



THE DNA MOLECULE IS AUTOPOIETIC, DYNAMIC, EVOLVING, AND A FORM OF CONSCIOUSNESS

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The purpose of this paper is to investigate a potential source for the emergence of neurological (neuron-based) forms of consciousness and to justify the theory of DNA consciousness as a legitimate form or degree of consciousness. This will be done by a comparative analysis of the criteria of some of the elements of consciousness i.e. being autopoietic, dynamic, and evolving; as proposed and maintained by thinkers in the field of consciousness (e.g. Allen Comb and Humberto Maturana). The results that were found were that the DNA molecule like neuron-based consciousness is also autopoietic, dynamic, and evolving, which are all validated by this molecule's behaviors and objective activities. Consequently, the main conclusion that is derived in this work is that if the DNA molecule is autopoietic, dynamic, and evolving, which is supported by modern molecular genetics; then the proposal of DNA consciousness is implicitly a legitimate form of consciousness.

Keywords: DNA consciousness, selected genetic destination, autopoiesis, interaction-based model of consciousness, interaction-complexity-consciousness ICC.

1.0 INTRODUCTION: DEFINING CONSCIOUSNESS

Consciousness still wears a mysterious cloak. Experts in all fields struggle to agree on a unified definition of consciousness. In fact, the problem is not finding a definition but rather it is that there are too many definitions and consciousness is now defined in a multidisciplinary fashion (Grandy 2006a). The emergence of these many equivocal definitions of consciousness and how they can be problematic when attempting to define consciousness was mentioned by Chris Nunn in his *Editor's Introduction: Defining Consciousness* (Nunn 2009). In his brief summary he points out that some of the definitions of consciousness are only subtly different from each other and that others are mutually incompatible with each other. One thing is certain about the definition of consciousness i.e. it means many things to many different scholars and researchers and that is the main problem.

Has this multidisciplinary phenomenon and multiple interpretations of consciousness materialized because consciousness is more than just one thing? Is consciousness many different things? Perhaps there are more facets of consciousness that we are simply unable to comprehend at our current neurological state of evolution or humankind may be unable to evaluate with our current technology. The first part of this is conceivable because the human brain only perceives a limited amount of the electromagnetic spectrum. As far as our technological advancement, again there is much in the world and the universe that we do not understand e.g. quantum

entanglement. The obvious fact that humankind is missing or lacking pieces of the *consciousness puzzle* has also been pointed out by Piero Scaruffi in his book *The Nature of Consciousness* (Scaruffi 2006).

At this point it is very clear that there are several unresolved issues regarding consciousness. Is it based solely on neurologic circuitry? Does it involve quantum physics? Are there other forms or degrees of consciousness?

In this article I will:

- 1) Briefly discuss current problems in defining what consciousness is. I will mainly focus on reductionism (or neurological reductionism) and the involvement of quantum physics in consciousness. In summary of this section I will propose how the theory of DNA consciousness may solve some (but not all) of these problems in understanding consciousness.
- 2) Discuss and explain in detail the theory of DNA consciousness and provide the history of the theory's development since its conception in 2004. Then I will briefly explain how I intend on defending the theory of DNA consciousness as a legitimate theory of consciousness.
- 3) I will provide objective reasoning to support that the DNA molecule is an autopoietic system. This reasoning will be fortified by current discoveries in molecular biology and genetics.
- 4) I will briefly discuss dynamic systems and evolution. In this section I will justify that the DNA molecule is a dynamic system and that its direct involvement in evolution is what gives rise to neurological consciousness.
- 5) By defending DNA consciousness as a legitimate form of consciousness I will then go on to propose that the DNA molecule (and thus DNA consciousness) can serve as an intermediate between quantum consciousness and neuron-based consciousness.

1.1 Neurological Reductionism

Many neuroscientists believe that consciousness is purely a function of the brain and neurons. This is known as *reductionism*. I think that we cannot yet completely defend the notion that consciousness is only an epiphenomenon of neurobiology because there is too much that is not fully understood even though neuroscientists do understand a great deal about the brain and its parts. This is not to imply that I support dualism, which may appear as a contradiction but I will defend my position in other parts of this paper. At this point in time neuroscientists know a great deal about neurons, neurotransmitters, and how the brain works. However, new developments continue to be discovered that contradict what neuroscientists once maintained to be true. I will briefly mention three current examples.

The first example is the recent discovery that white matter synapses in the brain exhibit vesicular neurotransmitter release (Alix and Domingues 2011). Until recently it was assumed that only gray matter in the central nervous system utilized vesicular neurotransmitter release. It is now known that synaptic-style release of glutamate (a major excitatory neurotransmitter) occurs in deep white matter. This may have implications in diseases such as multiple sclerosis, Alzheimer disease, Huntington disease, schizophrenia, and stroke/ischemia-related conditions.

The second example that I will use to illustrate that neuroscientist do not fully understand all of the dynamics of the brain is the new understandings of endogenous electrical fields generated by the brain. Historically neuroscientists have maintained that electrical fields generated by the brain are merely epiphenomena of structured neuronal network activity. Recently, it has been shown that externally applied electric fields can modulate pharmacologically evoked network activity and may be able to guide neocortical network activity (Frohlich and McCormick 2010). This means that not only does the brain's activity generate an electric field but externally applied electrical fields can affect the physiology of the brain's activity. This technology is also used in therapies that use deep brain stimulation to treat conditions e.g. refractory hypertension (Patel et al 2011).

The third example involves new findings in the pathophysiology of Alzheimer disease. Beta-amyloid protein (A β) has long been regarded as the menacing culprit that causes Alzheimer disease primarily because it is found in high amounts (in postmortem analysis) in the brain tissue of patients who suffered from this disease. For decades the accumulation of A β has been considered a catabolic byproduct that lacks any meaningful role. However, recent research has proven that A β is a normal byproduct of cellular metabolism (Grandy 2011b). Furthermore, a new and perplexing discovery has been made about A β , and that is that it also has characteristics of an antimicrobial peptide (Soscia et al. 2010). So how does it fight infection in the brain, but also cause Alzheimer's disease? Once again, neuroscientists do not completely understand everything about the brain and its parts.

These three examples illustrate that even though neuroscientists know a great deal about the human brain that there is still much we do not understand. Therefore, if we do not know everything there is to know about the brain then we cannot support that neurological reductionism is the only explanation of consciousness. In addition, I have already suggested in other papers that there are other degrees of consciousness and that human consciousness is at the high end of neuron-based consciousness and that other degrees of consciousness exist down to the level of quarks, also known by some as *primordial consciousness*, but the human brain is unable to perceive these other degrees of consciousness.

The terms neurological or neuron-based consciousness describe the type or degree of consciousness experienced by organisms that utilize neurons to interact with the external environment. I will later explain in section 2.1 that this concept of interactions is central to all degrees of consciousness. Every animal's nervous system varies from species to species, from the lowest invertebrate to the highest vertebrate. Consequently, each state of each species' degree of consciousness would vary in degree that is based on that particular nervous system and genetic propensity. More specifically, each individual nervous system's development in complexity (or simplicity) is directly dependent on what is contained and expressed by the inherent genome. This correlation on *genome-dependent complexity*¹ will also be discussed in section 2 of this paper.

I have discussed some of the problems presented with reductionism, new evidence that contradicts supporting such a model, and briefly mentioned DNA consciousness, which will provide some solutions to the neurologic reductionism theory. Next I will address the involvement of quantum physics in consciousness.

¹ This is a phrase that I will use to illustrate the direct relationship between the genetic content and what genes are expressed, which both ultimately affect degrees of complexity.

