Summarizing the findings of Streltsov et al, Zyga (2015)[21] reports that Streltsov et al arrived at their conclusion by showing that

> … in general, any nonzero amount of coherence in a system can be converted into an equal amount of entanglement between that system and another initially incoherent one.

This development provides a most important insight with respect to the objective of this paper. The equivalence of coherence with entanglement has important implications for DNA and biology. Given the manner in which DNA replicates, and given that de Broglie wave properties apply also to DNA molecules, it would seem logical to infer that all the DNA molecules within any one organism are entangled. What might the implications of such entanglement be? One that comes immediately to mind is the *binding problem*. The *binding problem* relates to how the many cells, limbs, senses and organs comprising a living entity come together in a unified conscious whole, and entanglement would seem to be the candidate of choice. Other implications might be more nuanced, but they are certainly no less important… phenomenology, pragmatism and the nature of space and time. Reincarnation? The nature of self? The implications are far-reaching, but well beyond the scope of this chapter. The thing that most interests us, though, is the possible role that entanglement might have in enabling molecules to "know" the rules that account for their properties that are essential to sustaining life.

**Of cities and cells**

There exists more than one compelling theory of Culture and Mind. But if we do not know about any of them, then we are unlikely to appreciate how people going about their daily affairs relate to the Cultural Mind. We are unlikely to understand how personal identity relates to cultural identity. We are unlikely to understand how a culture or a person resembles a thought (Jarosek S. , 2001)[22]. One such theoretical framework that I am alluding to, in the first instance, is the semiotics of Charles Sanders Peirce. Within any one city, people go about their daily affairs without having to think of the part that they play in the urban-cultural identity that delivers their purpose. Yet there exists this theoretical framework, in Peircean semiotics, that explains how individual human behaviour relates to the cultural whole. One does not need to know of this theory in order to make it work for them. The vast majority of people survive just fine, without really understanding the culture that makes it all possible.

On behalf of Harvard University, XVIVO produced the previously referenced video clip, linked to by MoreThinking (2013)[23], on the Inner Life of the Cell. It represents a simulation of the processes that take place within a living cell. It is inspiring, and well worth taking time out to watch it through: https://youtu.be/FzcTgrxMzZk

In the video, there are molecular "critters" doing their thing. There is one guy, a motor protein, who lugs around a huge load along a microtubule… he certainly won't know the whys and wherefors of his existence, as he lugs his enormous load trailing behind him, along the length of the microtubule. And he has no eyes or other senses, and so the only thing that can possibly matter to him (in the spirit of Peirce's *pragmatism*), or enter into his zone of awareness, is the microtubule and his load. As with people in an urban culture, or living creatures in an ecosystem, these micro-critters don't need to know how their activities relate to the cellular whole. They just do what their molecular form predisposes them to do. The inside of a cell is a lively, dynamic ecosystem with much activity taking place. The critters of this micro-ecosystem might remind us more of smurfs, pac-mans and other computer game characters than the living, breathing creatures of nature red in tooth and claw, but they are just as essential to survival.

At one level the video is disappointing, because it does not provide easy answers. There is no hint of mechanics or circuits, mathematics or chemistry, software or computer, or anything even remotely consistent with the established infotech or mechanistic narrative. There is nothing here that would enable us to declare "Eureka! Now I get it!" It's just more of the same that we are already familiar with. What we see around us, or in our ecosystems, is what appears to transpire within the confines of a cellular ecosystem. Above ground is the same as below. To the uninitiated, it would seem that rampant complexity is the rule, throughout all the levels above and below. To those confined to the infotech, mechanistic narratives, it's just the same, old same-old, but in micro. But at another level, the XVIVO simulation portrays a fundamentally different kind of ecosystem to that with which we are familiar. It is an ecosystem of co-operation. The scene resembles a science fiction setting on an alien planet where sleep-walking zombies toil day-in and day-out, to fulfil an agenda of which they have no comprehension, for a leader that they have never seen. Like obedient, anonymous slaves in a vast factory complex in an enormous alien megalopolis, each microcritter toils without rest, sleep or complaint, making its contribution to the greater whole. There is no survival of the fittest in this microcosm. The blood-and-guts of survival takes place beyond the cell wall, but not within it.

