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Something More Deeply Hidden-Volume 1

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This book is **dedicated** to: Sabrina Dawn Wallace, her two young daughters, her husband, as well as her caretaker or care-giver. I have learned a great deal from Sabrina, and I not only greatly admire her phoenix-rising-from-the-ashes-like resiliency with respect to the many difficulties and challenges which have interdicted her life path over the years (and this admiration is constrained only by the limits of my understanding concerning the details of her existential journey), but I also have tremendous respect for her rigorous and compassionate dedication to the project she initiated a number of years ago which is attempting to induce people to seek to take control of their lives, beginning with learning about their own bodies -- especially their biofields.

There could be any number of the observations or comments that are given expression in the following pages with which Sabrina might take exception. However, I am quite confident in her ability – if she chooses to exercise it -- to clearly state what she considers to be problematic with anything that might be said in the ensuing set of conceptual exercises, and I also am confident in her willingness to acknowledge that whatever she might be saying is her considered opinion which could be incorrect – and, notwithstanding such a possibility, her perspectives are always well-considered and, at least from my perspective, frequently (bordering on invariably) correct. Furthermore, whatever she might have to offer in the way of point-counterpoint emerges out of a context that is rooted in the hope that the communication which takes place will give expression to an adult conversation through which people exchange ideas in an "I-Thou"-like interaction.

Thank you, Sabrina, for your support, encouragement, and willingness to share your understanding concerning an array of extremely important topics that are relevant to the essential lives of people. Along with thousands of other individuals, I am indebted to you.

Sorry for being so slow on the uptake. Nonetheless, the wine does seem to be improving with age – although this assessment might have more to do with the impact of the wine on my sensibilities rather than having anything to do with the quality of my understanding improving with the passage of time.

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Introduction

The title for the current work – namely, *Something* *More* *Deeply Hidden* – gives expression to a thought that occurred to me following my encounter with Sean Carroll's book: *Something Deeply Hidden: Quantum Worlds and the Emergence of Spacetime*. The aforementioned title for my own book bubbled to the surface of my consciousness in apparent response to the manner in which the title of Carroll's offering seemed somewhat perplexing to me as I went through the contents of his book.

Perhaps, the meaning of the phrase "something deeply hidden" is a way of alluding to the possibility that the true nature of quantum mechanics is something which tends to be deeply hidden from most people, even some of the quantum physicists themselves. Maybe this condition of quantum phenomena being a 'hidden something' is due to an unfortunate series of events that could be explored in a future volume by Lemony Snicket.

Alternatively, of course, a much more serious approach to addressing the ignorance which many people might have concerning the notion of quantum worlds would be to write a book that seeks to assist people to better understand quantum phenomena and, thereby, render that topic less deeply hidden from those who might possess little insight into such dynamics. Naturally, if one could show -- as Carroll tries to do in his book -- how "spacetime" emerges from quantum worlds, then, this would be an added bonus because there probably are as many individuals who consider the idea of "spacetime" to be a "something" which is as deeply hidden as the notion of quantum worlds appears to be.

"Spacetime" is a term that occupies a central position in Einstein's general theory of relativity. More colloquially, this latter theory gives expression to the mathematical framework Einstein employed to refine and modulate certain facets of Newton's work concerning gravity.

Surprisingly, one has to wait until page 310 of a 325 page book to discover that the title of Carroll's aforementioned book consists of words which Einstein once said. More specifically, Carroll relates a story told by Einstein about an experience the latter individual had as a young boy that describes his curiosity about, and mystification concerning, the way in which the needle of a compass could be affected by unseen forces and Einstein had concluded: "Something deeply hidden had to be behind things."

What Einstein came to believe the nature of the "something deeply hidden" to be and what Carroll considers the "something deeply hidden" to be are really quite different from one another. Einstein never fully accepted certain facets of the quantum framework and always felt that the theory was an incomplete and inconsistent system of thought, whereas, contrary to Einstein, Carroll – based on the perspective put forth in his own book: *Something Deeply Hidden* -- clearly believes there is a way of making quantum mechanics both consistent and complete, and this 'something' has to do with his understanding of quantum worlds or the many worlds interpretation of quantum mechanics.

The reader will have to wait until Chapters 23-25 of the second volume to be introduced to a more extended discussion concerning some of the issues, problems, and questions that arise in conjunction with quantum phenomena -- including Carroll's "many-worlds" approach to those phenomena. For now, however, some contextual background will be provided that might help orient readers with respect to the nature of the disagreement which Einstein had with those individuals who became card-carrying members of the quantum physics club, and, in the process, this will begin to move readers toward discovering why the present book is entitled: *Something <u>More</u> Deeply Hidden*.

Let's begin with the 5th and 6th Solvay Conferences that were held in Brussels in 1927 and 1930 respectively. Although many talks, presentations, and discussions took place during those two gatherings, the dynamics which I would like to focus on, to some degree, have to do with the interactions between Niels Bohr and Albert Einstein concerning their discussions about the nature and foundations of physics.

Although Einstein was part of the planning committee for arranging speakers to address the participants of the 5th Solvay Conference, the purpose of those meetings was to explore various issues and questions concerning quantum mechanics. Consequently, despite the fact that Einstein had been invited to give a presentation during the conference, he declined to do so because, on the one hand, he didn't feel sufficiently well-versed in the developments which had been taking, place in quantum research to make a meaningful contribution to the subject, and, perhaps, more relevantly with respect to present purposes, he didn't agree with the statistical perspective that constituted an important part of the foundations of quantum mechanics.

Einstein was more interested in the dimensions of reality which made the probabilities of quantum phenomena possible than he was in learning how to use mathematical techniques to calculate what events or properties were most likely to occur under certain physical conditions. Nonetheless, Niels Bohr, another attendee of the 1927 Solvay Conference, had a different approach to the scope and nature of physics – an approach which challenged Einstein's belief that: (a) there existed an objective reality which was quite independent of human conceptual activity, and (b) if human beings were to have any hope of understanding the phenomena to which objective reality gave expression, then, human thinking would have to find ways of capturing the structural properties and dynamics of physical events -- for example, through the mathematical techniques and methodology of physics.

In contradistinction to the foregoing possibilities, Bohr maintained that the phenomenon of wave-particle duality was an inherent aspect of reality which resisted attempts to uncover some fundamental, objective world which existed independently of human activities. Furthermore, according to him, quantum phenomena could only be properly understood through the lenses of complementarity.

Complementarity encompassed the idea that certain properties that were related to one another – such as momentum and position or time and energy – could not be simultaneously measured. In other words, the more accurately one might be able to measure one aspect of a given set of properties that were linked through the dynamics of complementarity -- say, momentum and position -- then, the fuzzier or less precise would one's measurement be with respect to the other component of that dynamic, and in the case of the property of position the other facet of this kind of complementarity would be momentum.

For Bohr, Heisenberg's "Uncertainty Principle" was not just a statement about methodological limits concerning the simultaneous measurement of certain complementary properties. That principle was a reflection of the way reality inherently manifested itself.

According to classical physics (i.e., physics prior to the emergence of quantum mechanics), the process of observing nature did not alter the way in which nature took place. That which is observed is something which is separate from the process of observation, and, of course, the task of the latter process was to find ways of capturing or identifying the actual character of that which was being observed.

Bohr rejected the foregoing perspective. He believed that one could not separate observer and observed.

As a result, according to Bohr, reality had no intrinsic existence independent of observation. Consequently, a particle – whether it is a photon, electron, or some other kind of quantum entity – does not exist until a measurement takes place.

In other words, Bohr maintained that unobserved quantum particles do not exist. Such particles only come into existence through the dynamics of measurement, and, therefore, outside of the parameters of such a process, the notion of particles having an existence which was independent of the measurement process was meaningless.

As indicated previously, Einstein maintained that objects had an existence which was independent of human activity, scientific or otherwise. He believed that the challenge with which science was confronted was to discover the nature of that which had an existence independent of human beings.

In contrast, Bohr held that the task of science was not to become caught up in narratives about the nature of objects that were not being observed. Instead, he proposed that science was only about the process of making measurements and using such measurements to describe the physical phenomena which were manifest in observation.

The term: "Copenhagen interpretation," was never used by Bohr as a way of categorizing his approach to science. Nonetheless, this is the term that has come to be identified with Bohr's perspective concerning quantum physics.

From Bohr's point of view – as well as those individuals, such as Heisenberg, who concurred with that way of thinking -- quantum phenomena were about potentials rather than actualities. Observation or measurement was the way in which one turned potentials in to realities.

No one who adopted the Copenhagen interpretative approach to engaging quantum physics – and, in time, that approach became the dominant position within the community of quantum physicists – was ever able to account for the nature of the transitional process which turned potentials into actualities through the process of measurement. Consequently, quantum phenomena operated in a way that could not be reconciled with the world of classical objects of everyday life – such as human beings, scientific instrumentation, and the like – which seemed to have an on-going sort of permanence or reality, and while there have been many attempts to do so (such as Sean Carroll's book: *Something Deeply Hidden*), no one has ever solved -- to everyone's satisfaction -- the problem of how to account for the way in which quantum potentials were able to turn into the sorts of classical realities which seem to constitute our everyday world.

Bohr and those who agreed with him considered quantum theory to be a complete and consistent scientific position. Einstein felt that quantum theory was neither consistent nor complete.

For example, as noted in passing during an earlier portion of this introduction, one of the questions which always has haunted the shadowy corridors of quantum physics has to do with the issue of what, exactly, is a quantum potential, and how does it transition into a measurable something in conjunction with the process of observation. Einstein believed that the only way of resolving such a problem would be to argue for the existence of what came to be known as "hidden variables" – that is, objective realities which were present – although currently unseen -- and which gave rise to phenomena that were being described by means of Max Born's probabilistic reworking of, or re-interpreting of, Schrödinger's equation.

Apparently, according to Bohr and those who agreed with him, observable reality emerged from quantum potentials sort of like Athena allegedly came into existence fully formed from the skull of Zeus. Einstein contended that such a position entailed inconsistencies with respect to the dynamics of how quantum potentials became part of the world of observables, and he further argued that the key to removing those sorts of inconsistencies could be found in the realm of hidden variables which were anathema to Bohr' ecclesiastical school of quantum thinking.

Bohr considered quantum mechanics to be as complete a system of physical description as one could achieve. However, though complete, he acknowledged that such descriptions were constrained by the way in which Heisenberg's Uncertainty Principle limited what could be measured at any given moment.

At various junctures during the Solvay Conferences of 1927 and 1930, Bohr and Einstein engaged in a series of discussions concerning the foundations of physics. Many of those discussions revolved about various thought experiments which Einstein proposed to Bohr as demonstrations indicating – possibly -- that quantum theory was inconsistent or incomplete in some way.

After each thought experiment was outlined, Bohr would point out some feature of the experiment that was problematic and which, consequently, vitiated the thought experiment's value as a possible counter to Bohr's approach to quantum physics. After his various attempts to throw a conceptual monkey wrench into Bohr's perspective were frustrated or blocked in one way or another, Einstein would retreat to his conference living quarters and begin to develop a new kind of thought experiment which would be presented to Bohr during their next session, only, subsequently, to be met with further objections by Bohr concerning some sort of faulty logic inherent in the new thought experiment which Einstein had assembled.

When people examine the details concerning the point-counterpoint of the Einstein-Bohr discussions during the two Solvay Conferences that took place in 1927 and 1930, most of those individuals tend to feel that Bohr came out on top of such interchanges. Nonetheless, pointing out the weaknesses in someone else's thought experiments is not necessarily the same thing as demonstrating that one's own position is unassailable.

Quantum physics gives expression to a powerful system of very precise descriptions – indeed, extending out to many decimal places of accuracy. Nevertheless, the questions to which Einstein was trying to allude through his thought experiments remain – namely, how do quantum potentials or possibilities transition into actual observable dynamics with determinate properties, and how do probabilities suddenly turn into precise, determinate outcomes upon measurement?

In 1932, John von Neumann wrote a book – later translated into English (1955) -- with the title: *Mathematical Foundations of Quantum Mechanics* – and, among other things, the book addressed the issue of hidden variable theories. In this respect, the author put forth a theorem which supposedly indicated that the hidden variable issue was beset with certain problems which made them very difficult, if not impossible, to construct in any sort of defensible manner.

However, in putting forth the aforementioned theorem, von Neumann had made a problematic assumption with respect to his claim that hidden variable theories were inherently incapable of developing a system of quantum mechanics which was fully capable of generating the sorts of predictions that made quantum mechanics so powerful and accurate. In other words, if one put aside von Neumann's questionable assumption concerning what hidden variable theories had to be like, then, there might still be some conceptual or theoretical wiggle room that remained within which certain possibilities involving the notion of hidden variables might exist.

In effect, what von Neumann had done was to put forth an argument about why a particular kind of hidden variable theoretical structure could not possibly work. However, if one could come up with some other edition of hidden variable theory that which did not fall under the umbrella of the assumption which von Neumann was making about what hidden variable theories involved, then, although certain kinds of hidden variable theories might have been ruled out by von Neumann's work, nonetheless, the possibility still existed that there might be other kinds of hidden variable theories that were not covered by von Neumann's assumption concerning hidden variable theories, and, indeed, eventually, both Louis de Broglie and David Bohm did come up with a theory of hidden variables in quantum mechanics that could not be subsumed under the assumption which von Neumann had made about how hidden variable theories were structured.

The foregoing mistake or error was first pointed out by a German mathematician and philosopher by the name of Grete Hermann (1901 – 1984). Although written material by, and data on, Grete Hermann's ideas and life are, somewhat, difficult to find, nonetheless, a thesis by Giulia Paparo which had been written for the latter's master's degree in compliance with the requirements of Utrecht University, provides a great deal of insight concerning the life, times, and perspective of Grete Hermann.

The foregoing master's thesis introduces the reader to some of Grete Hermann's thoughts on: Quantum mechanics, science, philosophy, mathematics, education, ethics, history, and politics. Although some of that material will be revisited in the ensuing first chapter of the present book, for the time being, focus will be directed toward trying to summarize certain, limited aspects of Hermann's position on the relationship between hidden variable theory and quantum mechanics.

To begin with, as Giulia Paparo points out in a footnote on the very first page of her thesis, neither she, nor Grete Hermann, is making any claim that von Neumann had committed an irredeemable error which invalidated all of his thinking with respect to hidden variable theories. Rather, the mistake to which the attention of a reader is being drawn is that von Neumann was not justified in considering his treatment of hidden variable theory to be an exhaustive characterization of such theories, and, consequently, although what he did show was valid, nonetheless, what he claimed concerning hidden variable theories was not necessarily universally true, and, therefore, one had to place certain constraints on the applicability of his argument in relation to other possible kinds or forms of hidden variable theory.

Throughout her thesis, Paparo also clearly indicates that the mistake which had been identified by Grete Hermann in the work of von Neumann's mathematical systemization of quantum dynamics, the identified mistake did not appear to be considered by Hermann to be all that significant. For example, Grete Hermann believed that von Neumann had mathematically shown quantum mechanics to be a complete and consistent theoretical framework and, consequently, for all practical purposes – and irrespective of the mistake von Neumann had made with respect to his assumption concerning the structural nature of hidden variable theories – Hermann believed that there was nothing of any substantial nature that was likely to challenge the idea that quantum theory was complete and consistent.

Grete Hermann's primary concern was to demonstrate that quantum mechanics could be reconciled with Kantian philosophy as developed by Jacob Fries and Leonard Nelson. Nelson was a mentor, of sorts, for Hermann, as Fries had been a mentor of Nelson, and all three of those individuals sought to operate out of a form of Kantian philosophy that was modified in various ways by Fries, Nelson, and Hermann.

Hermann was interested in, among things, preserving the fundamental role of a priori influences with respect to quantum mechanics. In addition, she wanted to show that the notion of causality was still present in quantum dynamics.

As intimated previously there will be a few critical reflections which will be offered in Chapter 1 of the present book concerning both the aforementioned issue of a priori judgments as well as the topic of causality. However, noting that notwithstanding the mistake my von Neumann which had been uncovered, nevertheless, for now, it is sufficient to point out that Hermann didn't seem to believe that hidden variable theories constituted any sort of challenge to claims of completeness involving quantum mechanics as mathematically presented by von Neumann will be sufficient.

Grete Hermann felt that von Neumann's assumption concerning hidden variable theories was somewhat circular in nature – that, in a sense, he was assuming his conclusions. Paparo also points out in her thesis that some thirty years later and, apparently, without any awareness of what Grete Hermann had discovered three decades earlier, John Stewart Bell (he of Bell's inequality and the issue of entanglement fame), noted the same sort of problem in von Neumann's treatment of hidden variables as Grete Hermann had done, but he referred to the nature of the mistaken assumption as being arbitrary in character and, therefore, unjustified.