1.2 Quantum Physics and Consciousness

It has also been proposed that consciousness is a process of quantum physics or at the very least some how quantum physics is involved. There are a few models that have been proposed such as the quantum mind theory currently known as the Hameroff-Penrose orchestrated reduction (Hameroff and Penrose 1996). Another proposal is the process model of the physics of consciousness as proposed by Wolfgang Baer (Baer 2010). However, there are certain limitations to these models and proposals, mostly because a testable system and general consent is lacking (Grandy 2009a). Let us take a very brief look at the history of quantum physics and its involvement in consciousness.

Sir Roger Penrose proposed the quantum mind theory (Penrose 1989). His original proposal was that classic physics (or the laws of Sir Isaac Newton) were inadequate to fully explain the phenomenon of consciousness and that quantum physics must be implemented (Grandy 2009a). Although this concept was fascinating at the time it was conceptualize it still met considerable criticism. In all likelihood, some of this criticism was secondary to the intimidation inspired by attempting to understand quantum physics. Currently Penrose maintains that consciousness should be considered a manifestation of quantum cytoskeletal states in the neurons and the interplay between quantum and classical levels of activity.

There are two main reasons the quantum mind theory was criticized. First, it is argued that in order for useful functioning of neurons in the brain to occur, they would need to attain a spatial or temporal scale (i.e. lasting for at least a limited amount of time in a definite physical space). Opponents claim that this would not be possible because the possible quantum states of the brain would decohere² prior to that spatial or temporal scale being attained. There is no empirical evidence to support these statements and are consequentially anecdotal. According to these unjustified notions quantum effects e.g. superposition and entanglement, would be insignificant in the process of consciousness.

A second reason that quantum mind theory meets criticism is because the current technology may not be adequate to provide scientific proof, primarily because unanimously accepted testable models do not exist (Grandy 2009a). Consequently, we are left with a handful of interpretations of quantum theory and speculations of consciousness models.

A possible solution to these two criticisms of quantum mind theory may have been addressed when Penrose collaborated with Stuart Hameroff to propose the Orch OR (orchestrated objective reduction) model of consciousness. This model proposes that quantum computations occur in microtubules in the cytoplasm of neurons, which takes place in the gap junction-linked dendrites (Hameroff and Penrose 1996). This proposal attributes consciousness to a sequence of discrete conscious moments wherein each moment is a quantum computation that is terminated by an objective threshold for quantum state reduction. In this quantum computation within the dendritic microtubules it is proposed to be orchestrated by synaptic inputs and axonal firing. This is a neurocomputational proposal and provides a testable model of quantum phenomenon during the process of neurological consciousness. However, there is some criticism to this model as well. Danko Dimchev Georgiev illustrated 24 possible problems in his 2006 *Falsification of Hameroff-Penrose Orch OR Model of Consciousness and*

² Quantum decoherence is defined as the process that gives the appearance of wave function collapse. This is where a system in a state of superposition is reduced to a single possibility. This occurs when the system interacts with its environment (or an observer) in a manner that is thermodynamically irreversible.

*Novel Avenues for Development of Quantum Mind Theory*³. The evaluation of these 24 purported problems with the Orch OR model is beyond the scope of this paper.

The Orch OR model, which is to some degree a testable model, is a good attempt at supporting quantum mind theory. It has met some opposition and flaws have been pointed out. However, this is at the very least a good starting point and gives investigators a step in the right direction toward exploring a neurocomputational model. In section 2.1.1 of this paper I propose how the Orch OR model fits into the concept of interaction-complexity-consciousness. As of now, no other objectively testable models exist. Next, I will briefly discuss an early application of quantum physics equations to the process of consciousness.

Evan Harris Walker (1935-2006) was among the first pioneers to merge quantum physics equations and consciousness. He proposed that information is measured in the neurons by what he termed *consciousness* and *will channel* capacities, which function in terms of a closed loop system. Walker further stated that when this information is measured it coerces on a real solution when one probable state occurs and all other possible states collapse i.e. it undergoes decoherence. He demonstrated this by adding $\log_2 P$ to Schrodinger's equation⁴, which is $E\Psi = \hat{H}\Psi$ (Walker 2000). This was an attempt to address the central axiom that observation causes the collapse of probability wave function, known as the *measurement problem* or the *quantum enigma*⁵, which brings consciousness directly into quantum theory, thus the application of quantum operators instead of classic dynamic variables.

Walker based his early theory of consciousness on what he terms quantum mechanical electron tunneling effects that take place within the synaptic cleft (Walker 1998). This is where electrons jump or *tunnel* from the pre-synapse over the distance of the synaptic cleft (180Å found in CNS synapses and 150Å in ephapses or electrical synapses) to the post-synapse of the next neuron. This produces a quantum or “virtual” nervous system overlaying the “real” nervous system. The later is proposed to obey classical laws of physics that most neuroscientist are comfortable with. Walker does point out in his 1998 article in the section entitled *Quantum Mechanical Interconnection of Synaptic Functioning*, that quantum electron tunneling does not provide us with a complete theory of consciousness, but it serves as a first step.

Since Walker, there have been many more proposals of quantum physics equations and their connection to consciousness. However, very few of these proposals connect consciousness as a process, as a fundamental entity, or to a tangible process reality; nor do they connect the interaction between the mental and material reference frame. In addition, none of the modern proposals observe or discuss their limitations in explaining consciousness. Some of these problems were addressed in recent work by Wolfgang Baer. His proposal of a process model of consciousness incorporates new developments within the architecture of quantum mind theory and attempts to define the mathematical relation between the mental and material reference frame (Baer 2010). His model is a modification of the Von Neumann processes⁶. However,

³ This is published on <http://philsci-archive.pitt.edu/archive/00003049/> for more detail on the purported 24 problems with the Orch OR model.

⁴ This is one of two forms of Schrodinger's equation, which is used to describe how the quantum states of a physical system change in relation to time. Keep in mind that the Schrodinger equation does not give one deterministic solution but rather it gives a collection of possibilities.

⁵ This is a term conceived by Rosenblum and Kuttner (2006), whom propose that this is where physics encounters consciousness. It is noteworthy to mention that their book *The Quantum Enigma* will be updated with a second edition in mid to later 2011.

⁶ For more details on the Von Neumann process model of consciousness please consult *Mathematical Foundations of Quantum Mechanics* (1955).

Baer's model does not clarify how and what is being calculated with the equations that he inserted in these processes.

Finally, many of the opponents of quantum physics involvement in consciousness believe that the neurophysiology of the brain is too wet and noisy for any quantum effects to be appreciated. Some cognitive scientists and psychologist e.g. Bruce Bridgeman insist that the scale and temperature of biological systems preclude any significant role of quantum physics. This is supposedly maintained by some physicists (e.g. Michael Nauenberg).⁷ However, as previously mentioned, Evans Harris Walker has proven that there are quantum effects that can be accounted for in between the synapses of the neurons and provided calculations which have stood up to scientific scrutiny. This makes it even more perplexing that modern thinkers in the arena of consciousness would abandon the weapon of quantum physics. As I mentioned earlier, the science of quantum physics can be intimidating; so intimidating that some are willing to brandish 19th Century concepts of the physical sciences in order to escape having to confront it and its involvement in consciousness.

1.3 Summing it all up: What Does Neurobiology and Quantum Physics have to do with DNA Consciousness?

So which best explains consciousness- neurobiology, quantum physics, or do both play a part in it? If consciousness cannot be objectively proven to be purely a product of the brain and neurons then it is imperative that we investigate deeper. However, the more neuroscientists learn about the brain, the smaller the pieces become wandering toward the quantum realm.