Another thing that we notice within this ecosystem of unquestioning servitude is the apparent absence of any division of labour by sex. This is significant, because in the higher ecosystems, sex differences seem to play a role in addressing the evolutionary tensions between the known and the unknown. Irrespective of whether it is a colony of ants, bees or termites… or a pride of lions, or a herd of elephants, or a tribe of meerkats… there exists a kind of matriarchal authority that is the first source of the things that matter (Peirce's *pragmatism*). Within the cell wall, by contrast, any tension between the known and the unknown requires no sexual dimorphism to address it. Continuity appears to be contingent only on complicity and imitation-by-entanglement. Beyond the cell wall, we recognize a cellular ecosystem constrained by the physics and chemistry with which we are familiar. We may not understand how all this works, but at least we are familiar with the competing narratives that have evolved to try to interpret it. We might *think* we know, but we don't… the false illusion of a little bit of knowledge is dangerous. But within the cell wall, if we are paying close attention to the implications, none of our familiar narratives resonate at all. There is no Newtonian physics, nor infotech IT, nor math, nor chemistry that can rise to the challenge. Perhaps the principles of quantum mechanics will provide the key to understanding what is taking place within the cellular domain. Is it entanglement that enables molecules to "know" the rules of proper conduct… the rules that enable them to execute the functions upon which life depends?

It seems inconceivable that our friend the motor protein, persisting across time with very specific duties, is the product of natural selection. How can he possibly "know" what duties are expected of him? Entanglement with other motor proteins exactly like him would be more logical than that suggested in the current dominant narrative. Of course this does not explain *everything*, for it raises the question… how can matter matter to matter? Indeed, it raises more questions than it answers, but surely that is preferable to assuming wrong answers. For those open to considering a religious or spiritual context, it opens up new possibilities to explore, to account for a universe now estimated to number of the order of 2 trillion galaxies. And perhaps it is the same dumb dirt, with the same specific, life-crucial properties that exist on earth, that exists throughout those 2 trillion galaxies. The more we know, surely, the more we realize that we don't know.

**To summarize**

In summary, there appears to be two domains in which semiotic principles play out:

- There is the Peircean-biosemiotic domain. *Jakob von Uexküll* and *Thomas Sebeok* are two notable pioneers of the biosemiotic paradigm. The synthesis of biosemiotics with the semiotics of C.S. Peirce thus describes the domain where pragmatism, mind-body predispositions and Peirce's three categories are important parts of the narrative. The Peircean-biosemiotic domain is one that applies to any living entity that makes choices from its ecosystem;

- There is the intra-cellular domain where the principles of quantum mechanics play a dominant role. In this domain, something resembling mind-body predispositions and the three categories also seems to be in evidence, but the matter of pragmatism takes on a very different form. The intra-cellular domain would appear to be more automated, and we are reminded of Peirce's reference to matter as being *mind hide-bound by habit*. Accordingly, references to pragmatism become problematic when trying to define how these molecules can define their "experiences" to matter. The astonishing complexity within a cell cannot persist across time without the very specific properties of these molecules. The question is, what role does quantum mechanics play in informing them *how to be*... how to define the things that matter? How can anything "matter" to matter, so as to account for the properties of atoms and molecules... the properties without which life would not be possible?

**DNA entanglement and consciousness**

Solid evidence in support of the relationship between DNA entanglement and consciousness is, at this point in time, thin on the ground, given that the topic of DNA entanglement has not consolidated any solid presence in the cultural narrative. Nonetheless, circumstancial evidence does exist. And in light of what has been discussed in preceding pages, with respect to coherence in large molecules, much of it is compelling.