Unlike Hermann, Bell maintained – and Paparo gives emphasis to this difference -- that the mistake made by von Neumann opened the door to the possibility of developing various kinds of hidden variable theories that would not be covered by the arbitrary assumption von

Neumann had made concerning the alleged structural nature of hidden variable theories. Conceivably, there was something more deeply hidden than von Neumann and others who accepted his perspective might have believed to be possible.

Although, as previously indicated, a more developed discussion concerning some of the issues related to quantum mechanics will have to wait for a later chapter, the following consideration will have to suffice for the moment. More specifically, the wave function is about probabilities, and Schrödinger's wave equation is used to work out quantitative identities which are related to those probabilities, and, yet, all too few individuals seem to grasp the tremendous disconnect that appears to divide, on the one hand, the probabilities of allegedly superpositional potentials from, on the other hand, the precise values that emerge through the collapse or decoherence of the probability distributions that are used to describe quantum dynamics. Even Schrödinger, who won a Nobel Prize for the foregoing wave equation was quite dissatisfied with the probabilistic interpretation of his mathematical treatment that had been proposed by Max Born.

Schrödinger believed that his equation was dealing with objective realities and not probabilities. He believed that those probabilities were a function of some more fundamental dimension of reality, and, yet, the only way that his equations actually appeared to generate useful results is if his equation were treated as if it were alluding to probabilities that collapsed into determinate results (i.e., underwent decoherence) through measurement or observation.

Apparently, Schrödinger – notwithstanding his Nobel Prize -- didn't understand what he had accomplished with his wave equation. He needed someone else – namely, Max Born – to show him what could be done with the equation as long as one didn't ask too many questions about the nature of the relationship between the equation and reality.

No one could provide any plausible answers concerning the actual dynamics of decoherence. No one could explain how potentials turned into actualities. No one could explain how probabilities turned into determinate outcomes through the process of measurement.

There seemed – according to Schrödinger (and Einstein) -- to be something more deeply hidden beneath the surface of probabilities.

Yet, under the philosophical influence of Bohr, Heisenberg, Pauli and others, no one was permitted to talk about those possibilities.

Einstein tried to talk about such issues during several of the Solvay Conferences, but he was stalled by Bohr's counter-arguments – arguments which were capable of casting doubt upon the viability of the thought experiments that Einstein had brought forth, but arguments which did not necessarily demonstrate that hidden variable theories couldn't be developed that might be viable. Von Neumann claimed he had demonstrated that all forms of hidden variables theory could be discounted, and, yet, even though Grete Hermann and John Stewart Bell had pointed out that von Neumann was mistaken in the assumption he had made about the structural nature of hidden variable theories, nevertheless, despite being unfamiliar with either the work of Hermann or Bell, most quantum physicists assume that the issue of hidden variable theory is settled science, and this was not, and is not, the case.

In some ways, there has been a sort of Overton window imposed on the issue of quantum mechanics. In other words, seemingly, constraints -- both official and unofficial -- are often placed on how one should engage and speak about the phenomena that are being described through quantum mechanics.

Those constraints come in the form of: Career opportunities, post-doctoral fellowships, jobs, book deals, speaking invitations, symposium offers, teaching positions, grant money, media accessibility, and journal publications. People (both within the general area of quantum mechanics as well as those who go about life outside of that field) are induced to believe that there is academic freedom as well as an absence of censorship with respect to research concerning quantum mechanics, but individuals -- all of whom are physicists -- such as David Bohm (*The Implicate Order*), (F. David Peat (*Infinite Potential*), Sabine Hossenfelder (*Lost in Math*), Alexander Unsicker (*The Higgs Fake*), Lee Smolin (*The Trouble With Physics*), and Peter Woit (*Not Even Wrong*) –– tend to paint a very different picture of what has transpired, and continues, to transpire, in certain areas of research connected to, among other topics, quantum physics.

Although the following incident is only anecdotal, it is consistent with the perspective that is given expression through the aforementioned works. More specifically, approximately, 45 years ago, I had a conversation with a doctoral student in physics at a local but world-class university. She indicated that there was a cult-like atmosphere within her department, and unless one toed the party line with respect to how the professors in the department believed that physics should be done or what they considered were legitimate areas of research, one would be unlikely to secure one's doctorate.

The foregoing books and the one anecdotal incident noted above indicate that to varying degrees, an Overton-like window has been in effect in relation to quantum physics for nearly 100 years (starting, arbitrarily, with the Solvay Conference of 1927). One might even refer to the problem being alluded to in the last several paragraphs as a species of Orwellian Newspeak in which certain ideas and words tend to be banished from conversation to such an extent that those ideas and words begin to disappear from the minds of people, and, as a result, those individuals might no longer be capable of critically thinking about the subject in any way that touches upon those ideas or words.

The foregoing pages of critical reflection have not been undertaken with the idea of proving that some particular account of hidden variables is true. Rather, the intent has been to take the reader through a set of concrete contexts that disclose how there is often an array of considerations (some well considered and others less so) surrounding the notion that there might be something more deeply hidden than the theories that we use are willing to acknowledge – something more deeply hidden for which not inconsequential evidence can often be offered which indicates that references to something more deeply hidden should not automatically be dismissed without critically reflecting on a variety of issues which are relevant to such an issue.

During the course of this book, there will be nearly thirty chapters which explore different kinds of problems and dynamics indicating that our world -- does indeed -- seem to be governed by something more deeply hidden than many of our theories are willing to acknowledge. As such, the material in this book is offered as food for thought and, as well, presented with the belief that inducing people to engage in critical reflection concerning an array of issues and problems is a constructive, heuristic process and should not be pre-judged as a waste of their time.

Perhaps, if a reader sticks with the book until the end, a line from the Jakob Dylan song, *One Headlight*, might be applicable. “Man, I ain’t changed, but I know I ain’t the same.” Or, maybe, an earlier line from that same song will describe what could transpire: “I turn the engine, but the engine doesn’t turn.” Obviously, my preference would be that the former line is more descriptive of your reading experience than the latter one might be.

<u>Chapter 1</u>: Epistemological Considerations

As pointed out in the Introduction, Grete Hermann was the first individual who noticed that John von Neumann had made a mistake, or committed an error, during his landmark book *Mathematical Foundations of Quantum Mechanics* (English version of the original German edition). The nature of the mistake was in the form of an over-exuberant assumption concerning the nature of the structure of hidden variable theories.

Emmy Noether had been Grete Hermann's graduate advisor. Noether was a first-rate mathematician who also had made important contributions to mathematical physics.

Noether's advisee was interested in bringing mathematics, quantum physics, philosophy, and science together within a workable interdisciplinary framework that could be used to analyze a variety of issues. However, von Neumann's sloppiness with respect to assumptions was not foremost among her list of concerns with respect to quantum mechanics.

Her primary worry had to do with whether, or not, quantum mechanics was inconsistent with various facets of Kant's general philosophical perspective which had undergone some modifications by people who were had helped shaped certain aspects of Hermann's thinking. These modifications had been contributed by Leonard Nelson, one of Hermann's mentors, as well as Nelson's mentor Jacob Fries, but Hermann wanted to make her own contributions to both quantum mechanics and philosophy.

Despite realizing the nature of the mistake which had been committed by von Neumann, Hermann continued to believe that hidden variable theories did not constitute any sort of challenge to the completeness of quantum mechanics. However, at the same time, she was concerned about the implications which quantum mechanics might have for certain aspects of Kantian philosophy (broadly conceived), including the concept of causality.

After all, respected scientists such as Niels Bohr and Werner Heisenberg were arguing that nothing really existed in any objective, independent sense prior to the process of observation or measurement. Those arguments (despite resistance from Einstein, Schrödinger, and de Broglie) were being accepted by an increasing number of researchers who were exploring the dynamics of quantum phenomena.

Probabilities and potentials in the form of superpositional configurations or clouds of quantum possibilities were somehow being induced to emerge as determinate results through the dynamics of measurement or observation. Unfortunately, no one could explain how such a transition took place, and this state of affairs was referred to as the "measurement problem."

Bohr, among others, was claiming there is an epistemologically unbridgeable divide which existed between the micro realm of quantum, superpositional phenomena and the macro, classical world of everyday life. Notwithstanding the existence of such a divide, nevertheless, he maintained there was a mutual dependence between the micro and the macro realms, and the existence of this mutual dependence was given expression through Bohr's 'principle of correspondence' which brought the two worlds together through the manner in which quantum mechanics could provide a formal description that made sense of macro phenomena.

Given the foregoing considerations, there is a sense in which the term "quantum mechanics" is somewhat misleading. After all, if potentials or probabilities don't take on specific, concrete form until an observation or measurement had been made, and if one doesn't understand how potentials transition into determinate outcomes through the process of observation or measurement, then, one has no access to what the nature of the alleged mechanics or dynamics are which supposedly are taking place on the quantum level and, in addition, whatever dynamics one does have access to (namely, the act of measurement or observation) is not occurring on the quantum level but takes place on a classical level.

If one accepts Bohr's approach to things, quantum mechanics refers to a field of study in which people don't necessarily understand what is transpiring. Yet, counter-intuitively, despite the presence of such a sizable cloud of unknowing, precise answers to specific, concrete problems can be generated through a process that no one really understands.

After reading Bohr's response to the Einstein, Podolsky, and Rosen paper ("*Can Quantum Mechanical Description of Physical Reality Be Considered Complete*" -- 1935, *Physical Review*), Schrödinger wrote a letter to Bohr. The gist of Schrödinger's critique of Bohr's response to the Einstein, Podolsky, and Rosen paper was that Schrödinger couldn't understand how Bohr's contention that one must classically interpret the results of observation or measurement was tied to the notion that those interpretations were a function of quantum phenomena in some essential way. In short, Schrödinger wanted to know on what Bohr was basing the foregoing contention concerning the nature of the essential relationship between classical measurements and quantum phenomena.

A clear understanding of the alleged links between the micro and macro, or the quantum and the classical, worlds appeared to be missing. Was this lack of clarity merely due to Bohr's well-known capacity for expressing himself in obscure and, sometimes, completely unintelligible, if not confusing, ways, or was there a sizable chunk of physics that was missing from quantum descriptions?

Among other things, the foregoing conundrum carried significant implications for the issue of causality. A well-known thought experiment of Laplace signified the classical perspective with respect to the issue of causality.

Laplace asked one to image an Intellect that possessed extraordinary powers of knowing and understanding. Subsequently, for obscure reasons, this Intellect was transformed into a demon by some individuals.

According to Laplace, if this Intellect comprehended all of the laws governing the dynamics of bodies, whether large or small, and if this Intellect had acquired knowledge of all bodies in existence in relation to properties such as position and so on, then, this kind of Intellect would be able to devise an epistemological framework which would enable that Being to grasp the nature of the movements of all bodies in the past, present, and future. As a result, this Intellect would understand how the past was connected to the future via the present, and, thereby, grasp the presence of causality in those events.

Quantum mechanics seemed to present something of a challenge for the foregoing perspective. In other words, if, as a result of the

Indeterminacy Principle in which one could not simultaneously measure properties which were considered to be complementary to one another (such as position and momentum, or energy and time, as well as waves and particles), and if potentials did not become determinate until a measurement or observation was made, and if the correspondence between the quantum world and the classical world was something of a mystery, then, where did the idea of causality fit into those sorts of dynamics?

What would Laplace's Intellect make of quantum mechanics? Given that the Intellect is merely a function of Pierre-Simon Laplace's thought experiment, one has difficulty knowing what adjustments Laplace might have made to his conceptual fiction had the 18th-19th century engineer, physicist, astronomer, and philosopher known about quantum mechanics.

More pertinently, perhaps, one might note that Laplace lived between 1749 and 1827. Therefore, he existed at a time when quantum mechanics had not begun to seep into awareness and would not do so for another 73 years until Planck's came up with a purely mathematical solution for resolving some discrepancies between what was expected by Planck's own theoretical equation concerning a given kind of phenomenon and what had been actually measured in relation to that phenomenon.

As a result, perhaps Laplace's Intellect entity would not be susceptible to the modern disease of becoming infected by the imaginative complexities of quantum mechanics. In other words, being the truly formidable Being that the Intellect was imagined by Laplace to be, the Intellect might not have been distracted by all the mathematical chatter and improvised accounts present in the mysteries surrounding quantum mechanics, and, instead the Being might have simply returned to the noumena – that is, things in themselves independent of all conceptualizations – with which the entity might have been familiar, and, consequently, the Intellect might not have become entangled in the phenomena which Bohr and so many other quantum physicists seem to be preoccupied.

Laplace's Intellect was provided with knowledge of things by an assumption in the Frenchman's thought experiment. Nothing was said about how the Intellect might have acquired knowledge of particle dynamics if that Being had not been provided with such understanding through a thought experiment's presupposition.

Would the Intellect have been hemmed in by the manner in which human beings have been forced to proceed with respect to quantum mechanics? Or, conceivably, would the Intellect have capabilities which enabled the Being to have a relation with the universe which was rooted in a different way of accessing and understanding the phenomena of the universe?

Presumably, we will never know how Laplace's Intelligent Being would have addressed the issue of causality in conjunction with the challenge which quantum mechanics seemed to pose for that issue. However, thanks to the research of Giulia Paparo, we do know how Grete Hermann handled the situation.

To begin with, Hermann did not believe that empirical means could be used to demonstrate that the principle of causality was present or absent in any given case. This is because she operated out of a framework which assumed Kant's position concerning causality was correct.

More specifically, Kant maintained that the principle of causality was a function of a priori dynamics. In other words, the principle of causality is something which is inherent in human cognition (i.e., the way our mind works) and, therefore, was not derived from experience – this is, after all, the essence of the a priori perceptual process.

Moreover, the capacity to engage experience through the lenses of a priori principles – one of which involved causality – was considered by Kant to be a necessity if human beings were to be able to grasp the nature of phenomenal dynamics and associated relationships. According to Kant, noumena, or things in themselves, were beyond our capacity to grasp, and, as a result, all we could access and hope to understand through our use of pure reason (that is, a form of understanding which was independent of experience) were the phenomena which noumena made possible and which were accessed through different a priori categories, such as causality.

Before moving on with Hermann's attempt to reconcile causality and quantum mechanics, one might note how Hermann did not appear to recognize that by accepting Kant's general perspective in the way she did, doing so, entailed a hidden variable-like problem of its own. In other words, if human beings are incapable of accessing the realm of noumena – or things in themselves – then, we don't really know what the nature of the relationship is between noumena and the phenomena which make up the structural properties of our everyday life, anymore than Bohr and other quantum physicists could explain how the probabilities and potentials of non-existent phenomena became the determinate results of the measurement process.

If we don't know what the nature of the relationship is between noumena and phenomena, then, one cannot be sure whether, among other things, causality is a function of noumena or is an expression of pure reason independent of experience and, therefore, just gives expression to the way in which the human capacity to understand has been constructed. Conceivably, we do not come into this world with a ready-made category of pure reason that enables human beings to frame our experiences in, among ways, causal terms.

Even if Kant were correct about the a priori source of our understanding of causality, one still would be faced with the problem of trying to explain, in specific terms, how this a priori exercise of pure reason imposes itself on phenomena in a way that leads to workable, concrete, and heuristically valuable understandings of everyday events. In other words, how does the a priori capacity to frame experience in causal terms get translated into specific instances of injecting causality into, or recognizing the presence of causality in, the realm of everyday phenomena?

Perhaps we arrive in existence with a capacity that, within certain parameters, is sensitive to the presence of the causal dynamics which, for example, noumena might inject into phenomenal events. This would be a form of epistemological sensitivity that provides the sort of experiential data which could enable human beings to infer or conclude that phenomenal events appear to have certain kinds of causal relationships because there is something independent of human beings (e.g., possibly, the noumena) which is making those dynamics possible and causal in nature.

If the foregoing scenario were true, then, one might have to rethink the whole issue of a priori categories involving principles such as causality. While Hermann might be correct that one cannot empirically demonstrate either, on the one hand, that causality is something which is present in phenomena and must, somehow, be grasped by human beings, or, on the other hand, that causality is something which is present in human cognition and is being projected onto, or imposed on, phenomenal events, nevertheless, given such an understanding, she, presumably, also would be required to acknowledge that her assumption concerning Kant's belief about the a priori nature of the principle of causality seems to exhibit a certain resonance with the mistaken nature of the assumption which von Neumann had made in connection with the structure of hidden variable theories – namely, that, in a sense, he had assumed his conclusions, just as Hermann has, in a sense, assumed her conclusions by using a Kantian perspective concerning the nature of a priori categories to advance her argument that judgments involving causality are necessarily a priori and, therefore, are not subject to empirical considerations.