If quantum effects are involved in neurological consciousness then this needs to be evaluated and not disregarded with nineteenth century concepts of the physical sciences. We can likely agree that a large portion of what we call consciousness is in fact based on neurons and their actions, and that there may be other factors involved that we do not yet understand or can not objectively study with our current technology. That is to say there is some involvement of quantum phenomena. If neurobiology and quantum physics are both involved, which seems to be the most likely answer, then where do they connect? Later in this paper I will provide reasoning to support that the DNA molecule may serve as an intermediate between quantum forces (or quantum consciousness) and neuron-based consciousness.

At this juncture it is prudent to focus on what is known. What gives rise to neurons and the brain? The answer is DNA. How does DNA do this? Does the DNA molecule have a form of consciousness of its own in order to carry this out? To answer this we must attempt to objectify the theory of DNA consciousness which is the main goal of this paper.

Another one of the unexplained facets of consciousness that will be addressed here that has been surfacing more and more lately is the burning question of how humankind's consciousness emerged. Did humankind's consciousness evolve? What did it evolve from? Well known neurobiologist and Nobel laureate Gerald Edelman maintains that the human brain did evolve and that consequently consciousness evolved from a primary form up to a higher order consciousness (Edelman 1993)⁸. This is an evolutionary approach to explaining the emergence

⁷ The opinions of Bridgeman and Nauenberg are based on an email correspondence between Bridgeman and myself. This was in regards to the usefulness and limitations of quantum physics in explaining consciousness on October 20, 2010.

⁸ Edelman's model maintains that humankind has higher order consciousness, which is conscious of being conscious, and this interacts with a primary consciousness. The primary consciousness is fundamental form of

of consciousness. If we are to take an evolutionary approach to the evolution or emergence of neurological consciousness then again we must make our first stop at the DNA molecule, because DNA underlies the evolution of all traits, characteristics, and physical attributes of all species. This would therefore include consciousness and all of the neurobiological processes involved. This is how understanding DNA consciousness will accomplish resolving some of the problems of consciousness.

In order to establish if DNA possesses a form or degree of consciousness we need to establish what are some of the elements of consciousness as a process? It must then be determined if the DNA molecule possesses some or all of these elements. In doing this it can be established that there is some common ground and use it to accept or reject the theory of DNA consciousness. However, before doing this allow me to begin by defining what the theory of DNA consciousness is.

2.0 THE HISTORY AND THEORY OF DNA CONSCIOUSNESS

The theory of DNA consciousness originally began as a statement that the DNA molecule is a special form of molecular consciousness with a will of its own. I had first proposed this theory in 2004 after rereading Ernst Haeckel's chapter on *Consciousness* in his book *The Riddle of the Universe*. In that chapter he enumerated the different views of consciousness of his time. It was his explanation of atomistic consciousness (which he provided no approbation for) that made me think of the many atoms forming many molecules and ultimately forming a large functional macromolecule of DNA. This special molecule would then utilize nucleic information to provide the building blocks to produce cells, then more specialized cells- neurons, and ultimately the brain. It was at this point that the dynamic evolution of consciousness as a process became apparent, and like the theory of organic evolution everything boils down to the DNA molecule.

This dynamic view of energy driven evolution is similar to the view proposed by Allan Combs (Combs and Goerner 1998), in that he proposes consciousness as an organic, self-generating, and autopoietic system that is continuously in the act of creating and recreating itself moment by moment. However, Combs never speculated on the genetics underlying the process of consciousness. In fact, he never mentions the DNA molecule, but his proposals enforce a dynamic view of consciousness based on energy and matter within the confines of evolution.

The phrase *DNA consciousness* was first published simultaneously in two separate entries in *The Encyclopedia of Anthropology* (Grandy 2006a; Grandy 2006b). In the entry entitled *Consciousness*, DNA consciousness was then proposed to have been the force responsible for driving evolution, not just in terms of phenotype but also producing consciousness. At that time I had pointed out that there was a lack of experimental evidence and more theoretical architecture was necessary. In the entry entitled *DNA molecule* I had pointed out that the many biochemical activities of the DNA molecule appear to give it a life [force] of its own i.e. a form of consciousness. This would be expounded upon in later works.

In my entry on *Consciousness* in *The Encyclopedia of Time* (Grandy 2009a) I had made it clear that by surveying the history of our understanding of consciousness that one thing was very evident: that through out time we have continued to change our opinion of consciousness when new breakthroughs and new science emerges. Therefore, as mentioned previously we cannot claim to know everything about the neurobiology of consciousness and we have not been able to

consciousness that he proposes is a result of reentry between regions of the brain that carry out perceptual categorization and those regions mediating value-category memory.

rule out the involvement of quantum physics or explain its involvement, mostly because phenomenon like decoherence and entanglement still can not be fully explained. Consequently, the proposal of different forms or degrees of consciousness, including DNA consciousness cannot and should not be disregarded.

A more comprehensive synthesis of DNA consciousness was presented at the *International Conference on Humanism and Posthumanism 2009*, at Belgrade University, Serbia (Grandy 2011a)⁹. The 2009 synthesis of the theory of DNA consciousness proposed that the DNA molecule possesses a form of consciousness that is different than humankind's neurological consciousness, and it is also responsible for giving rise to the evolution and emergence of that neurological consciousness in addition to the consciousness of all nucleic life forms. The synthesis of DNA consciousness at that point (still 2009) had 5 main themes:

- I. DNA consciousness is a special form of molecular consciousness (and a special molecule for that matter) held together by quantum forces and interactions; notably between the hydrogen-bonds of the pairing nucleotides (A=T and C=G) and the 3'-5' phosphodiester bonds between the molecules of 2'-deoxyribose that comprise the backbone of the DNA molecule (Grandy 2009b). This special molecule is able to perform many special functions such as replication of itself, reliably passing on the inheritance of genetic traits, and symbiotic interactions with other nucleic life forms e.g. RNA (Grandy 2006c).
- II. DNA consciousness is a degree of consciousness that humans can not perceive. This is primarily because our sensory organs evolved in the macroscopic world and can only perceive a small portion of the total electromagnetic spectrum; consequently our neurological consciousness is time-dependent and only interprets a small fraction of the total picture. The atomic world and quantum interactions are not time-dependent and are too small for humans to actually *see*. Therefore, humankind does not possess the hardware to observe these atomistic and molecular forms of consciousness. In addition, the DNA molecule does not *think*, *see*, or *feel* as humans do because it does not possess a nervous system or sensory organs; thus no obvious *communication* can take place between humans and the DNA molecule.
- III. DNA consciousness has given rise to neuron-based consciousness. This is seen in the early phases of embryological development in all vertebrates when the Hox and Pax gene families¹⁰ establish body patterning, notochord formation, brain morphogenesis, and the progenitors of sensory organs like the eyes (Moore 2008; Van Auken 2000; Nolte 2006; Yan 2007). The phenomenon of DNA consciousness is also highlighted by the

⁹ Originally the proceedings of the International Conference on Humanism and Posthumanism 2009 at Belgrade University were projected to be published in 2010. However, the proceedings were published later, in 2011. Consequently, my article on *DNA Consciousness* was referenced in another article *Selected Genetic Destination: The Rise of Homo Sapiens Genomicus* (Grandy 2010b) in *The International Journal of Arts and Sciences* as coming out in 2010, but instead came out in 2011.

¹⁰ The Hox and Pax gene families are responsible for the initial control and segmentation of body patterning in all vertebrates. On the other hand invertebrates do not possess these genes. However, recent genetic studies on invertebrates suggest that some of these species may have similar genes or precursors to them but at this point there is much speculation.

occurrence of *colinearity*¹¹. Therefore, the DNA molecule must possess a form or degree of consciousness in order to orchestrate or give rise to neurological consciousness because it would be problematic to assume that this orchestration was merely a random act. It is also unlikely that neurological consciousness spontaneously emerged or evolved without an underlying biological mechanism to mold or transform it.