**Non-local correlations between neural networks**

In their experiment testing for the possibility of non-local correlations between separated neural networks, Pizzi et al (2004)[24] conclude that "after an initial stage where the system interacts by direct contact, also in the following stage where the system has been separated into two sections, a sort of correlation persists between sections. This is what, at a macroscopic level, we verify in our experiment: it seems that neurons utilize the quantum information to synchronize." Given what we know of entanglement between particles and molecules, the only way in which correlations between separated neural networks might conceivably occur is via the DNA molecules within the neurons.

**Non-local correlations and cells isolated from the body**

When I first heard of Cleve Backster a couple of decades ago, he suggested an experimental approach analogous to that of Pizzi et al (2004)[25]. In one his earliest experiments, he removed some cells from a female subject, and connected them to his EEG equipment. As she was walking around outside, the graphical plot on his EEG correlated with her experiences outside. More recently, a video clip on Backster's work, Cleve Backster - Primary Perception (Greentechnique, 2011)[26], describes the same kind of experiment, beginning at 5:44, where a subject's emotional responses coincided with EEG readings. Within the context of our discussion, it would seem that there can only be one mechanism that might elicit this kind of reaction... *DNA entanglement*. Unfortunately there are grounds to be skeptical of Backster's experiments, especially when he ventures into the topic of plants having feelings, and his experiments involving eggs and yoghurt. And others who have tried to replicate his results have failed. Given his more controversial experiments and their absence of guiding principles (axiomatic framework), it is tempting to dismiss Backster altogether some kind of New Age charlatan. Was Backster a fraud? Or was he simply a "true believer" who was too keen to interpret spurious results as evidence that supported his agenda? Given the eccentric emphasis of his other experiments, we can anticipate skeptical reporting on the one set of experiments that do suggest a theoretical direction and that do deserve a closer look. We need to keep an open but skeptical mind. *DNA entanglement* is a sensible, logical inference, given the absence of anything that might "process" the DNA data. Backster's biopsy-human experiments (testing a culture of biopsied cells for responses to the experiences of the host subject) are worth having a closer look at... this kind of experiment is not costly, and could provide further compelling evidence to suggest *DNA entanglement*.

**DNA's predisposition to completeness**

Within the context of the established genocentric narrative, it is difficult to envisage how a lifeless DNA molecule, with all its complexity, can persist, given the forces of entropy that are arrayed against it. But what if there is something about the DNA molecule that "motivates" it to completeness... an ability to heal itself? Baldwin et al (2008)[27] report on their experiment which shows that intact, double-stranded DNA is able to recognize similarities in other DNA strands from a distance, without physical contact. They conclude:

> ... regardless of the underlying mechanism, the segregation of identical DNAs in highly hydrated cholesteric spherulites provides evidence for homology recognition between intact double helices through physical forces as an intrinsic property of DNA. It is notable that some recognition of unknown origin and pairing between homologous double helices has been proposed as a necessary step preceding double strand breaks in homologous DNA recombination within cells.

While the authors conjecture conventional (non-quantum) physics to try to explain this remarkable phenomenon, they provide no evidence for their conjecture. At this point in time the observation stands on its own, and the question remains... is there something about a DNA molecule that "motivates" it to repair itself? Another conjecture that has occurred in discussions on this topic is that the DNA itself might be alive, in the same sense that a virus is alive.

**Neural plasticity inconsistent with genocentrism**

The established genocentric narrative is responsible for inconsistencies that continue to baffle researchers, who continue to be persuaded by its mechanistic assumptions. For example, many continue to look for the genetic correlates that explain the correlation between what hand a person predominantly uses and the cerebral hemisphere he favors to process language. Writing for The Scientist Magazine, Grant (2015)[28] reports on a paper by Somers et al (2015). He introduces the nature of this dilemma that is keeping researchers busy:

> For decades, psychologists and biologists have puzzled over the physiological roots of two human traits—handedness and the asymmetrical nature of language in the brain. A peculiar behavioral distribution has spurred them on: the world over, 95 percent of right-handed people do the bulk of language processing in the left hemisphere of their cerebral cortex, while only 75 percent of left-handers show the same pattern. (The other 5 percent of right-handers and 25 percent of left-handers display what is called "atypical lateralization," meaning their language processing happens bilaterally or mostly in their right hemispheres.)