A little later in the present chapter, the topic of a priori dynamics will be revisited. For now, let's return to Hermann's concerns about whether, or not, quantum dynamics vitiated the principle of causality.

As noted previously, Hermann believed that von Neumann had made a mistake with respect to his treatment of hidden variable theories because, among other things, he believed that quantum systems could be treated as consisting of a group of uniform particles that could not be distinguished from one another, and, as a result, there would be no difference to the dynamics of such a system if one were to exchange another like-particle for any of the particles which were present in that system. Hermann contended, however, that even though she agreed -- notwithstanding the process of an exchange of one uniform particle for another -- that the statistical character of such a system would not change, nonetheless, she believed von Neumann could not rule out the possibility that if particles were individually considered, then, those individual particles might exhibit their own determinate properties.

There appears to be a potential problem with the foregoing way of analyzing things irrespective of whether one is engaging issues through the lenses of quantum mechanics or the lenses of Kantian-like philosophy. If Bohr is correct (and I am picking on Bohr because the vast majority of quantum physicists seem to accept his philosophical orientation concerning the relationship between quantum phenomena and the classical world), and, therefore, particles do not exist independently of the measurement process, then, one cannot possibly know anything about what is making such a statistical system possible, and, consequently, one cannot say whether that system consists of particles which are uniform in nature, as von Neumann, asserts, or consists of particles which are unique and, as a result, as Hermann suggests, might have their own determinate nature.

If a system is being described statistically, then, one would like to know why the statistical properties of that system are characterized in one way rather than another. The wave function can't address that problem since all the function can do is give expression to the alleged superpositional probabilities or statistics associated with a given context without any account of how such a probability or statistical distribution comes to have the properties it does.

Notwithstanding the foregoing considerations or Hermann's own criticism of von Neumann's treatment of hidden variable theories, she proceeds to argue that although she accepts the viability and completeness of quantum mechanics, she does not believe that mathematics is capable of determining, in any definitive, manner whether, the indeterminacy which is associated with quantum mechanics is a problem that, as Bohr maintained, is inherent in the very nature of phenomena, or whether such indeterminacy is merely a reflection of our ignorance concerning a given situation. At this point, one should keep in mind that part of the reason for von Neumann's decision to include a discussion of hidden variable theories in his mathematical formalization of quantum mechanics was to lend support to Bohr's position over against the hidden variables perspective of individuals such as Einstein, Schrödinger, and/or de Broglie. However, if mathematical formalism was incapable of determining whether, or not, indeterminacy was either inherent in ontological dynamics or was the result of ignorance concerning the details of a given context, then, how did Hermann propose to demonstrate that causality was an issue that needed to be engaged through philosophy?

According to Giulia Paparo, Hermann believed that most people's conception of causality involves several components. On the one hand, there is the idea that every effect has a cause, and, on the other hand, there is the notion that if one knows what causes a given effect, then, one is in a position to be able to predict future outcomes concerning such effects.

Notwithstanding the foregoing sorts of considerations, Hermann maintained that a distinction must be drawn between causality and predictability. For example, there is no inconsistency in saying that a given event is unpredictable and, yet, has a cause because the nature of the cause might be so complex that even if one knew all the elements which gave expression to such a causal dynamic, nonetheless, one might not know how to fit the elements together in the right way to enable one to predict the future.

When I was an undergraduate, I took a philosophy course with Morton White who a few years later took up residence at the Institute for Advanced Study that is associated with Princeton University. He had a very interesting way of thinking about the issue of causality.

One of the examples that he used to illustrate his perspective had to do with the lighting of a match. Normally speaking, most of us would say that the striking of a match against a given surface is what caused the match to light, but the situation is actually much more complicated than our usually superficial way of understanding such a process tends to suggest.

A match head is not likely to light if the match head did not have the right combination of: (a) phosphorus (used for inducing combustion), (b) potassium chlorate (supplies oxygen for combustion), (c) two kinds of binders (such as various kinds of starches, gums, and animal glue which help hold the ingredients together prior to igniting and also provide combustibles during the process of initial ignition, as well as other materials such as ground glass which, through fusion, helps keep the burning ash together), and (d) diatomaceous earth (provides bulk as well as helps regulate the speed of the combustion process). Furthermore, if the match is wet, it is not likely to ignite. In addition, if the nature of the surface against which the match is struck is not sufficiently rigid or is not made from the right kinds of materials with the right kind of uneven contours, then, the match is not likely to light. Moreover, if the motion with which the match is struck is not done with the right force, the match might not light. Also, if the atmosphere surrounding the match does not contain sufficient oxygen or contains other gasses that have the capacity to suppress ignition, then the match is not likely to light. Alternatively, if there are gusts of wind present, then, the match not light. Finally, if the stick on which the match head rests does not have the right tensile strength, then, the match is unlikely to light if the stick breaks during the process of striking it against a given surface.

For good measure, one might throw into the foregoing mix of considerations the idea that in order for the match to light, there has to be at least one individual who wants to light a match. The existence of such an individual would involve all of the causal events that had led to the point in time and circumstances which had led to a need, perceived or otherwise, to light a match and which, as well, had given rise to conditions that entailed the purchase of said matches as well as the gathering of resources and hiring of people to manufacture, deliver to market, and sell those matches.

In the case of lighting a match, the causality dynamics are fairly complex even though most of us don't actually think too much about what is required for a match to light. Yet, lighting a match is just one kind of causality complex in our everyday lives – lives which consist of a multiplicity of causal relationships which depend on an array of necessary conditions being realized in order for certain kinds of effects to be forthcoming.

Hermann contends that due to the role which indeterminacy plays in quantum phenomena, one cannot predict the future course of quantum systems. Nonetheless, even if predictability is lost to varying degrees, she believes the principle of causality is still active in such systems because once an observation or measurement has been made, one can, in a sense, reverse engineer the outcome and establish the causal chain which led to such a result.

Kant maintained that the temporal sequence of events is a fundamental element of our experience. Furthermore, Kant contends that the conjecture involving two events which are temporally contiguous, in some way, to one another might be causally connected is not something that is a function of direct experience but is, instead, the result of the way a priori dynamics bind those contiguous temporal events together in a synthetic act of pure reason – that is, reason devoid of experiential considerations.

For Hermann, once a measurement or an observation has been made in relation to some sort of quantum phenomenon, then, the reconstruction of the experimental context associated with the study of such a phenomenon offers one an opportunity to try to figure out causal relationships by reflecting on various temporal sequences of events entailed by the experiment and which conceptually links some of those events together as causally related through a synthetic form of judgment that is provided by the inherent capability in human beings for engaging such events through the a priori category or principle of causation. One might not be able to predict the behavior of a quantum system over time, but, nevertheless, through a process of post-experimental reconstruction, one can establish causal relationships through the exercise of pure reason's rootedness in a priori categories.

However, for Hermann, Kant's a priori principle of causation does not provide an absolute understanding concerning the nature of phenomena. Instead, it offers a regulative principle that is intended to help a person manageably cope with the overwhelming amount of experiential data that flows into one's life over time.

Grete Hermann also believed that quantum physics does not lead to absolute knowledge. Understanding is tied to what is manifested in the process of observation or measurement, and, therefore, all knowledge is relative to the observations or measurements that are made, and, in this sense, the understanding which is acquired through the measurement and observation of quantum phenomena is relative in a way that is consonant with the manner in which the regulative nature of the causal principle being expressed through a priori synthetic judgments is also relative in nature – relative to the temporal sequences that are being linked together in a given set of experiential events. The foregoing perspective gives expression to Hermann's relativistic-like interpretation of quantum mechanics.

As noted earlier, Hermann's argued that the presence of causality can be identified through the reconstruction of an experiment by retracing the sequence of temporal events which took one from the beginning of an experiment to its termination. Whether one agrees with Hermann that those temporal events can be understood from a Kantian-like perspective as potential links in a conceptual relationship that is being constructed through indigenous, a priori capabilities which synthetically link together some of those temporal events to form a causal bond between the selected temporal events, or, alternatively, one believes that causality has something to do with the way in which objects, entities, relationships, and dynamics which have an existence that is independent of human thought can be shaped and effected by forces of various kinds that also need not be a function of human existence (although, in some instances, this might be the case), nevertheless, irrespective of which of the two foregoing possibilities one prefers, the reconstruction process that attempts to identify the presence of causality cannot just be a matter of linking two temporal events and labeling the linkage to be causal in nature.

In other words, there must be something ontologically substantive which indicates, suggests, or supports the notion that whatever binds two temporal events together is more than a belief, conjecture, hypothesis, or assertion. Moreover, when alluding to the dynamics of causality in a particular context, one's perspective is seriously deficient if one cannot provide details that can be independently corroborated with respect to the nature of such causal dynamics even if one is correct that two temporal events do, in fact, have a causal connection of some kind.

To claim, as Kant and Hermann do, that two temporally separated events are causally linked because an a priori dynamic has generated a synthetic judgment that claims such is the case, fails to demonstrate that this sort of a judgment is correct, or even if correct, that this kind of a claim fails to specify what the nature of the causal link is or indicate how one should go about verifying either the general claim of causality or provide a method for working out the details of the alleged causal relationship. To claim, as Herman does, that one can engage in a process of reconstructing the dynamics which, supposedly, gave rise to a particular kind of observation or measurement in order to determine the nature of the causal relationship in relation to different aspects of a quantum phenomena also entails a variety of questions, not the least of which is: How do specific outcomes get generated by a set of superpositional potentials and probabilities, or, stated in another way, how do quantum entities which, allegedly, do not exist prior to a measurement or prior to an observation, suddenly take on concrete, ontological status following such an observation or measurement.

There is a sense in which quantum physicists are sort of like idiot savants. They can engage in the most amazing calculations that produce concrete, verifiable results, and, yet, they do not appear to have a clue about how such results are possible … they just keep churning out the numbers.

In another sense, quantum physics is conducted in a manner that is similar to a form of conduct or methodology that is present in clinical medicine. More specifically, in the latter case, doctors will use off-label medicines to treat a disease of some kind, but such usage is not rooted in any understanding of how or why those medicines work in medical cases for which those drugs had not initially come into existence as a form of treatment.

If something has been found to be successful in a clinical setting, doctors are often not that fussy about the considerable ignorance which surrounds the use of such off-label drugs as long as the outcome from such usage leads to a successful outcome. This resonates with the way in which quantum physicists appear to be less concerned with whether, or not, they understand what is going on as long as what is taking place is leading to useful results.

Returning to Grete Hermann, one should note that she engaged in regular professional exchanges with some fairly prominent individuals in the world of physics. For example, not only did she have a close relationship with her mentor Emmy Noether, who, as previously indicated, had made a number of substantial contributions concerning the mathematics of quantum physics, but, in addition, Hermann also interacted with people such as Werner Heisenberg, Carl Friedrich Weiszäcker (a student of both Bohr and Heisenberg), Paul Bernays (a colleague of David Hilbert who – until Gödel came along – had been trying to place all of mathematics on a logically and philosophically unassailable foundation), as well as Pascual Jordan (a prominent mathematician and participant in the development of quantum mechanics).

Heisenberg used an entire chapter of his 1972 book, *Physics and Beyond*, to explore certain aspects of the discussions which he had with Grete Hermann concerning issues involving quantum mechanics, Kantian philosophy, and the issue of causality. With respect to Hermann's contention that empirical methods are incapable of disproving the principle of causality, Heisenberg agrees to some extent.

For example, he cites an example which seems to concur with Hermann's perspective concerning the limits of empirical methods by referencing the case of Radium B. More specifically, he indicates that no one knows why, when considering any given quantity of Radium, one atom rather than another is subject to decay, and no one knows why electrons are emitted in one direction rather than another during any given process of decay.

Heisenberg proceeds to indicate that despite the existence of things which are not known about different aspects of physics, quantum physics is, nonetheless, a complete system. He adds that notwithstanding the existence of aspects of reality which are not known, there are no grounds for supposing that other kinds of causes exist which can explain that for which quantum physics is not able to provide an explanation.

The foregoing is a rather astonishing, if not mystifying, claim. According to Heisenberg, we do not know, on the one hand, why the atoms in Radium B decay at different rates, and, yet, apparently missing from the foregoing observation is the fact that the half-life of different forms of Radium takes place at a regular rate. In short, there seems to be a disconnect here between: (a) acknowledging that we do not why atoms of a given radioactive element decay at different rates even while the half-life of elements consisting of a set of such atoms remains stable, and (b) claiming that quantum dynamics is a complete theory, because if quantum dynamics is truly a complete system, then, why can't it account for why different radioactive atoms decay when they do or why a collective of such radioactive atoms decay in determinate amounts per unit of time.

The foregoing disconnect also applies to Grete Hermann's perspective. After all, despite having demonstrated that there is a problem with von Neumann's treatment of the hidden variables issue, she tends to downplay that discovery and continues to accept the notion that quantum mechanics is a complete system while remaining committed to a position which maintains that the principle of causality is not inconsistent with quantum physics.

Consequently, just as Heisenberg is confronted with the problem of needing to provide a non-contradictory account in relation to the issue of how not being able to explain in what way the decay behavior of radioactive atoms is consistent with the idea that quantum mechanics is a complete system for dealing with quantum phenomena, so too, Hermann faces the same conundrum because, like Heisenberg, she accepts the idea that quantum mechanics is a complete system and, as a result, there is no need to look for answers beyond what is provided by quantum mechanics. Furthermore, Hermann is also faced with the additional task of providing an explanation for how we know that a priori synthetic judgments provide a complete, non-arbitrary, and non-superficial account of the alleged causal relationship involving various temporal events if we don't know what the nature of the relationship is between noumena (things in themselves) and the phenomena that are experienced in our everyday lives.

In her master's thesis, Giulia Paparo describes how although Heisenberg accepts Kant's claim that a priori categories of understanding are necessary conditions for the acquisition of knowledge, nonetheless, Heisenberg believes the indeterminacies which are present in quantum mechanics place constraints on what sorts of knowledge are possible in conjunction with those a priori categories. However, Heisenberg uses a peculiar example to illustrate what he considers the relationship to be between classical physics and the new physics of quantum mechanics.

More specifically, Heisenberg states that prior to the voyages of Columbus near the end of the 15th century, people generally believed that the world was flat and, consequently, if one travelled far enough one would risk falling off the edge of the Earth. Heisenberg goes on to indicate that once Columbus had made his journeys to the new world, people realized that the world was round and, therefore, searching for locations where the flat Earth became a cliff-like affair that supposedly dropped off into the abyss of space became a useless exercise.

Heisenberg's understanding seems a little muddled at this point. While it might be true that prior to Columbus there were a certain number of people who believed that the world was flat, nevertheless, the idea that the world was round and not flat actually already existed during the time of Pythagoras -- roughly 500 B.C.. As a result, many educated Europeans were familiar with the arguments and data that had accumulated for several thousand years prior to the 15th century and which demonstrated the spherical nature of the Earth.

How much of that understanding had filtered down to the generality of people is unknown. Therefore, contrary to what Heisenberg indicates, one cannot be sure what people, in general, might have believed about the nature of the Earth's shape.

Moreover, the journeys taken by Columbus didn't really prove that the world was round. Rather, it only proved that many people, including Columbus, appeared to be confused concerning how one might go about trying to navigate their way to India and Cathay (China).

As far as ocean expeditions are concerned, it was not Columbus, but the world tour undertaken by Ferdinand Magellan which led to successfully circumnavigating the Earth – and, thereby, provided additional evidence that the world was round. The 1,082 day journey which constituted the Magellan expedition started in September of 1519 with: Five ships, 250 men worth of crews to man those ships, and Magellan, but the journey ended without Magellan, three of the ships, as well as a smaller contingent of sailors than when the expedition had begun.

Heisenberg's problematic understanding concerning Columbus and the spherical nature of the Earth seems to resonate with the way he understands the nature of the relationship among Kant, classical physics, and quantum mechanics. For example, although Heisenberg claims to agree with Hermann that Kant's theory of a priori categories still holds, he, like Hermann, fails to provide any evidence to demonstrate that Kant's perspective is correct, and, therefore, like his Columbus illustration, his perspective is somewhat muddled with respect to Kant's relevance to quantum physics.