- IV. After the DNA molecule gives rise to the emergence of the brain and nervous system it then provides a continuum for neurological consciousness via genomic and epigenetic dynamics. It is implicit that neurological vertebrate consciousness (but not all forms of consciousness) is largely a process of neurons and their actions¹². This is assumed to be true because elements of consciousness do not take place without certain processes of the brain. However, actively underlying this neurophysiologic process are three dynamic actions of the DNA molecule: 1) its continuous interactions within the cells (metabolism), 2) its interactions with other cells (and other nucleic life forms) in the brain and body, and 3) its interaction with the environment outside the organism. Therefore, there are *three dynamic levels of DNA consciousness* that scientists have detected scientifically and can consequently be studied objectively. These dynamic levels are based on interactions that indicate intentionality¹³.
- V. DNA consciousness has evolved through life forms on this planet; becoming more complex along the way, up to *Homo sapiens sapiens* i.e. modern humans. At this point in evolution, DNA consciousness was finally able to give rise to a degree of vertebrate neurological consciousness in the macroscopic world that would develop the technological ability to unlock the secrets of the DNA molecule. That is to say, the DNA molecule discovered itself through the macroscopic vessel of humankind. Now the technology to alter genomes exists with the advent of genetic engineering and selected genetic destination (SGD)¹⁴. This process has been proposed to potentially give rise to a new subspecies *Homo sapiens genomicus*, which could evolve toward a higher degree of neurological consciousness or perhaps something beyond (Grandy 2010b).

These five major themes of the synthesis of DNA consciousness serve as a starting point toward eventually answering one of the “big questions”- where does consciousness come from? But

¹¹ Colinearity is the parallel between the physical position of Hox genes along the chromosome and the pattern of their expression, from anterior to posterior, in the developing embryo. However, some studies have shown that this distribution is not always collinear (Monteiro 2006). Colinearity is still a phenomenon worth mentioning because it shows a tendency towards the organization of complexity, which implies *intentionality*.

¹² Reductionists maintain that consciousness is purely a result of the function of neurons. As mentioned earlier we have not been able to rule out the involvement of quantum physics. However, there is an overwhelming amount of evidence at this point to support that neurons assume an important role in neurological consciousness, but are not themselves solely responsible.

¹³ By intentionality I am referring to the definition used in the concept of energy driven evolution i.e. intentionality is the movement toward energy [concentrations] that are needed to sustain life (Combs and Goerner 1998).

¹⁴ Selected Genetic Destination (SGD) is having control over the evolution of a species, including humans, with genetic engineering (Grandy 2010b). That is that a genetic destination is selected and then made possible with technological manipulation of the genome. Thus the concept of SGD was conceived in 2008 and published later in 2010.

before this proposal could go any further a new definition of consciousness would need to be attempted, which I will discuss next.

2.1 The Interaction-Based Model of Consciousness

In past articles I argued that the focus of consciousness has always been on human consciousness or what I consider a higher degree of vertebrate neurological consciousness. However, there is no all-encompassing definition of consciousness which allows the inclusion of other forms or degrees of consciousness. It became obvious during my synthesis of DNA consciousness that a novel definition needed to be derived that encompassed all degrees of consciousness; from the level of quarks up to the level of humans. So how should this phenomenal process be defined?

As I pointed out at the beginning of this paper there are already too many definitions of consciousness. Thus a superior definition would have to exclude words like *human*, *mind*, *brain*, *awareness*, or *perception*. This would allow gravitation toward the derivative of what consciousness actually *is*. After I had formulated the five major themes of DNA consciousness I purposed a new definition of consciousness, which I later called *the interaction-based model of consciousness*. This proposal states that: *consciousness is the interaction of a thing (be it an organism, DNA molecule, or atom) with the external environment and more specifically the interaction of energy with other forms of energy*. I would later modify this to- *the interaction of things (be it an organism, DNA molecule, or atom) with other things, the external environment, and more specifically the interaction of energy with other forms of energy*. This was done to account for what was actually being interacted with in the external environment i.e. other *things* and forms of energy, ergo the definition evolved in 2011 from the one proposed in 2009.

The interaction-based model of consciousness allows four specific advantages that no other definitions of consciousness currently can offer:

1. Transcendence of the limitations that the anthropistic¹⁵ and reductionist models impose. The limitations posed by reductionism have already been discussed in detail (in Section 1.1). There are some theories of consciousness that attempt to support the anthropistic theory of consciousness. Currently, anthropistic models of consciousness are typically considered outdated by most modern consciousness researchers. However, there are no adequate models to account for the possibility that all things have a degree of consciousness. This is exactly the problem that the interaction-based model of consciousness attempts to solve.
2. The eradication of any exclusion criteria as to what does or does not possess consciousness. This allows the graduation from forms of consciousness; anthropistic, neurologic, animal, biological, cellular, and atomistic, to degrees of consciousness, which up until this point I have occasionally used forms and degrees interchangeably. However, in the next section I will discuss the concept of interaction-complexity-consciousness that provides a strong argument that everything exists as degrees of consciousness.

¹⁵ The anthropistic theory of consciousness maintains that only humans possess consciousness, because only humans possess a soul, which is where this theory proposes that consciousness comes from. This is extremely similar to dualism and conversely dualism is a form of the anthropistic theory of consciousness, which I have discussed in previous works (Grandy 2009a; Grandy 2006a).

3. This interaction-based model allows consciousness to be viewed within the dynamic framework of evolution. In fact, the evolution of consciousness, as you will see, mirrors the dynamic process of evolution. This will be discussed in detail in section 2.1.1.
4. This definition allows the incorporation of quantum physics into the explanation of consciousness. As mentioned earlier, quantum physics involvement in consciousness creates many problematic issues. However, interaction (of an observer) with a system in superposition is the direct cause of decoherence. Therefore, this model may provide answers to the quantum enigma. In addition, this could potentially be compatible with the Penrose-Hammeroff Orch OR as this phenomenon occurs continuously with the interactions of neuron-based consciousness.

So I have derived a novel definition of consciousness that avoids many of the traps and pitfalls that other current definitions succumb to. I have also enumerated four important advantages that it provides. Next, I will discuss how the interaction-based model of consciousness transforms into the concept of interaction-complexity-consciousness.

2.1.1 Interaction-Complexity-Consciousness

The interaction-based model of consciousness was originally proposed in 2009 and then modified in 2011. In early May of 2011, I attended *The Science of Consciousness Conference: Brain, Mind, and Reality* at Stockholm University, Sweden at Aula Magna Hall. While preparing my poster presentation on DNA consciousness¹⁶ I was struggling to justify how the interaction based model of consciousness could account for a universally underlying consciousness from a scientific point of view. It was at this point that the interaction-based model of consciousness evolved into a physical process that can account for all degrees of consciousness from the level of quarks up to the level of humans. This process is now known as the concept of interaction-complexity-consciousness (ICC).