Somers et al (2015)[29] studied the genetic makeup of 355 people from 37 large families that comprised generations of lefties, performing genetic linkage analyses of left-handedness, atypical lateralization, and degree of language lateralization in the brain. They conclude that there was no genetic overlap, and that the idea of a shared gene is wrong. The evidence strongly suggests that monogenic theories of handedness or language lateralization are incorrect. Quoting Sebastian Ocklenburg, a neuroscientist at Ruhr University Bochum who was not involved with the study, Grant notes:

> ... the results hammer a nail in the coffin of both the monogenic theory and the idea that the observed relationship between handedness and language lateralization involves genetic overlap. 'It's the first study that shows that the genetic factors that are influencing these traits are not overlapping,' he says. 'This study more or less showed that this kind of theory, which is based on distributions of behaviors, is basically wrong on a number of levels.'

None of this should come as any surprise to those of us working in biosemiotics, particularly within the context of plasticity. Indeed, it provides us with further evidence to substantiate the suggestion that there is no DNA blueprint to account for the functional specializations of the brain. Instead, a better appreciation of neural plasticity is called for.

**Neural plasticity works with DNA entanglement**

Thus far, we've gone some considerable way to addressing the inconsistencies of the genocentric paradigm, with the realities of how life actually works. Let us now take a closer look at why this paradigm is especially problematic when it comes to understanding neural plasticity, and the role of experience in wiring the brain. The notion that the functional specializations of the brain are defined in the genetic blueprint, and that the brain is thus locked into a predetermined developmental trajectory, is an unrealistic model that fails to recognize the dynamic nature of neural plasticity. In reality, there is nothing that *determines* how the brain is wired, and nothing that *determines* the behavior of individual neurons or any other individual cell. This is why incorporating DNA entanglement into our narrative provides a route to a more compelling and satisfying alternative.

Every entity is its own autopoietic agent, autonomously establishing the things that matter in its own right… this relates to Peirce's pragmatism, and how an entity (holon, such as a cell or any other creature) defines the things that matter. In this context, it helps to think in terms of *predispositions* instead of causes… hence the predispositions provided by hands, legs and larynx in humans, or wings, beak and feathers in birds, versus the predispositions provided by synapses, axons and dendrites in neurons. Consistent with autopoiesis, systems theory and the recently introduced topic to biosemiotics of *scaffolding*, the brain is more realistically portrayed as a colony of autonomous agents, much like a city comprised of people, or a hive comprised of bees. As is suggested in the title of McDonald's (2015)[30] paper, Biologists Discover Bacteria Communicate Like Neurons in the Brain. But we extend this metaphor further, to infer that DNA entanglement provides individual cells in a brain (and body) with immediate access to the knowledge of the collective whole. And this is analogous to how telecommunications technologies provide people in a city with immediate access to the knowledge of the collective whole that is the city (or country, or globalised world).

Clinical and laboratory evidence is increasingly coming to light that is consistent with this interpretation, and neural plasticity needs to be taken much more seriously than the currently established narrative allows. For example, with reference to a case documented in Lancet by Feuillet et al (2007), New Scientist and Reuters (2007) describe a man with severe hydrocephalus (water on the brain) who is able to function normally, despite massive ventricular enlargement resulting in a 50 to 75% reduction in brain volume. He is a married father of two children who works as a civil servant. While his IQ at 75 is considered below average, he is not mentally impaired or disabled (this story is also available online (Goldhill, 2016)[31]). How can a man can continue to function normally, despite such massive ventricular enlargement with more than 50% of his brain displaced, leaving just a thin perimeter of actual brain tissue compacted against the inside of his skull? The existing paradigm, with its mechanistic narrative assuming cause-and-effect, is ill-equipped to rise to the challenge. In order to understand what is going on, we need to properly factor in neural plasticity.