Furthermore, while Heisenberg believed – incorrectly perhaps – that just as people's ideas about the shape of the Earth changed following Columbus's journey to the New World, so too, people's ideas concerning the nature of objectivity and causality also would have to change with the emergence of quantum mechanics, nevertheless, like

Columbus, Heisenberg appears to be under the influence of a certain amount of confusion concerning how to go about navigating to the destination one desires. Heisenberg claims that quantum mechanics limits the kind of objectivity one can have, but he doesn't seem to consider the possibility that the reason why one's access to objective knowledge concerning the nature of the universe is limited is a function of structural character and properties of quantum methodology and not necessarily due to an indeterminacy which he contends is, allegedly, in the very fabric of physical phenomena.

Carl Friedrich Weiszäcker, a physicist and philosopher (and who had worked under Heisenberg's supervision in the attempt to build a nuclear weapon for Germany during the Second World War), also was part of the foregoing discussion involving Werner Heisenberg and Grete Hermann. He agreed with Heisenberg and Hermann that while Kant's a priori categories still retained a certain amount of validity, nonetheless, he also agreed with Heisenberg that such validity was circumscribed by the limits which, among other considerations, the principle of indeterminacy had revealed concerning the nature of the world.

As a result, he maintained that one can no longer have a complete, objective, causality-laden, universally valid knowledge of the phenomenal universe as Kant believed was possible. Instead, one was limited to what could be established through observation of individual experiments.

Consequently, Weiszäcker believed that whatever Kant had to say about the acquisition of knowledge would have to be relativized to concrete particulars rather than be captured through abstract universals. As a result, Weiszäcker maintained that Kant's notion of a priori categories were nothing more than general rules of logic that could be verified through experience and experimentation rather than constitute necessary pre-conditions for the existence of knowledge.

Weiszäcker didn't indicate how these rules of logic came into being or what their source might have been. Moreover, although he presumed that there were ways in which such rules of logic could be verified through experience and experimentation, he didn't specify what those ways were or what the criteria were for establishing verification in such cases.

Weiszäcker also argued that Kant's notion of 'das ding an sich' (the thing in itself) becomes problematic on the quantum level because, due to issues of indeterminacy, one would find coning to know the absolute characteristics of things in themselves to be an impossibility. Leaving aside the consideration that Kant did not believe things in themselves, or the noumena, could ever be known by human beings, and therefore, Weiszäcker's comments concerning the issue of things in themselves and the quantum level were irrelevant to Kantian philosophy, nevertheless, like Heisenberg, Weiszäcker fails to note the potential difference between the limits of one's methodology and the nature of reality or how the former could be the source of limitation and obfuscation rather than epistemological limitation being an inherent dimension of reality.

Weiszäcker claimed that Kant's system of thought would have to be relativized in the light of quantum methodology. Yet, Weiszäcker did not seem to appreciate that reality had been relativized by quantum methodology because reality was being made a function of what quantum methodology permitted one to see or consider, and, therefore, like the drunk looking for his lost keys at night, a questionable decision was made to look for lost things where there is some degree of light (such as beneath the light standard of quantum mechanics) rather than search for the key wherever it is that they actually might have been lost – which could have been anywhere between the bar (noumena) and the parking lot (phenomena).

A number of pages ago, indication was given that the issue of a priori categories would be brought back into the discussion. Let us, now, turn briefly to that promised topic.

For the sake of argument, let us assume that Kant is correct with respect to the nature of a priori categories. In other words, let us assume that a priori categories are innate in some sense, and, therefore, they help to make possible pure reason – that is, thought which is guided by an understanding which exists independent of experience.

What is the source of a priori understanding? Is it a function of, or does it give expression to, noumena, or is it a function of, or give expression to, something else other than experience, and, if the latter is the case, then, what is the nature of this something else?

What is the relationship, if any, of: Intuition, insight, veridical dreams, mystical unveiling, or revelation to a priori categories? Are these modalities of understanding forms of a priori categories?

The following anecdote bears upon the foregoing questions. More specifically, approximately 25 years ago I moved back to an area that was 60 miles away from where I had attended high school.

After living in the new area for about ten years, my brother told me one day that a former teacher and athletic coach of mine had found out that I was back in Maine and – for reasons that I couldn't fathom – he had communicated to my brother that he (i.e., my former coach) was somewhat "desperate" to talk with me. To be fair to my former teacher's and coach's actual state of mind, however, the term "desperate" might have been my brother's interpretation of what had been said rather that what was actually being communicated by the individual whose message my brother was passing on to me.

To some extent, I am inclined toward the sentiments expressed in Bruce Springfield's song "Glory Days" and tend to try to keep my distance from the gravitational pull of certain aspects of the past. Consequently, I wasn't sure that I wanted to meet my former high school teacher and coach in order to talk about the old days, but, eventually, called the phone number which had been passed on to me by my brother and arranged for a time and place when and where we could meet.

My former teacher and coach invited me to come to his home -- about a forty-minute, or so, drive from my residence – and join him for some lunch. He indicated that his wife had some sort of church activity to attend, but we could eat and would have time to talk.

When I arrived, his wife had not, yet, left for her meeting but had stayed long enough to fix some lunch. Unfortunately, she had fixed some sort of pork dish and I apologized for not being able to consume what she had prepared because I was Muslim.

Not too long after my arrival, and following a certain amount of conversation with her and her husband, the wife of my former teacher and coach left for her pre-arranged meeting. Once his wife departed, we talked for a number of hours.

There were two primary themes that emerged during that conversation. For one thing, I realized that within me was an element of the sort of emotion that is often left over from childhood interactions with someone who had been an authority figure in one's life, and the presence of that feeling bothered me but I didn't wish to bring it up during our talk. The second prominent theme which came to fruition through our meeting is that I developed a genuine appreciation and respect for him as a person – a set of feelings and thoughts that I probably didn't have when I was his student and was just a self-absorbed, emotionally insecure, dumb teenager.

This new found appreciation and respect for him as a person and not as an authority figure was possible because during our conversation he related a lot of information concerning what had transpired in his life over the last fifty years, or so, prior to our get together. I found him to be a very compassionate, caring, and dedicated individual on a variety of levels.

Assuming that someone might wonder whether I talked much about my life during the conversation, the answer is no. This is not because my former teacher and coach was not interested in me and, therefore, didn't ask any questions, but, rather, I sometimes have a knack for inducing people to talk about themselves and, consequently, I often spent my time following up on various leads that were present in his comments as we were talking about this or that.

Eventually, his wife returned from her outing. The discussion continued for a while longer, but I sensed that, perhaps, the meeting should come to a close, and, broached my intentions to undertake my return journey home.

When I finished that drive and walked into the house, my wife asked me a variety of questions about the meeting. I recounted – in outline form – what had transpired during the session with my former teacher and coach, commented on a few aspects of the meeting, and, that was it.

My wife has never seen or talked with the foregoing individual. Prior to my meeting with him, I never talked about him with my wife, and after that one discussion with my wife following the foregoing meeting, I didn't bring the topic up again with my wife.

A number of months later, my wife told me about a dream she had had the night before. She said that my former teacher and coach had contacted her and told her that he was trying to get in touch with me.

Within a day or two of that dream, the local paper reported that the man had passed away. What is the nature or significance of that dream?

Some people, of course, will say that the dream has no significance. It was just a meaningless construction of the unconscious mind that took a few strands of data which she had picked up from me and those elements were assembled into the form of a dream because that is one of the things that the unconscious does.

The foregoing account might be true. However, there is no evidence to prove that this sort of interpretation is true, and, as such, it is just conjecture.

Where do dreams come from? Why do some dreams seem to have more resonance with certain aspects of our everyday lives than do other dreams?

Where do thoughts come from? While one can prove that certain physical events in the brain – such as the presence of various kinds of: Neurotransmitters, dynamics involving synaptic connections, the existence of networks of action potentials, as well as the presence of different kinds of frequency phenomena – can all be shown to have some sort of an association with human thought, nonetheless, whether such factors are correlational or causal in nature, or whether the human brain is a receiver/transmitter or a generator of thought (and, possibly, both) is not a straightforward issue.

Quantum mechanics is unable to account for the source or characteristics related to: Ideas, consciousness, logic, reason, intelligence, understanding, dreams, insight, intuition, memory, artistic talent, language, morality, spirituality, creativity, or choice. Quantum mechanics can't even explain its own capacity to provide correct answers to various questions, and, yet, one is encouraged by quantum physicists – as well as those who are under their influence -- to believe that not only are there no hidden variables outside of the framework of quantum mechanics which might be needed to explain any of the aforementioned phenomena, but such hidden variables cannot possibly exist despite the fact John von Neumann's claim that he has mathematically proven such entities cannot exist has been shown to be mathematically questionable by not only Grete Hermann and, some thirty years later, by John Stewart Bell, but as well, individuals such as Louis de Broglie and David Bohm actually came up with working models of quantum mechanics that incorporated dynamics involving hidden variables.

String theory, symmetry breaking, super symmetry, TOEs or theories of everything, supergravity, and unified field theories, are all pursued with the assumption that some version of quantum dynamics and the standard model constitutes the foundations of existence and makes all phenomena possible. Unfortunately, as the previously noted list of unresolved human capabilities (i.e., consciousness, language, reason, intelligence, etc.) suggests, there is a considerable amount of ignorance, arrogance, and unsubstantiated conjectures embedded in such an assumption.

For example, surely, somewhere in the 10^{500} candidates that are associated with string theory, there exists a version of ontology that is capable of fully describing my wife's dream. Now, if we can just figure out which one of those candidates is the correct one … and, oh yes, while we wait for the correct selection to reveal itself, there are those among us who believe entertaining other approaches to my wife's dream which suggest, in any way, that such events might lay outside the boundaries or confines of quantum theory is not an appropriate stance to take because that wouldn't be scientific.

Just as Einstein sought to limit time to being a function of what a clock measures, so too, quantum physicists appear to contend that in order for any given process of seeking truth to be able to give expression to legitimate knowledge requires that such exploratory efforts must comply with the game of seeking the truth in accordance with the rules which science has laid down as to what is, and is not, acceptable with respect to quantum methodological principles for seeking the truth even though, as previously noted, quantum physics is unable to provide plausible, let alone provable, accounts concerning so many aspects of human existence.

One approach to acquiring knowledge is to engage in a set of practices that are directed outward toward the physical world and are intended to help one to reach out to the universe in order to be able to grasp the character of that which seems to make phenomena possible and which lends to those phenomena the properties that are discovered through certain kinds of rigorously controlled experiences. Another approach to acquiring knowledge is to seek to let existence inform one about its nature through the dynamics of affordances in which the environment – broadly construed – teaches the individual about itself.

Considered from the latter perspective, my wife's dream concerning my former teacher or coach might have been an affordance through which she was being informed by the environment – broadly construed -- about something which had taken place in that environment. Conceivably, some of the significance entailed by that affordance might have been disclosed a day, or so, later when news concerning the passing away of my former teacher and coach became public knowledge.

To whatever extent a priori events are true, they could be understood as affordances in which the environment – broadly conceived -- is seeking to inform us about itself. Of course the operative phrase here is "to whatever extent a priori events are true," but this only means that affordances are confronted with the same sorts of problems with which previously mentioned attempts are confronted which seek to discern the nature of the truth concerning the nature of phenomena and our relationship with Being through so-called scientific means that seek to reach out into the universe and grab hold of some aspect of it.

Ideas, insights, unveilings, intuition, dreams, authentic (as opposed to sham) revelations, and mystical experiences might all give expression to affordances that are being presented to us by the environment – broadly construed. In such cases, the task becomes a matter of, first, trying to discern the difference between the wheat and the chaff in relation to what has value or what is problematic with respect to those kinds of experiences and, then, trying to discern what sorts of truth, if any, are being transmitted through those experiences.

From the foregoing perspective, if one wishes to construe, say, the principle of causality as an expression of a priori dynamics, then, one should not consider it to be something that the human mind imposes on temporal events by synthetically joining them through an act of pure reason. Instead, conceivably, a priori dynamics might give expression to an environmental affordance in which one is being informed about the existence and, possibly, nature of a causal connection between two events which are experienced as being temporally separated.

Given the foregoing considerations, we are faced with having to choose among three broad possibilities. Either we must find a reliable way to grab hold of phenomena, or we must find a way for phenomena to grab hold of us through affordances, or we must find a way of using both possibilities in heuristic combinations with one another.

What is the significance of the probabilities associated with quantum calculations? Rather than interpret those statistics through the lens of superpositional possibilities, perhaps one should engage those probabilities as a form of affordance that is being communicated to scientists from the environment – broadly conceived -- and which have something to do with the underlying phenomena that give those probabilities their characteristic forms in a given set of circumstances but have nothing to do with superpositional considerations which are just part of a system that, for unknown reasons, is able to provide very precise descriptions of certain aspects of experience.

In physics there is a concept referred to as "action." There are different ways of understanding this term.

For example in mechanics, if one is engaging issues through the framework of the notion of 'action', then, this generally entails (as Lagrange and Hamilton did, each in his own manner) reflecting on the way in which potential and kinetic energy exhibit different relational modalities with respect to one another and, in the process, transform one kind of energy into the other. This notion of action is often invoked when trying to determine which pathway or dynamic involves the principle of least action, and there were instances in which engaging problems through the lenses of action -- rather than, say, force or energy -- made one's life easier when the time came for calculating answers to physics problems of various kinds.

When light travels from point A to point B it does so in accordance with the principle of least action. However, what constitutes the nature of least action will depend on the conditions that exist between A and B.

In a vacuum, for instance, light will travel with one kind of dynamic that will be reflected in its compliance with the principle of least action. However, if, at some point during its journey, light travels through water, then, the pathway of the light will become altered as the interaction between light and water gives expression to the principle of least action in a slightly different way as the light responds to the differences in optical density between a vacuum and water.

The light isn't making any calculations to bring about such an adjustment. The change is automatic because the on-going dynamic consists of two affordances – one in which light serves as an environment, of sorts, for water, and another in which the water serves as an environment, of sorts for the light, and the combination of the two affordances gives expression to the principle of least action as the two environments inform one another (and us) about their respective natures and interact accordingly.

The light doesn't have agency through which it selects the path that will result in the least amount of travel time. Light being what it is and water being what it is, the affordances of the two will come together according to the degrees of freedom and constraints which are present in those two natures, and the result will give expression to the principle of least action.

There is another school of thought, however, which seeks to argue that the foregoing sort of account is not accurate. This alternative approach suggests that not just light, but all quantum entities (e.g., electrons, neutrinos and so on), tend to explore all possible pathways going forward in order to select that pathway which will manifest the principle of least action.

As a result, the notion that light or any object travels about according to local rules of dynamics is alleged to be untenable. In a sense, according to this alternative approach which seeks to understand the dynamics of quantum entities, the local rules approach to understanding those dynamics (which is often consonant with our phenomenological sense of how the world appears to work) constitutes an illusion of sorts.

In order to obtain, hopefully, a better understanding of what is at stake here, perhaps, a very brief recapitulation of certain aspects of the history of quantum dynamics is in order. The ensuing analysis will be far more qualitative in nature than quantitative.

Planck's constant -- $6.62607015 \times 10^{-34}$ J·Hz^{-1} -- is a value which gives expression to the nature of the packages of energy that are released or absorbed during various forms of dynamics which take place on the quantum level. According to Planck, whenever a dynamic of some kind transpired in the natural world, that dynamic would be a function of energies which were some whole number multiplied by the Planck constant, and this constituted the 'quantum of action'.

During his 1905 paper on the photoelectric effect, Einstein argued that, under certain conditions, light behaves in a way that suggests it might exist in the form of packets of energy which have the capacity to induce electrons to be released from metal. However, such a capacity came with a rider – namely, electrons would only be ejected from a metal if the frequency of the light hitting the metal was above a certain threshold related to Planck's quantum of action, and as long as this condition was not satisfied, then, no matter how intense the energy of the illuminating light might be, electrons would not be released from a metal's surface.

Nearly a decade after Einstein's paper on the photoelectric effect had been published, Niels Bohr tied the same quantum of action idea to the concept of a discretized notion of angular momentum (which an electron might be presumed to have as it makes its way around the nucleus). He did this as a way of trying to account for why negatively charged electrons continue to be stable in their orbits as they radiate energy rather than spiral toward the positively charged nucleus while those former particle travel about an atom.

In addition to providing a plausible response with respect to the stability issue of electrons, Bohr's manner of conceptualizing the dynamics of electrons in atoms had another dividend. It enabled him to correctly identify, quantify and have insight into the dynamics surrounding different energy levels of the hydrogen atom.