The concept of ICC states that- as *things* interact, these interactions increase the degree of complexity, and as these interactions increase the degree of complexity the consequence is that there is an increase in degrees of consciousness from the level of quarks up to the level of the human brain. Simply stated:

$$\uparrow \text{ interaction } \leftrightarrow \uparrow \text{ complexity } \leftrightarrow \uparrow \text{ degrees of consciousness}$$

This direct relationship can also be composed into a linear equation, where complexity acts as a mathematical operator that connects the relationship between degrees of interactions to degrees of consciousness:

$$\text{interaction (complexity) = degrees of consciousness}$$

Next, let us examine the real picture starting at one of the lowest levels that are known- quarks. Please note that I am not a quantum physicist so I will not go into the parts of quarks or string

¹⁶ Links to the abstract are provided: http://www.consciousness.arizona.edu/documents/CCS_2011_Program_pg2-13-1.pdf and http://sbs.arizona.edu/project/consciousness/report_poster_detail.php?abs=745 these can also be found on the Wikipedia article "DNA Consciousness".

theory. For the purpose of this illustration starting with quarks will suffice. Thus at the initial step quarks interact with each other to form subatomic particles, many consider this *primordial consciousness*. The subatomic particles then give rise to atoms. Now the atoms interact to form molecules that also interact with each other and start to become more complex. Note that at this level as the interactions increase that the levels of complexity increase, and as a result we see ascending degrees of consciousness from primordial consciousness to degrees of atomistic and molecular consciousness. These are all in accordance with the interaction-based model of consciousness.

At this point I would like to draw attention to the fact that something *special* happens when nucleotides emerge from the realm of molecular degrees of consciousness. As DNA and RNA species begin to interact complexity explodes! In fact, the ability of these molecules to self-assemble and reliably store a chemical record to produce protein products allows the exponential emergence of billions of life forms and consequently in degrees of consciousness. This is where DNA consciousness emerges and blossoms!

At this stage simple cells emerge and contain repertoires of DNA, which possess genes that define those cells. This will be discussed in greater detail in Section 3.0. Through natural selection and mutations these cells accumulate more genes. This allows them to increase the amount of interactions with the environment, thus increasing complexity and of course degrees of consciousness. It is also at this stage where a direct relationship to genome-dependent complexity is obvious.

As cells continue to specialize a second *special* thing happens when some cells develop electrochemical properties and eventually neurons emerge¹⁷. This gives rise to the earliest degrees of neuron-based consciousness seen in the invertebrates. Again, DNA consciousness plays an enormous role in the explosion of increases in new levels of interactions that are manifested in primordial sensory perception. This new level of interactions increases complexity and as a result increases degrees of consciousness.

Once invertebrates attain a certain degree of consciousness and a third *special* thing happens- the evolution of the Hox and Pax gene families. This is mentioned in the synthesis of DNA consciousness main theme III. At this point in evolution DNA develops novel genes that allow the centralization of the nervous system and cephalization (the appearance of a brain); thus the class of vertebrates is born. This birth ushers in a massive explosion of complexity and exponential increases in degrees of consciousness. It is from this process that human consciousness emerges. It should be clear now that it is ridiculous to assume that consciousness is a process that involves only the human brain! There are billions of degrees of consciousness antecedent to human consciousness.

It should be apparent at this point that not only does the ICC concept fit within the dynamic framework of evolution, but it goes hand-in-hand with it. The concept of ICC is seen from the beginning of primordial consciousness ascending up to the degree of human consciousness. I had also proposed that with genetic engineering that these degrees of consciousness can continue to ascend, which is mentioned in the next section as the fourth special thing that will happen in the ICC.

¹⁷ All cells intrinsically have electrochemical properties. However, neurons can conduct electrochemical signals over longer distances and that is what is so special about them.

2.2 DNA Consciousness and SGD- the forth *special* thing in the ICC

Up until this point I have enumerated three special things that happen in the ascending chain of ICC and proposed a fourth:

1. Nucleotides emerge and cause an explosion in complexity and degrees of consciousness by allowing exponentially larger amounts of interactions.
2. Eukaryotic cells develop the ability to conduct electrochemical signals over long distances, giving rise to early degrees of neuron-based consciousness. This is possible when cells developed genes that distinguish themselves as neurons. Two examples are the myelin gene regulatory factor- that is a transcriptional regulator required for CNS myelination (Emery et al 2009), and gene that produce proteins like synapsins- that are critical for neuron development (Fornasiero et al 2010).
3. The development of HOX and PAX gene families allow the emergence of vertebrates with cephalization and a centralized nervous system.
4. SGD- the ability to select a genetic destination and make this happen utilizing genetic engineering.

It is very important to note that all four of these special things that take place in the ICC involve DNA. This should also make a propelling case to substantiate the theory of DNA consciousness as it is involved in several key moments in the evolution of consciousness. Now that I have proposed that SGD is the forth *special* thing that will happen in the ascending chain of ICC, allow me to provide a quick background about SGD.

2.2.1 The History of SGD and how it applies to the future of DNA consciousness

In 2010, I included a small section on DNA consciousness at the end of my chapter on *DNA and Genetic Engineering* which was published in the two-volume reference handbook *21st Century Anthropology* (Grandy 2010a). Here I again propose that there could be the possibility of DNA consciousness, which would be very different from neurological consciousness. I also speculated how DNA was involved in the emergence of neurological consciousness and was based on the fact that gene clusters known as the *Hox* and *Pax* genes are responsible for giving rise to the basic plan of our nervous system and brain. If these gene families are responsible for giving rise to the machinery that is responsible for elements of neurological consciousness, then there should be a form of consciousness underlying those genes. More importantly I proposed that in the future genetic engineering may enable scientists to further explore how DNA is able to interact with itself, with other molecules and cells, and with the external environment which I have called the *three dynamic levels of DNA consciousness* (this was mentioned in the synthesis of DNA consciousness: main theme IV). More importantly genetic engineering may enable humankind to enhance consciousness. In addition, I had speculated how genetic engineering could be used to enhance human consciousness.

In a subsequent 2010 publication in the *International Journal of Arts and Sciences- Selected Genetic Destination: The Rise of Homo sapiens genomicus* I had addressed two important implications central to the evolution of DNA consciousness. The first was that with the advent of genetic engineering improvements could be made in humankind's degree of neurological

consciousness. This could be accomplished by creating aggressive human enhancements¹⁸ that would improve elements of neuron-based consciousness such as better memory, the ability to perceive more regions of the electromagnetic spectrum, increase neuron density, increase neuron interconnections, and enhance neuroplasticity. These types of aggressive human enhancements could give rise to a new subspecies *Homo sapiens genomicus* or ultimately a new species with a higher and superior degree of neurological consciousness.

The second important theme discussed was that perhaps DNA consciousness has a *will* of its own. If DNA consciousness is the driving force behind all biological evolution and the development of neurological consciousness then perhaps humankind was only meant to be transient. That is to say that DNA consciousness, through natural selection, gave rise to the emergence of *Homo sapiens sapiens* and higher degrees of neurological consciousness for the sole purpose of discovering the DNA molecule and unlocking its secrets and thus provide a new means of evolving DNA consciousness i.e. SGD to replace the much slower process of natural selection.

At this juncture I would like to point out that SGD will be the fourth special thing to take place in the ascending chain of ICC. In the previous publications I supported SGD as the next phase in human evolution, and in keeping consistency with the concept of ICC, I project that SGD will be the next special event that increases degrees of consciousness. Again, this fortifies the notion that evolution and consciousness are directly related and that relationship is substantiated by the concept of ICC.

I have so far reviewed the theory of DNA consciousness, discussed the history of its synthesis, and mentioned speculations from other works. In addition, I discussed the definition of *the interaction-based model of consciousness* and its transformation into the concept of ICC. Next, I will discuss how I plan to fortify the theory of DNA consciousness with comparative ideas about consciousness and modern molecular genetics.