Neural plasticity relates to autopoiesis and self-organization. Instead of being confined to a developmental trajectory that is spelled out in a genetic blueprint, the functional specializations in the brain are the products of self-organization. It's just what all living entities do. The infotech narrative cannot explain functional specializations in the brain. There is no need for centralized instructions authorized from above, to detail the functional plan… that is not how living systems work, whether in nature or in politics (the centralized economies under Stalinist communism were epic failures). Entropy will never allow it. The self-organization of neurons into functional specializations is no different to how any colony of social organisms self-organizes in response to pressures from the ecosystem. If water on the brain makes regions of the brain uninhabitable, then neurons will set themselves up in regions that are habitable. It is thus more realistic to think of a skull containing a brain as more like a bucket of bugs (BOB) or a hive of bees than a computer housing CPUs and circuit-boards.

**Broader implications of brain as bucket of bugs**

In dispensing with the assumption that the functional specializations in the brain are determined in the DNA blueprint, we can better appreciate the implications of neural plasticity and its relationship to experience. This has implications for many aspects of behavior, from "reflexes" that we assume to be "instinct" to gender roles and explaining the different psychologies of men and women. Even the beating of the heart can be understood from this perspective (like when foetal neurons begin to experience heart-muscle demands in the womb, for example, to set the development of the medulla oblongata). By taking this approach, we establish different assumptions that provide a very different interpretation of space and time to that provided by the established paradigms. We learn what space is by making choices from it. This begins in the womb and in infancy, when we reach and grope with our hands. The learning proceeds as we crawl through space on hands and feet as toddlers, and on to when we first begin to walk. And it proceeds into adulthood as we experience space in all sorts of activities, from our sports to our transportation technologies. Snails, ants, earthworms, whales and birds, with very different mind-bodies, acquire very different interpretations of what space is. This is because their bucket of bugs encounters very different wiring patterns, by virtue of very different bodies intercepting very different experiences. Neural plasticity 1:001. The essential point is that *everything* that we and every other organism can know about space and time is contingent on the experiences that wire our brains. I outline the basics of this approach in my (2013)[32] paper, Pragmatism, Neural Plasticity and Mind-Body Unity.

So what then is space? What is time? If we run with our Peircean-biosemiotic interpretation, then we have to revisit our assumptions. And when we factor in quantum mechanics, nonlocality and their relationship with probabilities, then the notion of time as a dimension of space-time becomes even more problematic. What is time? The progression of events that wires the brain is experienced as a passage of time… hence the relevance of body size, form and metabolism to how the passage of time is experienced… hence their impact on the functional specializations that get wired into the brain. Clearly, further discussion is beyond the purpose of this chapter. But do we see where we are going with this? What we are addressing here is a paradigm that opens up a whole new can of worms, new possibilities that cannot be imagined from the current mainstream narrative. It is therefore imperative that we properly address the physics of Mind and ask appropriate questions, instead of persisting with a broken narrative whose retirement is long overdue.

## Conclusion

The genocentric paradigm that currently dominates mainstream biology is expressed in a mechanistic, infotech narrative that presents DNA as somehow analogous to data… and that there is a technology implied, but not identified, to process it. Such a narrative that entertains the presence of data but no evidence of any mechanism to process it suggests the taking of liberties that urgently needs to be addressed. The Peircean-biosemiotic paradigm, by contrast, provides a compelling alternative to the infotech narrative. However, it too must eventually butt up against the hard reality of chemistry and physics, with a currently less than optimum explanation for semiosis at the cellular level. Even in our most nuanced narratives, we haven't quite shed the influences of realism. However, by factoring the question of *DNA entanglement* into the biosemiotic narrative, we provide the opportunity to free ourselves of the yoke of genetic determinism. There is sound reason for suggesting that even a stem cell has to *know how to be*, so that it can become a differentiated cell that is useful to the body within which it resides. Taking this approach, we have a narrative that is consistent with natural, semiotic principles right down to the cellular and molecular levels. In conclusion, there are compelling reasons to take *DNA entanglement* seriously, particularly within the context of the semiotic paradigm. And further work in that direction might go some considerable way to resolving the disparate paradoxes that currently show little sign of paradigmatic unity or consistency.

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