More specifically, when, for whatever reason, an orbiting electron in a hydrogen atom made the transition from a higher energy level to a lower level, then, energy is radiated. This energy is released in the form of a photon with a specific frequency, and by taking notice of these transitions under different circumstances, one could construct a profile for various levels of energy which a hydrogen atom might manifest in various conditions.

Einstein indicated that light had to have a certain quantum of action (as a function of frequency) in order to be able to induce electrons to be ejected from a metal's surface. Bohr indicated that the angular momentum of electrons also had to have a certain quantum of action – that was a product of frequency and some whole number (representing a given energy level) divided by 2π (which is connected to the way electron orbits were being modeled) in order for energy to be expended or radiated by an electron in a way that preserved the stability of the atom.

A little over a decade following Bohr's epiphany, Louis de Broglie began to think about some of the implications which might follow if one were to treat light – or any quantum entity – in a dualistic manner … that is, as capable of exhibiting both particle-like and wave-like properties. Given that Einstein had shown in his 1905 paper how light might have particle-like properties, de Broglie proposed in his doctoral dissertation that quantum particles could be considered to have a wave-like potential, and if this were the case, then, there would be a wave length associated with everything that was considered to be particularized matter.

What is a wave length? It can be described as the distance between two consecutive manifestations of the same phase point in any two wave structures that are being used to determine wave length, irrespective of whether this point of phase reference is a matter of the nodes, troughs or somewhere in between the node and trough of those two wave structures.

Usually, the metric for measuring distance in conjunction with wavelength is spatial in nature. Meters, or fractional portions of a meter, tend to serve as the metric for describing wave length.

However, in a sense, distance could also be construed in terms of some sort of 'action' involving the length of time within which a given configuration of energy is being manifested, and, if this were the case, then, frequency could be seen as the number of times that such an 'action' repeats itself during a temporal 'distance' of such-and-such length.

The foregoing way of looking at things could be used to think about the nature of so-called particles independently of whether a person was, on the one hand, conceiving of a wave as a phenomenon which, supposedly, is being transmitted through a given spatial medium of some kind, or, or the other hand, that individual was imagining waves as a phenomenon that is referred to as a standing wave. Standing waves can be described as an oscillatory dynamic of some kind.

In other words, oscillation involves cyclic transitions in value that do not move across space while manifesting peak amplitudes that do not change over time. In addition, standing waves have a phase profile which is expressed by a wavelength that is the same as all other manifestations of that same oscillatory dynamic.

In this sense, a wave is sort of like an 'action' attractor that has boundaries marked by the troughs that separate one manifestation of the action from the next manifestation of that action, as well as from previous instances of that action. Troughs mark the interval between manifestation of the attractor basins that give expression to the values of amplitude, frequency, and wave length that interact with one another to generate the quality and quantity of an 'action' dynamic.

The character of such an action attractor is a function of the amplitude, frequency, and length of time that it takes for that sort of an 'action' complex or configuration to complete its manner or cycle of manifestation. There are at least two perspectives through which might engage the foregoing considerations.

On the one hand, an individual might wish to describe that sort of action attractor complex as a continuous phenomenon, such as exhibited in a sine wave, Or, on the other hand, there could be instances in which a person might wish to consider such an action attractor complex as consisting of a discrete set of properties (e.g., amplitude, frequency, and wave length as a function of time rather than spatial distance) which are separated from successive manifestations of similar action attractor complexes by an interval that is marked by an absence of any properties (which constitutes the trough in continuous renditions of a wave).

Perhaps, depending on how one understands the notion of a wave, there aren't any necessary, or inherent, contradictions between particles and wave dynamics. In other words, when considered as a discrete action attractor (as opposed to being part of a continuous sequence of such attractors) – that is, when considered as a discrete locus of manifestation that gives expression to an action dynamic which constitutes a packet of interacting qualities such as amplitude, frequency, and wave length (understood as a function of time rather than spatial distance) – then, both waves and particles can be seen to be functions of action dynamics, and in such dynamics, there is no wave or particle, per se, but only the properties which are given expression through a given kind of 'action' phenomenon.

de Broglie's way of characterizing particles as phenomena that could be described as waves, and, therefore, phenomena which had the notion of wave length associated with them dovetails with Bohr's manner of conceiving of an electron's angular momentum in an atom. More specifically, if an electron were considered as a standing wave, then its dynamics could be discretized within an atom in accordance with de Broglie's way of thinking about particles such as the electron and that dynamic could be described through Planck's notion of a quantum of action and how energy was absorbed and emitted during such dynamics as a function of that kind of 'action' dynamic.

Now, let us return to issues involving the principle of least action. How does light, or any, quantum phenomenon, find its way to wherever it is going?

As noted previously, one possible answer to the foregoing question is that a given quantum entity merely interacts in accordance with the local conditions through which it journeys and will give expression to the principle of least action because that is what will automatically happen when the prevailing set of degrees of freedom and constraints which constitute the dynamics of a quantum entity's journey through a given set of conditions.

A quantum entity, manifestation, or phenomenon cannot do other that what prevailing conditions permit. As such, a constant feature in all such dynamics is that the principle of least action will be acting on, and/or through, a given quantum entity's mode of interacting with its environment.

In other words, the principle of least action is one of the affordances which the environment – broadly construed -- is communicating to a given quantum entity. The presence of a property of 'action' was noted as far back as Pierre Louis de Maupertuis (1698 – 1769), and was explored further by individuals such as Jean-Louis Lagrange (1736 – 1813) and William Rowan Hamilton (1805 – 1865).

There is, however, at least one other way of responding to the question of: How does a quantum entity proceed on whatever journey it is on at a given time? The short answer to the foregoing question from the perspective of the aforementioned, possible approach to the previous question is that such a quantum entity explores all possible paths and, somehow, finds the path which is in compliance with the principle of least action.

To illustrate this, let's consider aspects of the double slit experiment. According to standard descriptions of this experiment, electrons are released one at a time from some sort of electron generating device.

What is never said in such descriptions is whether the electron is released as a wave or a particle … just that things are done one at a time. In addition, nothing is said about having a choice as to whether one can consider the wave as constituting a discrete action attractor (as previously described) or one is required to consider a wave in the classical sense of a continuous succession of wave forms in which wavelength is understood to refer to some quantitative form of spatial length.

Another consideration which is not usually mentioned in relation to such experiments has to do with entanglement phenomena. In other words, how do we know whether, or not, other electrons with which a given electron which is being shot toward a screen might be entangled in a manner which could interfere with, affect or influence what happens during such an experiment, especially when it comes to the dynamics which take place in conjunction with the partition that contains one, or more slits, and has been placed between the electron gun and a screen that is able to detect the presence of electrons when the latter entities engage, and are engaged by, the detection screen?

According to some narratives concerning double-slit experiments, one is told that because we don't know which slit an electron goes through, we must operate in accordance with the perspective of quantum mechanics and suppose -- due, presumably, to, among other things, the property of superpositional considerations -- that the electron goes through both slits at the same time. However, what if the property of superpositional possibilities is an artifact of quantum methodology rather than an expression of ontological realities, and how would we determine which is the case?

The idea that quantum entities are inherently superpositional does not come from first principles. It comes from a process that is very similar to Planck's solution to the discrepancy which existed between the predictions that his own theory was making and what experimentalists were actually finding – namely, someone had stumbled upon a way to solve a problem without understanding what such a method for solving a certain kind of problem has to do with reality.

In Planck's case, he had no understanding why some atoms would emit energy while others did not, but he knew that if he used his quantum of action in his equations -- and keep in mind that not all atoms would have the energy necessary to emit energy -- he could get certain discrepancies between theoretical prediction and experimental measurements to disappear. In the case of considerations involving the idea of superpositional possibilities, Max Born had noted that if – for no real good reason rooted in fundamentals of physics – one were to square certain calculations, and if one, then, interpreted the outcome of such a process of squaring certain results as giving expression to probabilities, then, one could make sense of Schrödinger's equation as a way of identifying what the probabilities were for certain kinds of outcomes in a given set of circumstances.

Now, why -- for no reason other than that a given method leads to reliable, precise, useful results -- should one accept the contention that quantum mechanics is correct when it claims that the entities which it explores do not exist prior to observation or measurement except as superpositional possibilities or potentials that can be described through probabilities. There is nothing independent of quantum mechanics which is capable of verifying that such a framework's ideas concerning the alleged superpositional nature of ontology is correct.

However, with respect to the double-slit experiment, in order to determine what the probability is of a given electron ending up in one place on a detection screen rather than some other portion of that detection screen, one adds up the amplitudes of two electrons (one of which might be fictional in nature) which have been hypothesized to be going through both slits at the same time because we don't actually know which slit a given electron might have journeyed through and, therefore, we are relying on a framework which we have no reason to believe is capable of explaining the actual dynamics at the double-slit partition because that framework has not actually been derived from first principles … but, rather, it is the product of a fortuitous, heuristically valuable way of interpreting the results generated by Schrödinger's equation – an interpretation with which Schrödinger, himself, was unhappy (to put it mildly) because, like Einstein, he believed in an objective reality which existed independently of our experiments, mathematical treatments, and calculations.

At this point in the double-slit narrative, some individuals offer an account of an apparently apocryphal story concerning Richard Feynman who, supposedly, as a student, was attending a professor's presentation concerning the double-slit experiment and began asking questions about what would happen if one began to add more slits to the partition that stood between the electron gun and the detection screen. To make a longer story shorter, the more slits that one added, then, this meant that a person would have to add together the amplitudes of the alleged entities that supposedly went through all slits simultaneously because that individual had to suppose, on the basis of the superpositional aspect of quantum mechanics -- or in order to save theoretical appearances -- that the electron was going through all available slits.

The foregoing scenario can be made more complicated by introducing an infinite number of slits in the partition. Complications can be added to complications by proposing that other partitions with infinite slits should be placed in between the electron gun and the detection screen,

In principle, notwithstanding the addition of infinite numbers of slits and infinite numbers of partitions containing such slits, the method for calculating probabilities concerning the landing spot of any given electron that was shot from a gun would remain the same. In other words, to calculate the probability of where a given electron will land on the detection screen, one must add up all of the amplitudes from electrons that have been alleged to, simultaneously, be going through an infinite set of partitions with infinite numbers of slits because of the assumption that the nature of reality is superpositional in character.

In effect, the aforementioned scenario is indicating that with, or without, the infinite set of partitions, each containing infinite slits, through which an electron supposedly travels simultaneously, nonetheless, the results are the same. Allegedly, quantum entities are always, everywhere, simultaneously exploring an infinite set of superpositional possibilities in order to discover the principle of least action which will land a given electron that has been shot from a gun at a given point on a detection screen.

The foregoing considerations reflect the general form of the mathematical process known as the 'path integral formulation of quantum mechanics) which enables one to describe how, for example, electrons end up creating the probabilistic patterns they do on a detection screen. The mathematical process works, but there is no way to show that such a methodology actually describes what is transpiring as electrons journey from the gun, through the slits in the partition to the detection screen.

Instead of probing why such probabilistic patterns on the screen have the properties they do, quantum physicists tend to limit their focus and concerns to making calculations that are correct. Conceivably, the probabilistic patterns could be signs of the presence of an affordance which is indicating that the environment is trying to tell quantum physicists that there is a reason why the probabilities have the form that they do, but that reason falls outside of the lenses which quantum physics uses to look at such phenomena, and, consequently, like many practitioners of clinical medicine, quantum physicists seem to be satisfied with methods which generate useful results quite apart from whether those results enable us to understand what those results – irrespective of how precise and useful they might be -- have to do with the nature of reality, ontology or Being.

Wave amplitudes are a function of phase dynamics because whatever aspect of a wave one is considering gives expression to some facet of the phase. In turn, the dynamics of an "action attractor" determine the structural properties of phase because those dynamics are what modulates the nature of the phases that are possible for a given wave form.

As a wave form runs through its phase properties, the amplitude characteristics of the wave will change in accordance with the aspect of phase that is being manifested. Phase gives structural and dynamic form to the way a given "action attractor" operates in a given set of circumstances, such as a double-slit experiment.

Therefore, irrespective of whether one refers to an electron as particle-like or wave-like, ultimately, it is an action attractor. The electron action attractor manifests all of the properties which have been experimentally determined and are associated with electrons.

If one considers wavelength to be a function of time and not spatial distance, then, as far as the "electron action attractor" is concerned, one is dealing with a discrete manifestation of frequency, amplitude, and phase which is separated from other "electron action attractors" by intervals of non-action (assuming, of course, there are no entanglement phenomena taking place). If one continues to run the double-slit experiment for a period of time, the detector screen will display a pattern that looks like a wave with hills and valleys of nodes and troughs.

What one is seeing is not a wave, per se, but, rather, one is observing the way in which the phase of the electron action attractor engages, and is engaged by, the detector screen. Different phases will result in different amplitudes, and, therefore, one will see the probability distribution for different manifestations of phase/amplitude (some of which are cancelled out through the dynamics of interference), just as at the turn of the 20th century Planck observed that not all atoms – due to the phase in which their action attractor was in -- are able to release the quantum of action that is associated with the certain frequency areas of the spectrum, and, as a result, the energies experimentally emitted would could be reconciled with theoretical predictions.

There are different equations for calculating the 'action' or Lagrangian for a given kind of dynamic. For example, there is such an equation for electrodynamics, and there is such an equation for classical mechanics, and there is such an equation for special relativity as well as other kinds of dynamics.

The foregoing mathematical expressions constitute attempts to find a way to accurately describe what is happening in nature or in a given set of experimental circumstances. For quite some time, physicists have been searching for the Lagrangian equation that constitutes a theory of everything such that if one solves the equation by substituting relevant values, then, such an equation would be able to reflect the dynamics of pretty nearly everything … or so the theory goes.

Nonetheless, those sorts of accounts -- as appears to be the case of the double-slit experiment – do not necessarily explain what is actually taking place. Describing 'something' is not necessarily synonymous with explaining what is being provided with a description, and showing that 'something' can happen is not the same thing as providing an accurate account of what is actually happening when that 'something' occurs.

A lot of very useful understandings can flow though heuristically valuable descriptions – and this certainly is the case in quantum mechanics. However, understanding the nature of that which makes possible the phenomena that are being described mathematically is not necessarily a part of those kinds of descriptions.

For instance, one can speak of the notion of a sum over history of a quantum entity's movement between point A and point B and use a mathematical equation for calculating the end result of such a history, and the perspective which accompanies that sort of a calculation is that the particle is exploring all possible paths before settling on the one which will give expression to the principle of least action. Mathematically, such a way of doing things is able to provide an accurate answer concerning the likely location of the landing point of such an entity, but there is no way of proving that the quantum entity being studied actually does do what the mathematics claims is the case, anymore than the mathematics associated with quantum mechanics can show that quantum entities exist as superpositional probabilities or potentials prior to measurement even though that same mathematics can generate very precise answers to complex issues concerning quantum phenomena.

One could suppose that a quantum entity busies itself with exploring every possible pathway between point A and point B in search of a pathway that gives expression to the principle of least action. However, such an approach leads to bevy of questions, such as: How does a quantum entity go about its search, or how does it know that for which it is looking, or how much time would such a search take (and here we are getting into issues which resonate with the infinities that Gerardus ’t Hooft and Martinus Veltman mathematically removed from certain problematic areas of quantum field theory without also explaining how infinities were to be removed from the ontological side of things), or, once the correct path is found, then how is this communicated to the quantum entity and how does that entity decode the communication?

All of the foregoing sorts of questions would fall by the way side if one were to just entertain the possibility (for which there is a great deal of circumstantial evidence) that the principle of least action is an environmental affordance which engages, and is engaged by, any, and all, quantum entities that are moving from point A to point B. As such, the principle of least action is inherent in the nature of things and, consequently, nothing can travel from point A to point B without encountering that principle and being affected by the presence of its dynamic.

The principle of least action is like an attractor dynamic which induces anything traveling through its domain to behave in compliance with what such a dynamic requires in a given set of circumstances. The principle of least action sets out the degrees of freedom (i.e., what a given entity is able to do without violating the dynamics of the principle of least action) as well as the degrees of constraints (i.e., forces which will cancel out, or interfere with, the realization of various possibilities) that also will shape the path which will be taken by such an entity.

Mathematically, there is a way of providing accurate answers to questions concerning the movement of a given entity from point A to point B. However, those mathematical treatments do not necessarily have anything to do with how such an entity actually goes from one point to the other.