2.3 How to Justify DNA Consciousness?

Thinkers in the field of consciousness evolution, like Allen Combs, propose and support that consciousness is an autopoietic, dynamic, and an evolving process that favors an increase in complexity (Combs and Krippner 2003). According to Combs and Krippner, these are important features for understanding long-term changes and transformations of human consciousness through the developmental cognitive model and this is consistent with a *process view of human consciousness*¹⁹. In another work, Allan Combs and Sally Goerner support consciousness as a self-organizing process (Combs and Goerner 1998). They base this idea on the phenomenon that there is an innate tendency of energy systems to evolve into more complex systems. These systems evolve to capture energy which they then use to organize more complex structures. But what underlies these processes? I have already proposed that at a certain point in the ICC it is

¹⁸ In the article *Selected Genetic Destination: The Rise of Homo sapiens genomicus* I made the distinction between passive human enhancements and aggressive human enhancements. Simply stated, passive human enhancements are genetic therapies to correct an underlying medical defect whereas aggressive human enhancements are genetic therapies aimed at enhancing certain attributes i.e. height or memory beyond the subjective median of [genetic] functioning. This was to defend the notion that any gene therapy is a form of enhancement established on the genetic baseline. For more information please consult the article.

¹⁹ The process model of consciousness is a form of *process ontology*, which is defined as a cycle of activity between two sides with mental experiences on one side and physical causes on the other (Atmanspacher and Prines 2006). In this particular type of model the *process* constitutes the most basic elements of reality, instead of *substances* like mind and matter.

DNA. If it is the DNA molecule (and therefore DNA consciousness), then the DNA molecule should share some of those same attributes as consciousness i.e. that the DNA molecule is autopoietic, dynamic, and an evolving self-organizing system and consequently a form or degree of consciousness.

For the remainder of this paper I shall continue to maintain that the DNA molecule, and thus DNA consciousness, is autopoietic, dynamic, and an evolving self-organizing system. Consequently, by association this implies that the DNA molecule possesses a form or degree of consciousness because it shares many attributes of neurological consciousness and displays intentionality. In many ways I have already proven DNA has a degree of consciousness with in the concept of ICC. However, because ICC is my own theory I must justify DNA consciousness within the confines of other theories and currently established science. In doing this we can establish a scientific and evidence based approach to determining whether or not DNA consciousness is a realistic model of consciousness.

In summary of this section, I have established a novel definition of consciousness- the interaction based model of consciousness that solves some, but not all, of the problems with defining consciousness. This definition transforms into the concept of ICC, which accounts for all degrees of consciousness from the level of quarks up to the level of humans. As previous explained, during this transformation three (and eventually four) special things take place that involve DNA or DNA consciousness. I have defined DNA consciousness and explained why it is significant to illustrate that the DNA molecule is autopoietic, dynamic, and evolving self-organizing system i.e. that it is indeed a degree of consciousness and shows intentionality. Next I will provide scientific evidence that this is true, beginning with an evaluation of autopoietic processes and establish whether or not the DNA molecule meets the established criteria.

3.0 AUTOPOIETIC PROCESSES

Autopoietic processes are defined as processes that are self-maintaining systems, which are organizations or organisms that produce and replace their own components. The term autopoiesis was introduced by Chilean biologists Humberto Maturana and Francisco Varela, which they originally presented as a systems description to define and explain the nature of living systems (Maturana and Varela 1972). Maturana crafted the word autopoiesis in order to convey what takes place in the dynamics of the autonomy proper to living systems. Currently, autopoiesis or an autopoietic process refers to the dynamic self-organization and self-contained biological systems. Even though Maturana would later developed the idea of autopoiesis to have applications in regards to the nature of reflexive feedback control in living systems he would eventually apply it to the phenomenon of cognition.

In modern biology, an autopoietic process distinguishes itself from its environment because it is a closed system with no apparent inputs or outputs. An example of autopoiesis is a cell or an organism. However, what allows cells and organisms to be autopoietic? I propose that they are autopoietic because the DNA molecule itself must be autopoietic and it is the derivative of all organic evolution on this planet. Let us evaluate the criteria of an autopoietic system in order to justify that the DNA molecule qualifies as an autopoietic entity. **Table 1** lists the six generally accepted criteria of an autopoietic system.

First and foremost, does the DNA molecule have identifiable boundaries that are self produced?

Yes. In eukaryotic cells the DNA molecule resides in a condensed form inside the nucleus, which consists of a nuclear matrix and a nuclear cortex (Grandy 2010a). The perimeter of the nucleus is called the nuclear envelope, which is composed of a phospholipid double membrane and possesses nuclear pores to selectively allow the passage of information such as RNA species and transcription factors, in and out of the nucleus. The outer membrane of the nucleus is continuous with the endoplasmic reticulum²⁰. The inner membrane of the nucleus on the other hand faces the nucleoplasm and binds to chromatin. Chromatin functions to help package DNA (along with histone proteins) into a condensed form, assist in mitosis and meiosis, controls gene expression, and controls replication (Grandy 2010a).

Table 1: The six criteria of an autopoietic system.

1. The system has identifiable boundaries which distinguished it from the environment.
2. These boundaries are self-produced.
3. The components of the boundaries are also self-produced.
4. The system is mechanistic and subject to cause and effect.
5. The system possesses constituent elements and components.
6. The constituent elements and components are also self-produced.

I would like to go into more detail in regards to the genetic molecular biology in order to substantiate the DNA molecule meeting the criteria of being an autopoietic system. The DNA molecule in eukaryotes does possess genes that are responsible for producing components of the nuclear membrane. Some of the genes currently identified e.g. *Pah1p* and *Smp2p* have been shown to regulate the nuclear membrane structure by controlling the phospholipid synthesis and biogenesis (Han 2008; O'Hara 2006).

The inner portion of the nucleus is also organized by self-produced components. This is known as the nuclear lamina, which is a fibrillar network composed of lamin proteins A and C. These proteins form the core scaffolding and line the inner surface of the nuclear envelope. Mutations in the LMN genes that produce the lamin proteins are associated with cardiac and skeletal myopathies (Mewborn 2010; Mounkes 2003).

Now that I have provided scientific evidence for eukaryotic cells having identified borders that are composed of self-produced components, I will now provide scientific evidence for prokaryotic cells. The cell membrane of prokaryotes is composed of peptidoglycan, which is different than the cell membrane and nuclear membrane in eukaryotes which are composed out of phospholipids. Several genes in the DNA of prokaryotes have been identified that are essential for peptidoglycan synthesis. Some of those genes that have been discovered are in an entire family of genes known as *Mur genes* and have several subtypes that are known as *MurA-MurG*. These genes have also been shown to be vital for cell division in some cellular organelles e.g. chloroplast (Machida 2006).

Based on the brief genetic and molecular biology studies mentioned above it is evident that these boundaries are self-produced and self-assembled. In eukaryotes the production of the components of the boundaries takes place mostly during mitosis in order to produce two new and identical daughter cells, each with their own nucleus. In prokaryotes, there is no nucleus, but the

²⁰ The endoplasmic reticulum performs three cellular functions: 1) lipid and carbohydrate synthesis 2) segregates protein products for export or intracellular use 3) performs the initial posttranslational modifications.

diffusely associated DNA is maintained by the boundary of the cell membrane (no nuclear envelope) and follows the same schematic as the nucleus in the eukaryotic cell with regards to mitosis. Therefore, in both eukaryotes and prokaryotes, there are identifiable boundaries of the DNA molecule i.e. the nucleus and the cell wall, respectively; the components of each being self-produced. Fortifying this statement is the genetic evidence provided that some of the actual genes responsible for producing these boundaries have been identified. Consequently, the first three criteria are fulfilled on **Table 1**- the system has identifiable boundaries, those boundaries are self-produced, and the components of those boundaries are self-produced.