Richard Feynman is reported (perhaps apocryphally) to have advised a graduate student who had become deeply confused about the ontological character of the quantum world to 'just do the calculations; no one understands what is going on.' Well, conceivably, perhaps, in a sense, we do know what is going on in such cases – namely, the principle of least action is making its presence known to any entity that enters into its province of control, but although the calculations that are performed provide one with accurate answers concerning the dynamics of the principle of least action, no one knows why the calculations work which reverses the alleged advice of Feynman.

Leaving physics aside for the moment, one could consider the notion of 'action' to be an affordance of the environment – broadly conceived. In other words, irrespective of how one describes the action mathematically, when 'action' is considered to be an affordance, then, one is dealing with the environment's capacity to convey something about itself to whomever or whatever is engaging or is engaged by such an affordance.

A mathematical equation, expression, or function might descriptively capture something of what is being transmitted in a given set of circumstances. Whether such mathematical linguistics captures everything that is being transmitted in such a context is another issue.

Use whatever mathematical equation, expression, or function one likes, nevertheless, an individual will not find anything that will account for why radioactive atoms decay when they do or why radioactive elements have different kinds of signature half-lives. There are mathematical equations, expressions and functions which describe the general nature of the decay process and which are capable of indicating what the half-life of a given radioactive substance is, but none of those mathematical or physical tools will enable one to explain why a given atom will decay when it does or why the half-lives of radioactive elements have the specific properties that they do.

At the present time, the nature of the action of radioactive substances is unknown in certain fundamental ways. Furthermore, at the present time, the nature of the dynamics of action that make possible: Intelligence, consciousness, language, creativity, talent, intuition, insight, dreams, reason/logic, understanding, and so on are, also, unknown, and there is no guarantee that in a few years, decades, or longer anyone will discover that the nature of the action of such phenomena is necessarily a function of quantum dynamics, and if the nature of the action underlying such phenomena turns out to be a function of something other than quantum mechanics, then, however complete quantum mechanics might be considered to be, or not to be, that perspective would be irrelevant to providing any insight into the foregoing list of phenomena.

In many physical contexts, we have some understanding of the sort of energy -- both potential and kinetic – through which action is expressed. But, some modalities of energy might not be manifested in forms with which we are familiar, and to whatever extent this turns out to be the case, then, the nature of the principle of least action will be manifested differently.

For instance, if consciousness, intelligence, creativity, reason, understanding, and so on do not operate in accordance with, or only partially in accordance with, energy in the form of the strong force or electrodynamic forms of energy, or some other kind of force with which we are familiar, then, such energy will have a form of action that is not currently understood. Something more deeply hidden than quantum dynamics will be needed to probe those phenomena.

In the chapters that follow, there will be two broad sorts of epistemological questions which will shape the horizons of the explorations which are to be pursued. First, what makes experience or phenomena of a certain character possible, and, second, what might such experiences and phenomena tell us about the issue of whether, or not, there is something more deeply hidden in the nature of existence than many of the prevalent theories concerning various topics (e.g., dimensionality, information, energy, evolution, and biology) are prepared to acknowledge?

In addition to the foregoing two broad sets of interrogative issues which will modulate subsequent discussions, there is also a further kind of question which should be kept in mind. Epistemology is supposed to be about the nature of knowledge and what problems tend to serve as obstacles to realizing such knowledge, but, for the most part, people tend to have very little contact with real knowledge and, instead, operate through understandings.

To say one knows something, requires that one has an understanding which can be shown to be true with respect to a given topic or issue. In addition, in order to be considered as knowledge, one's understanding of the truth in such a given context requires that one can demonstrate one has a grasp of the dynamics to which such a context gives expression. Knowledge requires an understanding that transcends mere belief

Understandings are proposals about, or theories concerning, the truth of a given topic or issue. Such understandings provide one with maps of various aspects of existence and/or phenomenological experience which are intended to help one navigate one's ways through life.

However, there is no guarantee that such understandings provide accurate maps of either existence or experience. Such maps, might, or might not, be capable of being synchronized with existence and experience in accurate ways, but irrespective of whether such understandings are, or are not accurate, they provide one with hermeneutical orientations which have heuristic value (that is, they have, and are able to generate value of one kind or another), and, in this respect, they serve as the existential ships which, for better or worse, we use to carry us through the seas of life.

To further complicate the nature of the relationship between a given quality of understanding and knowledge, one needs to acknowledge that identifying the truth and being able to demonstrate that a person's understanding of alleged truth is not necessarily simple or straightforward.

Not everything which is labeled a "fact" is necessarily true. The nature of facticity can be as complicated as Morton White's previously discussed notion of causality, and, as such, many themes might need to come together in a fairly precise and nuanced manner in order for a given claim to be considered factual, just as many themes were necessary to come together in order to explain the cause of a match's lighting.

As one engages the material in various chapters throughout this book, one might want to ask oneself, the following question: Is one's understanding of the topics being discussed a matter of knowledge or are such understandings merely a hermeneutical rendering of life that is not necessarily true but has its uses?

Many people are content with the surface appearances of existence. The challenge which faces all of us is to ask whether there is something more deeply hidden beneath such surfaces, and, if so, what is the nature of that which might be hidden.

<u>Chapter 2:</u> Dimensional Qualities

The semester was coming to an end. The last class for my course on Dimensionality was entering a critical stage.

After having offered some opening comments which sought to put the trajectory of the course in some sort of perspective, I was about to provide participating students with one last opportunity to influence my thinking about what sort of grade should be given to them. In a sense, what was about to take place was an oral examination of sorts.

There had been several exams during the course. Term papers had been written by, and returned to, the students.

Extensive comments had been written by me on every page of every essay. I never cared for my own university experience concerning term papers which generally were returned to me with almost no remarks and, perhaps, at most, a question mark here and there, together with a one-word or two word notation appearing, from time to time, in the margins of the essay but which were either indecipherable or one had difficulty understanding what such "observations" were trying to indicate.

I had promised myself that if I were ever to be hired as a professor, I would try not to do to my students what had been done to me as well as many other individuals who attended university. Most of my students from past years had appeared to appreciate the fact that someone was willing to show respect for their efforts and ideas, but, there were a few who complained about the extensive commentary which appeared on their term papers because none of the professors they had encountered previously were, apparently, prepared to critically engage their term papers with a seriousness of educational purpose.

The argument often offered by many educators in relation to the foregoing considerations was that it wasn't practical to invest so much time with respect to student term papers. After all, time is a valuable resource and one had to learn how to distribute it judiciously, and, of course, temporal justice wouldn't be served if one were to actually try to take the time necessary to help educate students who were spending hundreds of thousands of dollars and going into a life-time of debt in order to get a degree that often meant nothing more than money spent and time wasted obtaining a piece of paper that entailed an array of forms of educational abuse … including many teachers who were more concerned with their personal interests and career than they were with any moral and educational responsibilities which they might have to their students.

I tried to balance critical rigor with fairness when determining a student's grade. The comments which might emerge through such rigor were never meant to impose my biases onto students but, instead, were intended to induce them to consider various possibilities which might have been absent in what they had written. Moreover, oftentimes the amount of comments were not necessarily a rejection of what had been said in an essay but, quite the opposite, were a sort of tribute to a student's thoughts and the way in which that person's ideas had stimulated my own thinking in different ways.

I proceeded to outline the guidelines for what was about to transpire in the classroom. "From time to time over the next several hours, I am going to raise certain questions. Those queries won't be addressed to anyone in particular, and, in fact, they will be up for grabs, sort of like a variation on Jeopardy, but I will be looking for more than a brief response from whoever decides to respond to the question.

"We don't have a buzzer system here. Therefore, we'll have to use the old-fashioned method of raising hands to determine who might be called upon to address the question being asked.

"Everyone will get at least one kick at the can, so to speak. Consequently, one of the things that shall affect who will be called upon has to do with who has, and who hasn't, had an opportunity to offer their thoughts previously in the current exercise.

"Brevity of responses – at least within certain boundaries of propriety – will be more highly regarded than longevity. As Supreme Court Justices are known to do, I might, or might not, ask questions with respect to what is being said through a given response, but, as is the case with the oral arguments being presented to the Supreme Court, one should not necessarily assume that such queries are a sign of disagreement rather than being an indication that I am looking for more information from the presenters.

"Moreover, if someone has finished their response to a given question or, in my opinion, has been given sufficient time to do so, and, yet, someone else in the class wishes to contribute to what has, or hasn't, been said with respect to a given question, then the latter individuals should raise their hand. Constructive additions to the discussion are welcome, but interjections of questionable sincerity or value will be noted as well.

"The following exercise is about your understanding of the issues and will be graded accordingly. However, what is about to take place should also be engaged as an educational dynamic in which each of you has an opportunity to learn from the responses of your fellow students and, hopefully, the discussion will induce every one of you to continue to critically reflect on the issues which bubble to the surface as we move forward with this oral examination process.

"The first question has a certain dimension of awkwardness to it – at least from my perspective – because, by way of full disclosure, I interacted with, and to a small degree, was familiar with the person that the question touches upon. We interacted with one another across a variety of venues and we were both members of the same group and organization, and, yet, oddly enough, we never discussed the issues that are about to be raised.

"Many years ago, I had purchased a copy of the book: *The Planiverse: Computer Contact with a Two-Dimensional World*, by A.K. Dewdney -- who, for many years, wrote a column in *Scientific American* concerning 'Mathematics and Games' -- but I never got around to reading his book until a year, or so, after he passed away. Consequently, I never had a chance to discuss the book with him.

His book has been included in the course syllabus as a suggested reading because, for a number of reasons, I believe it warrants being read. However, conceivably, not everyone here has chosen to read it.

As a result, the following challenge is directed at anyone in this class who did take the time to read that work. More specifically, my question is: What is your assessment of the aforementioned book?"

I looked around the table. Not everyone's hand was raised, but I called on Naomi who seemed quite enthusiastic in the way she was waving her hand.

Naomi began: "Well, there are several general comments which can be made. First, I was quite surprised to discover – and Professor Dewdney wrote about this in his Preface to the 2000 Millennium edition of his book, some 20 years after it had been released initially – that there were quite a few individuals who, on the basis of the contents of his book, believed he actually had made contact with beings from a two-dimensional world.

"Now, perhaps, the foregoing sorts of people did not understand that, in a sense, *The Planiverse* book was a creative re-visiting of an 1884 work by Edwin A. Abbott – who used the pseudonym of A. Square – and who had entitled his own book: *Flatland: A Romance in Many Dimensions*. More specifically, just as Abbott explored certain aspects of the notion of dimensionality using examples involving: So-called dimensionless points; a world called "Flatland" whose geography, people, buildings, and objects consisted only of length and breadth; as well as the impact that a three-dimensional sphere creature had on the thinking of a two-dimensional Flatlander about the nature of reality, so too, Professor Dewdney sought to explore a similar set of issues, but he probed those issues -- which involved: Physics, chemistry, biology, and various kinds of dynamics -- in a way that went far beyond what Edwin Abbott had done in the latter individual's book.

"A lot had happened in the ninety-plus years which had taken place between the two publications. So, Professor Dewdney was able to leverage a variety of mathematical, scientific, and computational modeling advancements which were not available to Edwin Abbott.

"As a result, Professor Dewdney was able to write very intriguing book, and, conceivably, he did such a tremendous job in providing a quite detailed description of what a two-dimensional world might be like, as well as had done this within a background context of a credible-sounding computer science course, that the creative combining of the two foregoing considerations created something like a form of virtual reality for various individuals which seemed to possess a certain quality of plausible existential substantiality. We might think that such individuals are excessively gullible, and, yet, there is considerable evidence which can be garnered today concerning a surprisingly large number of people who are treating their AI-assistants as if the latter were real persons and, apparently, are having difficulty differentiating between what is real and what is the result of some set of artificial, computational algorithms.

"The other facet of Professor Dewdney's book, *The Planiverse*, which I feel is worth noting is the manner in which he has been so creative in generating a world that induces people to think about various aspects of dimensionality. Indeed, toward the end of his book, he talks about the possibility of dimensions which are beyond the ones – namely, space and time -- with which we tend to be familiar … dimensions which are beyond length, breath, height (or depth), and time.

"As well, he talks about a form of potential knowledge which might be beyond that which is acquirable through rational means. In other words, just as a 2-D creature has an understanding of the limitations and possibilities present in the non-dimensional world of a "point," – an understanding which transcends what a point might be able to grasp through rational means -- and just as a 3-D sphere character has an understanding of the 2-D world that transcends the way in which the beings from the latter world understand the nature of reality and the manner in which that 2-D reality is being framed by the degrees of freedom and constraints which are present in a 2-D world, so too, perhaps there is some higher dimension – say, a fourth dimension – in which beings from such a realm understand the degrees of freedom and constraints that characterize the world of 3-D beings, and, in addition, such fourth-dimensional beings might have an understanding which transcends what 3-D creatures are able to grasp in relation to reality as a result of the restrictive framing that are present in three dimensions and, as a result, such 3-D beings are not able to wrap their minds around the possibility that there could be a dimension or dimensions which transcend what they know … dimensions which would give rise to a different understanding of the nature of reality."

I brought Naomi's response to a close at this juncture and said: "Naomi, I want your response to the following question to be very brief, but in your comments you have referred to the ideas of 2-D and 3-D worlds, and you have referred to length, breadth, height, and time in conjunction with those worlds, and, therefore, I am wondering if you think that length, breadth, and height are dimensions or degrees of freedom within the dimension of space?"

Naomi reflected on what was being asked for a moment. She responded with: "I guess the answer to your question would depend on what was meant by the notion of dimension. However, in general, I do think there does seem to be a difference between what might be referred to as the dimensionality of time and the way in which length, width/breadth, and height or depth seem to be not so much separate dimensions as they are variations on an underlying theme of spatial dimensionality, and if this is the case, then, the sphere character which is present in both *Flatland* and *The Planiverse* doesn't exist in a 3-D world but, rather, exists in a two-dimensional world made up of time and space in which the latter dimension offers the possibility of being oriented within that spatial dimension in a variety of ways, beginning with the dimensionless point, and working one's way through various geometric configurations involving planes, lines, polygons, solids, hyper-solids, and so on."

I thanked Naomi for her contribution and proceeded to briefly consider how to phrase the next question and, then, said: "The next question is also directed to those individuals among the members of the class – other than Naomi – who have read *The Planiverse* – namely, if you had one, or more, criticisms concerning Professor Dewdney's book, what would one of those criticisms be?"

A few hands went up. I called upon Jake.

"Before responding to your question," Jake indicated, "I would like to provide a bit of context … that is" – and he looked at me somewhat quizzically – "if that is okay? I nodded my head in a way that communicated assent to his query.

Jake proceeded with: "One of the other references listed on the course syllabus for suggested reading is the book, *Flatland* by Edwin Abbott, which was mentioned by Naomi in her response."

He paused for a few seconds, gathering his thoughts and continued with: "While Abbott takes his time getting to the point, so to speak, and spends much of the first half, or more, of the book using geometry as a medium for voicing various sorts of social, political, and philosophical commentary, in the second part of the book he begins to talk about the perceptual and conceptual perspectives of: Points, lines, circles, polygons, spheres, and beyond. For present purposes, the perspective which might be most relevant is that of the 'point.'"

"Abbott refers to the notion of Pointland as an 'Abyss of No dimensions.' He describes the world-view of a citizen of Pointland as being devoid of length, breadth, height or depth, and, consequently, a point is really nothing at all.

"Abbott's perspective resonates with Euclid's definition which indicates that a point has no part. In effect, a point has position but does not occupy space, and Euclid used points to help establish a foundation which would enable him to, among other things, draw lines between points and construct other kinds of geometrical configurations.

"During one part of *Flatland*, A. Square, the teller of the tale, has a dream in which a Sphere guide takes A. Square to Pointland where the rhapsodizing of a point is heard singing words that are somewhat ambiguous with respect to their referent – words such as: 'Infinite Beatitude of Existence.' Conceivably, a point is something of a solipsist in which nothing exists but itself and the only way any possibility can come into existence is through the manifestation of points which, somehow, come together in forms which we humans would refer to as: Planes, lines, polygons, solids, and hyper-space, but about which, individual points would be blissfully unaware.

"Obviously, Abbott is hoping that his readers will suspend some of their critical faculties and, therefore, not ask how a point – which has no dimensions – has the capacity to be able to say words (in the Queen's English no less) or, how a point, apparently, has some sort of awareness of something's existence as being an 'infinite beatitude' -- which tends to imply that the point has some sort of conception of the infinite as well as of beauty or, alternatively, that what is, is understood to be both beautiful and infinite in nature. Moreover, one can only wonder how a point which has no dimensions can participate in a temporal dimension that permits experience to transpire, and this is the case irrespective of whether, or not, the 'point' is aware of temporality per se … although, possibly, time might just be part and parcel of what constitutes an "infinite beatitude".

"Now, all of the foregoing serves as an introduction to whatever I might have to offer in the way of possible criticism of *The Planiverse*. If one accepts, as a working definition that a point is without dimensionality – at least in any spatial sense – then, one has to begin to raise questions about how spatial configurations are possible such as: Planes, lines, polygons, circles, and solids -- because all of these entities are, mathematically speaking, functions of points, the fundamental building block of geometry, but, unfortunately, points have no actual substantial reality.

"Any given plane, line, circle, polygon is said to consist of an infinite set of lowly dimensionless point. Maybe this is how Zeno's paradox got started because if one has to plow through an infinity of points to get from, say one end of a line to the other end of that same line, then, presumably, one could never reach the other end of the line – although the obvious redress for such a paradox is to mention that Euclid, and others, did precisely that on a regular basis, and, therefore, perhaps, there is an element of mystery or cloud of ambiguity concerning just what the nature of a point is – a mystery or a fuzzy ambiguity which carries implications for, among other possibilities, quantum physics since many particles are treated as mathematical points which, somehow, carry various quantum properties such as charge, mass, angular momentum, spin, and so on, and, yet, how does a point in any traditional mathematical sense have the ability to do any of this any more than points should have the capacity to talk, be aware of an 'infinite beatitude', as well as participate in time?

"The foregoing considerations carry over to my thoughts about Professor Dewdney's book *The Planiverse*. Taking advantage of the degrees of freedom which are present in the valuable technique referred to as literary license – the same license leveraged by Edwin Abbott -- Professor Dewdney talks about the physics, chemistry, biology, linguistics, astronomy, rocketry, transportation, environmental science, philosophy, religion, mysticism, commerce, history, wars, and politics of the world of Arde and the Ardeans who inhabit that plane of existence, and, yet, given that only length, breadth, and time have any sense of reality in such a world, then, one has to wonder if length, breadth, and time would be sufficient to account for the phenomena which are explored throughout *The Planiverse*.

“Of course, in Professor Dewdney’s book, the world of Arde actually gives expression to a set of computer algorithms. Awareness, vision, sensation, intelligence, reason, emotions, dreams, imagination, thought, movement, eating, breathing, language, creativity, music, weather, ecology, technology, and so on are not functions of length plus width plus time, but, instead, are functions of a program that, through an appropriate arrangement of 0’a and 1’s, assigns an array of properties to the objects which are populating the graphics arrangement that give visual structure, color, and dynamics to the virtual world that is being built.

“In the Millennium Edition of *The Planiverse*, there is a 34-page section that has been added to the main storyline of the original, 1980 work. The material in that part of the book provides an overview of some of the many suggestions, observations, possibilities, and so on that were sent to Professor Dewdney in response to the original edition of his book.

“Those comments were from academicians, scientists, and bright, thoughtful, interested amateurs. Some of the topics addressed in those comments had to do with detailed considerations and actual research which might have relevance to the possible physics, chemistry, planetary science, biology, astronomy, and technology of the 2-D world of Arde.

“So, my criticism -- if it can be called that -- concerning *The Planiverse* is fairly straightforward. Given – as I believe is the case based on what I said earlier – that: Points, planes, lines, geometric configurations plus time, cannot account for the multiple kinds of dynamics which are depicted in the book, and given that there appears to be a fairly clear indication in the book that the world of Arde as well as the Ardeans who inhabit that realm are functions of a program which supplies the world and its inhabitants with their properties and abilities, I came away from the book with an unsettled feeling. In other words, on the one hand, the book was a remarkable creative achievement and, obviously, in light of the tremendous response that the book induced, one can see that the material in the book stirred up a lot of constructive reflection, but, nevertheless, on the other hand, I feel that the book didn't help me to deepen my understanding concerning the issue of dimensionality despite the fact that the book focused on certain aspects of that very topic."

I motioned for Jake to stop and said: "I have a follow-up question to your response to my initial question and, as I indicated in relation to Naomi when I asked her a second question, I'm only looking for a relatively brief response from you with respect to the following query. More specifically, one Oxford humanist noted – and I believe Professor Dewdney mentioned this in the preface to the Millennium Edition as well -- that, in one sense, *The Planiverse*, is a Sufi story which, among things, might be seeking to induce people to begin thinking about the idea of dimensions and how our sense of reality often is a function of the notion of the way we understand the notion of dimensions through which we frame our experience of reality – perhaps an attempt to re-envision the notion of a Kantian category. You didn't touch on the foregoing possibility in your response to my initial question, and, now, that I have introduced this extra wrinkle to that query, would you wish to modulate your stated perspective in any way?"

Jake quickly said: "The issue you are raising is sort of the exception which proves my point." He smiled sheepishly and added: "Sorry for the pun."

I moved my index finger in a circular motion urging him to move on. "Please continue," I requested.

"Okay, let's assume that "*The Planiverse*" is a Sufi teaching story, and let's further assume that just as a sphere consists of a circle of circles then, perhaps, whatever lies beyond rational thought – that is, the unspoken, ineffable knowledge of the beyond to which the Ardean character Yendred alludes – gives expression to a sort of Dimension of dimensions, we still seem to be faced with the same problem – namely, what is dimensionality? … because points, planes, lines, circles, polygons, and solid geometry don't really tell us much except that those configurations are made possible by whatever the nature of the spatial dimension turns out to be.

"One can throw the temporal realm into the foregoing mix, and the problem doesn't appear to become any clearer. Time and space are referred to as dimensions, but we still don't seem to actually know what that means, and, furthermore, one can juxtapose time and space in any number of combinations, but such combinatorics don't appear to help one to understand how phenomena arise from the mere presence of those two dimensions,

"Seemingly, something more is needed. Now that "something" might be on the far side of the ineffable and is situated in the Dimension of dimensions, however, if this is the case, then, rational discourse is never going to find its way to a satisfactory answer concerning the issue of dimensionality, and, perhaps, this might encompass some of what Professor Dewdney is seeking to induce readers to consider, but I was hoping for a better sense of dimensionality – even on the level of space and time – and as the line from a popular song of yesteryear goes: 'I still haven't found what I'm looking for."

I nodded to Jake in a way which indicated that I had heard what I needed to hear and proceeded to transition to my next question. I broke the silence with: "Jake's comments have raised an important issue, and while I'm not sure we will arrive at a final resolution concerning that issue today, nonetheless, we can't really avoid the problem.

"I will preface my question with something that was alleged to have been said prior to the battle of gladiators in the Roman arena: "To those who are about to die, we salute you," and having dispensed with such pleasantries let me ask: "What is space?"

Leslie remarked: "That is a very hard question and seems a little unfair given the nature of questions which have been asked so far."

I acknowledged Leslie's observation and said: "Think of it in terms that are similar to a diving competition in which more technical dives come with both considerable risks as well as high rewards, and, so, even if one doesn't perfectly execute the dive, the difficulty of the challenge will be taken into consideration when arriving at a grade for assessing the quality of one's performance. Or, if you like, think of the question as akin to what was faced by cadets at the Starfleet Academy when they had to respond to the Kobayashi Maru problem which intentionally encompassed a set of conditions that were impossible to resolve and, apparently, was just a way of finding out what cadets might do if faced with an impossible task … and, no, unlike James

Tiberius Kirk, you cannot cheat when responding to the present puzzle."

For a moment, there was silence in the class. Students were weighing the pros and cons of raising their hands, but, finally, a few hands went up.

Looking at the candidates, I thought about who might be least flummoxed by what they were being asked to do. I said: "Carrie, surf's up."

"Well, scientifically speaking, there are only a couple of theories that address your query in any detail -- namely, general relativity and quantum mechanics. And, within the broad framework of those two theories, there are a lot of variations, and, consequently, given the time restrictions under which we are operating, perhaps the best way of proceeding is try to give some of the broad strokes that characterize how each of the aforementioned theories tends to engage the notion of space.

"Before, I get started, however, I must ask the diving judge if I will be permitted to increase the technical difficulty concerning the sort of dive that I wish to attempt – and, hopefully, I am using the term "dive" in its more constructive rather than problematic sense?

"What do you have in mind?" I replied.

She stated: "I would like to add 'time' to the menu. I tend to agree with Jake that there is something mysterious or ambiguous about the way in which dimensionality is often discussed, and, quite, frequently, the only two dimensions which tend to be mentioned in many discussions and treatments are just spatial and temporal ones.

"I feel there are similar difficulties which are present in the way that science goes about engaging the nature of both space and time. Therefore, even though the addition of 'time' complicates my task somewhat, nonetheless, by combining that notion to the idea of space, then, somewhat paradoxically, this might make talking about dimensionality somewhat easier."

Moving my hands, shoulders, eyes, and eyebrows in a way which intimated that I hoped she knew what she was getting into, I remarked: "Well, do with space and time what you will."

Skipping barely a beat, she started her presentation. “When someone, allegedly, once asked Einstein about the nature of time, the scientist is reported to have said that: “Time is what a clock measures.”

“In effect, Einstein had reduced the dimension of time to being a function of clocks. Conceivably, however, just as space has the capacity to offer degrees of freedom with respect to what sorts of possibilities and conditions exhibit spatial properties – such as points, planes, lines, circles, polygons, and so on – so too, it might be the case that time provides the degrees of freedom and constraints which enable clocks to be able to run according to their own metric irrespective of whether that metric is a matter of: The rate of flow of grains in an hour glass; the way in which the sun casts shadows on a sun dial, the frequency of certain atoms, or some set of arrangements concerning either mechanical dynamics or electronic circuitry.

“Whatever space is, it is something that enables certain kinds of phenomena to take place. As Wittgenstein might have observed, the objects that inhabit space have a family resemblance with one another that enables us to sense the presence of some sort of quality of spatiality even if we can’t pin down what it is that makes space what it is.

“Similarly, phenomena that seem to exhibit a temporal je ne sais quoi – an elusive, indefinable something or other -- all share a quality which we tend to recognize as being temporal in nature. Nonetheless, whatever this elusive something or other is, I have my doubts that time is what a clock measures but, instead, time merely seems to provide the necessary degrees of freedom which make the functioning of clocks possible, just as the presence of space – whatever it might be – provides the necessary degrees of freedom that enable, for instance, geometrical constructions to be possible … assuming, of course, that we have the time to explore and work with such spatial degrees of freedom.

“We don’t tend to claim that space is what geometrical constructions measure. Consequently, I’m not sure why one should maintain that time is what a clock measures.

“In fact, by accepting Einstein’s perspective, one runs the risk of conflating measurement with reality. Measurement is a way of representing, or alluding to, or interpreting that which is being measured, and if we are not careful, we often reify the measurement – which is an abstraction – and, then, proceed to try to existentially instantiate that abstraction by reducing reality to the measurement.

"There are two standard units of measurement that are often used in science which are referred to as: Planck time and Planck length. The latter unit of measurement – namely, the Planck length -- is set at: 10^{-35} meters, while the unit known as Planck time is specified to be 5×10^{-44} seconds.

"At levels of reality which are being alluded to through the foregoing units, the Standard Model of quantum field theory suggests there is considerable uncertainty about what might be taking place on the level of reality where those units are applicable. Generally speaking, however, under such circumstances, many scientists tend to believe that gravity could play a more influential role in shaping dynamics on that level than what is being contributed through other sorts of quantum events.

"The foregoing sorts of levels of reality are often described in terms of the quantum foam which, supposedly, characterizes dynamics on those miniscule levels. Quantum foam is the existential froth which, allegedly, is generated by the virtual particles which -- since John Wheeler in 1955 – are believed by many physicists to be continuously generated and destroyed on that level.

"Some people have interpreted the aforementioned quantum foam to constitute the very fabric of space. In other words, a variety of individuals tend to believe that, at its most fundamental level, space gives expressions to the patterns which are woven into the fabric of space through the woof and warp maneuvers of virtual particles that are constantly being created and destroyed throughout space and, therefore, determine as well as mark the boundaries which constitute the nature of that dimension.

"If it is true that space is a function of the creation and destruction of virtual particles, and if it is true that gravitational forces constitute the most influential dynamic on the level of virtual particles, then, this tends to resonate with Einstein's perspective in general relativity that gravity has the capacity to curve space since given $E=mc^2$, the energy being manifested through the creation and destruction of virtual particles would have a mass which would be associated with gravitational effects. On the other hand, if space is not a function of the foam allegedly created by the creation and destruction of virtual particles, then, while gravity might be a dominant force on the level of the Planck length, what is being curved is not necessarily space but a field consisting of constantly emerging and disappearing virtual particles. Moreover, given such a possibility, then, one is faced with the problem of trying to understand exactly how gravity curves the temporal aspect of the notion of "space-time" that, supposedly, constitutes the fabric within which, or through which, mass goes about its activities.

"Planck time and Planck length are operational concepts which allow people to have a standard way of talking about phenomena which might happen on the quantitative level designated by the Planck units. Currently, we have no means of testing hypotheses on the level of either the Planck time or Planck length, and, so, one needs to critically reflect on whether, or not, those units give descriptive, quantitative expression concerning what, respectively, time or space is?

"In many ways, those units are arbitrary and do not necessarily have anything of fundamental value to say about time or space other than that time and space are what makes those forms of standardized measurement possible. Are the qualities and properties of time and space such that they might be able to permit dynamics that take place in units of time and space that occur far below the horizons encapsulated by the notions of Planck time and Planck space?

"We don't know. We don't know whether space and time are either infinite in nature or are, instead, indefinitely extensive in some fashion without being infinite

"Moreover, perhaps, time and space are not material quantities at all, but rather, time and space might be conceived of as "affordances" – existential or ontological environments of a special kind – which provide a framework of degrees of freedom and constraints with respect to what can and cannot take place in those environments. Maybe, time and space are like attractor basins whose boundaries are a function of action dynamics which are peculiar and unique to space and time and which shape the properties of those attractor basin environments in a way that is similar to, and, yet, different from the manner in which the Planck Constant figures into determining action with respect to the emission and absorption of packages of energy according to the Standard Model of quantum physics.

"Is space a quantitative or material 'something' that can be divided up into various kinds of units, or is space a qualitative phenomenon of some kind which provides measurement with a medium to engage? Is time a quantitative or material 'something' that is measured by a clock, or is time a qualitative phenomenon that, among other things, permits clocks to do their thing?

"Does the notion of quantum foam even have anything to do with either time or space? Conceivably, quantum foam -- which allegedly has to do with the constant creation and destruction of virtual particles – is a function of a different dimension such as "energy" in some broadly conceived fashion.

Perhaps, different forms of energy – such as electromagnetism, the strong force, the weak force, and the gravitational forces -- are manifestations of an alternative form of dimensional presence in which those forces or forms of energy constitute some of the degrees of freedom and constraints that characterize the action dynamics through which such a dimension of energy operates.

"Why do quarks, electrons, neutrinos, and so on, have the energy signatures that they do? What induces those energies to be manifested in such constant ways?

"While I disagree with Einstein when he claims that "time is what clocks measure", I tend to agree with him when he is reported to have said that: "God does not play dice with the Universe." Indeed, one has difficulty wrapping one's mind around the idea that the constants of nature are a function of random, probabilistic dynamics because such a perspective is as completely arbitrary as is the supposition that if someone were to provide a group of monkeys with paper, typewriters, and whatever else was needed to support such a project that, sooner or later, one, or more, of the creatures will reproduce the contents of, perhaps, *Inherit the Wind*, *Flowers for Algernon*, or *The Glass Bead Game*.

"In fact, one might begin to suspect that the existential game was, in a sense, being rigged if so-called random phenomena kept generating dynamics which appear to be shaped by various kinds of values such as the constant which quantifies the nature of one of the fundamental quantum packets involved in the emission and absorption of energy -– namely, Planck's constant. This would be like being able to consistently roll an extended series of sevens or elevens and, then, encountering someone who claims that this sort of set of events is to be expected given an infinite sequence of those tosses even though such a given has not been given because, on the one hand, anyone who makes that kind of a claim is operating out of a framework which assumes that what is taking place is part of an infinite set of such tosses – which is pure conjecture -- and, on the other hand, an individual who makes the foregoing sort of claim concerning the presence of randomness is stating something which has a sort of oxymoronic aroma to it since in order for something to be truly random, then, the person who is claiming randomness will have to prove that such an extensive, consecutive run of 7's and 11's is not the result of an unknown algorithm which is shaping those tosses.