Secondly, does the DNA molecule possess its own basic elements and components? Yes. The entire molecular structure of DNA is composed of 4 nucleotides (adenine, guanine, cytosine, and thymine) and sugar phosphates that construct a double helix (Grandy 2006b). These components are all self-produced within the cell. An example is the thymidylate synthetase gene (gene symbol TYMS), which produces the thymidylate synthetase enzyme. This enzyme generates thymidine monophosphate, which undergoes phosphorylation twice to produce thymidine triphosphate (TTP). TTP (or thymine) is one of the four basic nucleotides in the DNA molecule. The other 3 nucleotides (adenine, guanine, and cytosine) are generated in a similar fashion. Essentially, the DNA molecule possesses genes that produce enzymes that generate constituent elements that the DNA molecule then utilizes in several ways. Therefore, two more criteria (numbers 5 and 6) are fulfilled from **Table 1**; the DNA molecule as a system possesses constituent elements and components, and those constituent elements are also self-produced.

I have used several very scientific lines of evidence to prove my points thus far. However, I have tried to simplify the biologic jargon along the way. Most of these issues were addressed in my previous articles on the DNA molecule (please consult the references for further information).

Third, is the DNA molecule mechanistic- is it subject to cause and effect? Yes. I will illustrate three examples to support this:

1. There are a few different ways in which chemical signals (e.g. RNA or transcription factors) can enter the nucleus and causes certain genes from the DNA molecule to transcribe a blueprint for protein production, known as translation (Grandy 2010a). Thus, chemical signals can cause the DNA molecule to *do something*- cause and effect.
2. A second line of evidence that the DNA molecule is subject to cause and effect is the occurrence of cancer. Carcinogens, mutagens, and certain viruses in the environment can damage the tumor suppressor TP53 gene²¹, known as “the guardian of the genome”. Damage to this gene causes the cell to replicate uncontrollably and undifferentiated, both of which have pathologic effects on the organism. Thus, certain agents can cause damage to the DNA molecule resulting in abnormal functioning- cause and effect.

²¹ The TP53 gene produces a protein known as p53 which is involved in the G1-phase of the cell cycle. This causes a delay between the cell phases that allows time for defects in the DNA molecule to be detected and repaired before the cell enters into G0-phase where mitosis suppressor proteins activate tissue-specific proteins to be synthesized (Pritchard and Korf 2008). This is interesting because this is the phase where the DNA molecule gives the cell its physical characteristics.

3. A third example is that drugs can have an effect on the DNA molecule. For example, 5-FU inhibits thymidylate synthetase, which is an enzyme that produces thymidine monophosphate (Askew et al. 2009). Thymidine monophosphate is phosphorylated to produce thymidine triphosphate (TTP) which is one of the four basic building blocks of the DNA molecule mentioned earlier. Consequently, 5-FU in effect prevents the DNA from replicating. Thus, certain drugs can inhibit the normal replication of the DNA molecule- cause and effect.

We now have at least three examples that illustrate how the DNA molecule is mechanistic and subject to cause and effect. Consequently, a sixth criterion (number 4 on **Table 1**) is fulfilled, which makes six out of six!

I have evaluated and concluded that the DNA molecule meets all six of the criteria of an autopoietic system, which was supported by molecular biology and genetics. It has identifiable boundaries, those boundaries are self produced; the components of the boundaries are self produced, it is mechanistic, it possesses constituent elements and components, and the components and elements are also self-produced. In the next phase of our inquisition we must evaluate consciousness as an autopoietic process.

3.1 Is Conscious an Autopoietic Process?

It has been proposed that consciousness is autopoietic because it is comprised of psychological processes such as thoughts, memories, and emotions, which collectively form an ongoing autopoietic system (Combs and Krippner 2003). This system recreates itself from moment to moment by the interactions of these psychological components and this system uses an entire set of mental physiological aspects of an individual's moment-to-moment experience, which is called mind-body.

Consciousness²² or a state of consciousness is constructed of its own constituents: thoughts, emotions, awareness, and perceptions. These constituents are self-produced. These self-produced constituents in effect create an identifiable boundary from the external environment. For example, you cannot experience someone else's consciousness. In addition, system constituents and elements are also self-produced i.e. brain regions, neurons, neurotransmitters, and electrochemical activity. Those constituents and elements are all self-produced, ironically by the DNA molecule (this is mentioned in major theme IV of DNA consciousness).

I did not go into as much detail as I did when I illustrated the DNA molecule being justified as an autopoietic system because the autopoietic nature of consciousness and cognition has been described in more detail in other works by Maturana²³ and Combs. However, neither of them discussed how consciousness is mechanistic- subject to cause and effect, which I will discuss very briefly.

There is one important example that illustrates how neurological consciousness is mechanistic and that resides in the fact that if certain regions of the brain are damaged the result is that consciousness as we know does not occur. For example, allow me to look at alertness, which is the state of wakefulness and considered a prerequisite for neurological consciousness.

²² Please take into consideration that this term consciousness is what I refer to as neurological consciousness as we are talking about the degree of consciousness derived from the actions of neurons.

²³ Maturana does discuss mechanistic representations of cognition in *Cognitive Strategies* but does not specifically defend consciousness as being subject to cause and effect.

In terms of neurobiology, alertness is identified with the *ascending reticular activating system-upper brainstem tegmentum* and *intralaminar nucleus of the thalamus* (Young and Pigott 1999). The thalamic reticular nucleus performs “gating” of specific reticular information that is then transmitted to the cerebral cortex. This thalamic gating of information sent to the cerebral cortex provides feedback to the brainstem centers that play a role in arousal. If damage is done to any of these regions of the brain then the component of alertness is impaired or nonfunctional.

I have briefly discussed how human consciousness is autopoietic as per Combs and Manturana. In addition, I have briefly justified how human consciousness is mechanistic, which was not mentioned in any of the previous works of Combs or Manturana. Next, I would like to briefly discuss the single cell approach to consciousness.

3.2 Autopoiesis and the Single Cell Approach to Consciousness

I have discussed autopoiesis and provided justification that the DNA molecule is an autopoietic system. In addition, I briefly outlined some proposals on how consciousness is autopoietic. Interestingly, there are many theories about cellular consciousness, also called polyzoism or recently as the single cell approach to consciousness. Prior to my proposal that the DNA molecule is an autopoietic system, cells were considered the smallest autopoietic units on the planet. I would like to briefly address and illustrate that cellular degrees of consciousness are merely a higher degree of consciousness manifested by the DNA molecule which is to say that these degrees of cellular consciousness are reliant on degrees of DNA consciousness (this was addressed in the Belgrade University conference proceedings mentioned in Section 2.0).

The theory of cellular consciousness originated as a legitimate theory in the late 1800’s. Ernst Haeckel enumerated the theory in the different views of consciousness in his book *The Riddle of the Universe*. In his chapter entitled *Consciousness* he defined consciousness as “a vital property of every cell”. He further stated that just as every living cell is considered what he termed as an “elementary organism” in anatomy and physiology that gives rise to multicellular systems. Thus, with “equal right” we should consider what he calls “cell-souls²⁴” to be the elementary “psychological unit” and that the combinations of these psychic activities of these cells are what result in the complex psychic activity of the higher organism.

Haeckel was mostly inspired by his research on protists, which he felt displayed expressions of sensation and will, which he believed were similar to the instincts and movements of higher animals. While he was maintaining the theory of cellular consciousness he suggested that the material basis of it was the protoplasm or the nucleus (DNA was not discovered at that time). He also mentions Fritz Schultze’s *psychade theory* that proposed that the elementary consciousness of the psychade would have the same relation to the individual cells as personal consciousness would have to the multicellular organism of the personality in higher animals and man. Haeckel would believe in this theory until later in his career.

At the end of Haeckel’s career he would abandon the concept of cellular consciousness and as he stated “feel compelled to agree with Max Verworn”. Verworn maintained that cells and protists do not have a developed self-consciousness, and that their sensations and movements are of an “unconscious character”.

²⁴ For more detail on Haeckel’s cellular psychology i.e. “cell-souls and soul-cells” consult his *General Morphology* (1866).

In the realm of psychology, William James discussed what he called polyzoism²⁵ (James 1890). According to this model, James proposed that “every brain-cell has its own individual consciousness being *ejective* to each other”. He also goes on to propose that there is a pontifical arch-cell and that the events of all other cells influence this arch-cell.

James would later reject polyzoism for two reasons. First, he rejects his earlier assumption about a pontifical cell, which was pivotal to his theory. Secondly, this theory was unable to account for the binding problem²⁶. In addition, James’ analysis was based on a nascent field of atomic physics, which undergone extreme revisions in the ensuing century.

So now we have some of the two earliest accounts, Haeckel and James, of the theory of cellular consciousness and they both were ultimately abandoned by their creators. Why? I believe that intuitively that they both suspected a form or degree of consciousness, but did not have the science or technology to validate it (like our current problem with quantum physics). As far as the binding problem, this is an issue with neurological consciousness but has been addressed adequately by Gerald Edelman.

Edelman proposed very sound neurophysiological solutions to the binding problem (Edelman 2005). He proposed that in the brain there are multiple cortical reasons to account for the variety of sensory elements and that mutual reentry interactions account for the ordered integration. Both of these contribute to the explanation of the single subjective experience. This of course accounts for the binding problem on the level of neurological consciousness. What about the different degrees of cellular consciousness? What accounts for the binding problem at this level?

All cells have a degree of consciousness based on genome-dependent complexity. This is in alliance with the concept of ICC. Biologically DNA methylation, genomic imprints, and chromatin signaling all allow selected genetic states to account for any cellular binding problems.

Does this make DNA a form of consciousness? Again, some of the elements of consciousness are that it is autopoietic, dynamic, and evolving. At this point I have established that the DNA molecule is autopoietic and gives rise to higher degrees of consciousness that is first seen in cells. This serves to support the theory of DNA consciousness. Next, I will investigate dynamic and evolving systems in an attempt to fortify this comparative analysis to further support the theory of DNA consciousness.

4.0 DYNAMIC SYSTEMS AND EVOLUTION

A system is dynamic if it moves, changes, or evolves in accordance to the mathematical *rule of transformation* (Prigogine 1984). Transformation is a rule that moves an element from one position or state to another position or state. The means by which this happens is typically referred to as an operator. In biological terms, dynamic systems are systems that change and evolve. The operators by which they function [to evolve] are well known as natural selection and the DNA molecule’s ability to mutate. Of course I have already proposed that in the future another operator of evolution will be SGD (Grandy 2010b).

²⁵ In modern biology polyzoism is considered the characteristic of being composed of smaller organisms that function as a colony or a collective whole.

²⁶ The binding problem states that during a single subjective experience there is a variety of sensory elements and an ordered integration of these elements. However, there is no explanation on how these elements are bound (Chalmers 1995).

The phenomenon of mutations has been discussed in two of prior publications (Grandy 2010a; Grandy 2006a). Essentially, a mutation is when one of the basic nucleotides- A, G, C, or T is changed and replaced with a different nucleotide. This can have three potential results to the gene affected: 1) no change in what that gene produces 2) a harmful change physiologically to that gene's product, or 3) a beneficial change physiologically to that gene's product. It is in this way that genome-dependent complexity allows organisms to evolve, stay the same, or perish; and it is directly connected to the DNA molecule.

It only required a minimal amount of convincing to prove that DNA is a dynamic and evolving system. In fact it has been discussed in hundreds, if not thousands, of other publications. I have directed my evaluation in correlation to DNA consciousness as per the goals of this paper.

In summary, the DNA molecule is a dynamic system and its direct involvement in macroscale evolution is what eventually gives rise to neurological degrees of consciousness. Therefore DNA is autopoietic, dynamic, and evolving. This justifies DNA consciousness as a degree of consciousness and as phenomenon of continuum with in the concept of ICC which is with in the confines of the interaction-based theory of consciousness.

5.0 CONCLUSION

Consciousness is woven of a tightly knit informational patchwork of subprocesses.

-Allan Combs 1998

What a beautiful and true statement about consciousness! The idea that it is a patchwork of subprocesses is similar to the statement that I made in the introduction that maybe consciousness is more than one thing. What I have proven is that consciousness exists in degrees that ascend up the chain of ICC. These degrees of consciousness are dependent on degrees of interaction which are transformed through the operator of complexity. This becomes genomic-dependent complexity once nucleotides appear. During the evolution of ICC three (and in the future four) *special* things happen that all involve DNA and that is what justifies the theory of DNA consciousness as a legitimate theory of consciousness because it is involved in all the important milestones of the evolution of consciousness. In addition, I have provided scientific evidence and comparative analysis to support the theory of DNA consciousness.

This paper should force us to recognize consciousness outside the realm of neurological phenomena. I have substantiated this idea with the interaction-based model of consciousness and further clarified this with the concept of ICC. In this schematic all *things* have a degree of consciousness which ascends as interactions increase complexity and that complexity increases degrees of consciousness. Consequently, all things have a degree of consciousness that can be substantiated with ICC.

Consciousness as a process meets the following criteria: it is autopoietic, dynamic, and evolving. The processes of the DNA molecule meet the same three criteria, which I have provided scientific, and in many cases molecular genetic proof to substantiate my proposals. Therefore, DNA consciousness is a legitimate form or degree of consciousness.

We also need to stop viewing DNA as merely the raw material from which we are derived. DNA consciousness is a degree of consciousness supported within the architecture of the concept of ICC and has the special ability to give rise to all degrees of cellular and neuron-based consciousness. As I have already discussed, this evidence is seen with the appearance of simple neuron-based consciousness in the first invertebrates. As the genes interact more with the

environment there is an explosion in complexity and then Hox and Pax genes evolve. These genes give rise to the consciousness of vertebrates and ultimately humans. Once again, these are all genome-dependent complexity. So in essence, DNA consciousness is where humankind's consciousness emerged from.

There are still many problems with understanding consciousness and I have attempted to address some, but not all of them. A fair amount of gravity is concentrated on questions involving quantum physics. The theory of DNA consciousness readily embraces this enigma. It is obvious that the DNA molecule is held together by quantum forces as the degree of DNA consciousness evolves from the primordial consciousness that emerges from quarks (and further than that, but for now I drew the line at quarks in this paper for good reasons). As I have already proven, DNA consciousness ultimately gives rise to neurological degrees of consciousness. Therefore, it can be seen that DNA consciousness is a dynamic intermediate between the primordial consciousness of quantum physics and neuron-based consciousness that evolves up the ascending chain of ICC.

As of now, humankind sits in an overweening fashion on the top of the consciousness mountain. However, I have discussed in other works²⁷ that with the advent of genetic engineering and SGD that humankind's neuron-based consciousness can evolve into even higher degrees of consciousness. In fact, I have made many strong arguments that this is the *purpose* of humankind- to provide a more effective means (that being SGD to replace natural selection) to further the evolution of DNA consciousness. This will give rise to a new subspecies *Homo sapiens genomicus* (or the man with the wisdom to alter his genome) and eventually new species in the future as DNA consciousness continues to evolve.

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²⁷ Here I provide an over simplification of SGD. I provide far more extensive detail in the publication *Selected Genetic Destination and the rise of Homo Sapiens Genomicus*. Please consult the reference for more detail.

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