"Moreover, if something is truly random, then, one shouldn't be able to predict what sequences will show up in such a set of events, nor can one necessarily demonstrate that all sequences must show up in an infinite series.

In fact, being able to predict that a particular sequence of 7's and 11's is certain to occur at some point in an infinite series would suggest that one is privy to some sort of insight into the nature of the influences that are inducing certain kinds of supposedly probabilistic events to show up in a non-probable manner, and the presence of an awareness involving the foregoing sorts of events tends to run contrary to the idea that the series in question actually qualities as being random in nature.

"Randomness is a modeling conjecture concerning the nature of the unknown. The reason that tests of significance have some heuristic value is because they provide a line of demarcation which indicates that certain results have a character that indicates that those results carry evidential weight which suggests that some dimension of the unknown is present in the dynamics being studied and that this unknown dimension gives expression to something other than a confluence of events which are related to one another in arbitrary, rather than determinate, ways.

"Could such results be due to some set of factors other than what might be being attributed, mistakenly, to some non-random dynamic? Yes, and this is an acknowledged possibility in statistical analysis which is known as a Type II error.

"Nonetheless, committing such an error does not make what is happening random. Instead, the error which has been committed merely means that we are wrong with respect to our understanding of the nature of what is being observed.

"The term "sigma 5 level of confidence" -- which is used in conjunction with, among other things, particle physics -- has to do with the number of standard deviations that a given measurement is from the expected value for the sort of event that is being studied. In many fields (e.g., psychology), sigma 2, or a 95% level of confidence, is often an accepted line of demarcation for, allegedly, differentiating between what might be true and what might be false, and as one works one's way up the sigma scale, one is approaching 100% confidence more and more closely.

"Levels of confidence at a sigma-five level or above indicate that, while not impossible, an observed outcome is highly unlikely to have been the result of events which were due to irrelevant or unanticipated influences -- in other words, the 5-sigma result is something which has a high-degree of likelihood that it is connected to a set of events in a manner which is either currently understood or which might not be understood but is highly relevant to one's experimental interests.

"Notwithstanding such considerations, obtaining an experimental outcome that is associated with a high level of confidence, doesn't necessarily guarantee anything. For example, during the Opera experiment that was run in 2011, a result occurred which indicated that a researcher could have nearly 100% confidence that what was being observed allegedly demonstrated that neutrinos were moving at a velocity which was greater than that of light. Yet, subsequently, the foregoing outcome was shown to have been due to mistakes made in conjunction with the experimental process.

"Most dynamics that occur in particle physics involve processes in which whatever it is that decays does so within a very, very, very short period of time. One rarely, if ever, directly observes that which one is trying to establish, but, rather, one has to try to reconstruct the dynamics which might have led to the decay products which can be observed and measured in order to try to determine if that in which one is most interested might have been able to give expression to the decay products that can be observed, and, unfortunately, various kinds of methodological or calculational errors are easy to make if one is not careful.

"However, the default orientation with respect to the unknown is not necessarily a matter of assuming that events are random unless they, somehow, can be shown to be otherwise. We don't know what we don't know.

"The foregoing comments are made with considerable appreciation for the fact that quantum dynamics is a very successful, incredibly precise enterprise. I'm not trying to question those results, but I do have a lot of questions concerning the assumptions, methods, and interpretations which have been used to frame those very precise results.

"For example, people often mention Schrödinger's cat in conjunction with quantum mechanics. Schrödinger's cat gained notoriety in a thought experiment that had been devised by Schrödinger to illustrate what he considered to be the silliness of the probabilistic make-over, or wave function modulation, of the Schrödinger equation.

More specifically, according to the wave functional description of the situation in which Schrödinger's cat found itself – and this involves being in a box where a radioactive substance might, or might not, decay and, thereby, lead to the release of a poisonous gas throughout the box's interior -- the aforementioned cat is, supposedly, in a superpositional state in which it, simultaneously, would be both dead and alive. According to those who follow the so-called Copenhagen interpretation of quantum mechanics (and, arguably, this is what the vast majority of quantum physicists abide by), which of the foregoing two possibilities is true (that is being dead or alive) would be determined by the act of opening Schrödinger's cat-containing box.

Before moving on with my response, I would like to note in passing that I don't know why a probability distribution of possible outcomes concerning a given set of conditions should be referred to as a wave function rather than as a probability distribution function. To be sure, there are certain structural similarities between the form of a wave and the form of a probability distribution, but if superpositional characteristics are expressions of probabilities that have no known determinate cause – that is, are random -- and cannot be affected by hidden variables, then, to call such probabilities a wave function seems to be an exercise in pre-judging a situation.

"In any case, there might be another kind of cat which is more relevant to quantum physics than Schrödinger's cat. This is Thorndike's cat.

"While Thorndike did perform certain kinds of learning experiments involving cats, I am unsure whether all of the details of the following account are accurate. Nevertheless, irrespective of whatever details might, or might not, be true, the account offers some food for thought with respect to quantum physics and the issue of dimensionality.

"The Thorndike experiments that I have in mind involve placing a cat in a puzzle box. The researchers wanted to study what happened when a given cat was placed in such boxes.

"Would the cats be able to solve the puzzle of how to get free from the box? If so, the researchers also wanted to know what learning, if any, might occur if a given cat was faced with the same problem across a number of trials.

"The solution to the puzzle box required the cat to find its way to a latch that was located in the interior of the box and, then, move that latch in a certain way that would permit the cat to escape. Cats successfully demonstrated their ability to accomplish this initial task.

"In addition, the researchers established that the amount of time required for the cat to move the latch in the required way decreased with subsequent trials. This decrease in the amount of time needed to solve the puzzle was interpreted to constitute a learning curve which indicated that the cats were presumed to have been able to discover better, quicker ways of solving the puzzle.

"Yet, when the actions of the cat were filmed, apparently, the researchers found that those animals hadn't developed a better understanding concerning the nature of the problem with which they were confronted. Instead, the film indicated that the set of motions which eventually ended when the interior latch had been manipulated by a cat in the right way were merely being repeated. In other words, before solving the puzzle box, a cat would go through different actions, and in subsequent trials the films showed that all of the motions which preceded finding the latch and moving it in the required way were all still being done, but they were being done more rapidly than the first couple of times the puzzle was solved.

"In other words, apparently, nothing new was being learned. The different motions of the cat's paws that eventually had led to the moving of the latch in a way that permitted escape – and many of those motions had nothing to do with solving the puzzle – were simply being executed more quickly.

"In certain ways, quantum physicists are like Thorndike's cats – or the physicists are like the version of those cats which has just been described. More specifically, just as the cats arrived at solutions for their puzzles more and more quickly, despite the fact that the improvements in resolving those problems didn't necessarily mean that the cats had developed a better understanding of the nature of the problem with which they had been confronted, something similar might be at work among quantum physicists.

"More specifically, from the time that Heisenberg, Pascual Jordan, and Max Born first came up with the cumbersome but effective matrix-mechanical way of solving problems in quantum physics, and continuing on through with the more elegant editions of quantum problem solving techniques such as: Schrödinger's wave equation, Paul Dirac's relativistic compliant equation, and Richard Feynman's sum-over histories approach, scientists have been finding quicker ways of solving problems in quantum physics. However, like Thorndike's cats, scientists don't necessarily have a better, more insightful appreciation of what they are doing.

"Among other things, their understanding of dimensions such as space and time haven't changed in any fundamental way. Instead, as is quite evident -- for example, in string theory – scientists simply have discovered new ways of mathematically moving about among a few of the geometric degrees of freedom and constraints that appear to be permitted by the dimensions of time and space.

"For quite some time, scientists have been looking for a unified field theory that is capable of accounting for all physical and material phenomena. The central theme inherent in such a search is the belief that some sort of symmetry breaking takes place in conjunction with an underlying singularity of unknown nature and, then, supposedly, out of this symmetry breaking event emerges, in a completely natural manner, the different kinds of particles, forces, energies, and phenomena which form the world that we experience.

"However, no one – to date -- has provided a viable, demonstrable account of how, for example, dimensionality emerges from such symmetry breaking. In fact, no one has provided a plausible explanation for how such symmetries apparently predate the emergence of time and space or how those symmetries could be broken prior to the existence of time and space."

I motioned for Carrie to stop and commented: "Looks like you have been able to stay on your board all the way to shore despite a few potential problems here and there. I won't ask you a follow up question because you response already has covered quite a lot of territory, and instead, the following question will be tossed upon the waters for some other candidate.

"How would the notions of space-time and zero-point energy fit into what Carrie has said in her response to my query concerning the nature of space and, now, at Carrie's suggestion, the nature of time?" As I finished the question, I surveyed the remaining members of the class who had not, yet, participated in the on-going exercise, waiting for hands to be raised.

Leslie's hand was the first hand to go up, although this seemed to take place somewhat hesitantly. I said: "Okay Leslie, would you like to take a shot at this question?"

She replied with: "Not really, but there are some ideas bouncing around inside of me that might be relevant." As she looked at the clock on the wall facing her, she added: "Besides, the degrees of temporal freedom that potentially are available to me in relation to the termination point of this class are quickly disappearing, so, hopefully, necessity will be the mother of invention in what follows."

As was the case with the way in which she raised her hand, the manner in which she began to respond to my question was somewhat tentative. Nonetheless, within a relatively short period of time, she began to settle into her presentation.

"I would like to expand on some of what Carrie was saying." She was about to add to her opening remarks but paused and was silent for a few seconds while her thoughts were shifting gears.

When she was ready, she began with: "Let me start things in another way. I have always had trouble with accepting Einstein's notion of 'space-time' as referring to some sort of a dimensional combination involving time and space. I don't have a problem with the idea of 'space-time' being used as a metric which can measure the degree of curvature in a given aspect of the gravitational field, but, as Carrie intimated in her comments, the curvature which is being measured is not necessarily either time or space, but, in fact, might just be the way in which energy fields and gravitational fields interact at the quantum level.

"I am aware of the experiments which have been done with comparing atomic clocks when one of those planes has remained on Earth while the other clock has been loaded onto a plane and flown to some altitude above Earth. Although the two clocks were synchronized at the beginning of the experiment, at the end of the experiment, they were no longer synchronized and, instead each of the clocks indicated that a different amount of time had passed during the experiment.

"Many individuals have interpreted the foregoing experiment to constitute evidence that time is affected by gravitational forces. However, there is at least one other way of looking at the issue.

"More specifically, given that atomic clocks operate on the basis of the frequencies with which certain atoms – for instance, Cesium atoms – resonate, and given that atomic frequencies are a function of quantum phenomena, and given that gravitational effects might tend to have considerable influence with respect to what takes place in conjunction with quantum phenomena, then, one might suppose that what is being affected is not time but, instead, what is being influenced might be a function of the gravitational conditions in which the atomic clock is operating on a quantum level.

“Clocks don’t necessarily measure time. Instead, clocks might just provide a method for mapping duration … a method which is potentially vulnerable to the way that prevailing conditions – such as gravity – might be a able to interfere with the operational dynamics of that clock. If two atomic clocks are being exposed to gravitational fields of different strengths (such as being in an airplane or being on the surface of the Earth), then, one might expect that the two clocks will operate in ways that reflect their respective circumstances.

“As indicated earlier, scientists have theorized that gravitation and frequencies might interact on the quantum level as a function of the way in which gravitation influences the expression of those frequencies. To be sure, how gravitation and frequencies might interact on, say, the Planck length is something of a mystery because, currently, we don’t have the experimental means of running experiments on such a level, nor do we have the technical equipment which would be sensitive enough to measure what is taking place on the level of the Planck length, but scientists do have a framework of understanding which might allow them to make educated guesses concerning the degree to which gravitational effects could, potentially, affect a given frequency – such as those that form the basis of atomic clocks.

“However, scientists don’t have a clue about the nature of time or how gravitation might interact with whatever time might be and, thereby, be able to curve time. Scientists don’t even know what gravitation is.

“Einstein invented a better mouse trap than the one which had been devised by Newton. For example, Einstein’s general theory of relativity was able to account for anomalies in the orbit of Mercury which escaped the Newtonian approach to such issues, and, as well, Einstein’s perspective predicted the existence of gravitational waves – something that was confirmed a few years ago.

“Nonetheless, neither Einstein nor Newton actually knew what made gravitation possible. Instead, they each had developed systems for describing gravitational behavior.

"Einstein's system involved the notion of 'space-time'. However, as indicated earlier, this is not so much an ontological joining of space and time as much as it constitutes a metric for measuring curvature in the gravitational field, and although many people jumped to the conclusion that what was curving was space and time, Einstein didn't really prove that such a dynamic was actually taking place.

"In a sense, the metric of "space-time" operates within General Relativity in a way that is similar to the manner in which imaginary numbers operate for quantum dynamics. Neither "space-time" nor the complex plane can be shown to have ontological counterparts, and, yet, they both can be used to develop methods for mapping or modeling certain kinds of ontological behavior … curvature in the case of General Relativity and spherical or circular functions in the case of quantum dynamics.

"In the latter instance, once Georg Riemann demonstrated that the complex plane could be understood as being equivalent to a sphere in which one pole was set at zero, while the other pole of the sphere touched infinity, then the complex plane could be used to analyze physical phenomena from the perspective of circular and spherical functions. In effect, one could make calculations using imaginary numbers that would describe how a sphere rotated and became altered under different conditions, and this form of mathematical modeling enabled scientists to describe different facets of quantum dynamics through the properties of the complex plane

"Quantum physicists came up with a set of techniques involving imaginary numbers that provided a way to certain kinds of quantum events in complex plane and Einstein had a way to quantitatively describe the existence of curvature in the gravitational field. Nonetheless, Einstein could not provide an intelligible answer concerning what the dynamics are that enable gravitation to curve time, and, in addition, he couldn't explain what the nature of the dynamics were that enabled gravitation to curve space.

He was unable to offer any insights into what either space or time were in and of themselves. Consequently, he was unable to provide any account which explains how gravitation – whatever it might be – is able to interact with time and space – whatever these dimensions might be -- to such a degree that the ontological properties of space and time or space-time are curved in the process.

"I also am aware of data which has been gathered in particle physics indicating that the decay rate of certain quantum entities can be affected when the velocities of those sorts of events approach the speed of light. Under conditions of higher velocity, those quantum phenomena – that is, the decay rate -- last longer than would be predicted under conditions of lower velocities.

"The slowing down of the decay rate of these high-velocity quantum particles has been interpreted by many observers as helping to validate special relativity's prediction concerning how time is affected by velocities near the speed of light. In other words, just as gravitational fields supposedly alter time to various degrees, so too, high velocities are believed by many to alter time as well.

"However, once again, just as no one has been able to demonstrate how gravitational effects directly engage time or space to bring about curvature, no one seems to be able to explain precisely how velocities approaching the speed of light are able to engage time in a way that could slow time down or speed it up. The Lorentz transformations which play a special role in special relativity provide a way of ensuring that the laws of physics are preserved in different frames of reference that are moving with constant acceleration relative to one another and each of which is trying to measure the same phenomenon.

"Nonetheless, there is no way to independently verify that the Lorentz transformations are actually showing that velocity is affecting, for example, time, per se, rather than merely reflecting: (a) how certain properties (e.g., decay rates) which are present in a given particle, or (b) the methods of measurement that are being used to characterize those events, are both capable of becoming altered under conditions in which the speed of those particles or entities approaches the speed of light.

"By making provisions for taking such relativistic effects into account, Dirac's equation was able to resolve certain kinds of issues which fell beyond the boundaries of Schrödinger's equation. However, what is being taken into account by Dirac's equation has nothing to do with time, per se, but has to do with keeping track of how quantum phenomena are affected or altered under conditions involving high velocity.

“General relativity and quantum dynamics – each in its own way – fail to provide fundamental accounts of what makes reality possible. On the one hand, General Relativity cannot explain how gravitation interacts with space and time to generate the curvature that is measured by the space-time metric, and, on the other hand, quantum dynamics cannot explain why the so-called wave function exhibits the probabilities it does

“Both systems, however, are very good at describing an array of behavioral properties that characterize various kinds of dynamics. Just don’t ask the practitioners of those systems to explain anything of a fundamental nature such as: What makes gravitation possible or why the Planck Constant has the value it does, or why different quantum phenomena – such as electrons, photons, neutrinos – have the properties they do.

“Neither general relativity nor quantum dynamics has been derived from first principles, and this is why various scientists have been seeking to discover a theory of everything because only then would they be able to understand, from beginning to end, how things work. Rather, the two aforementioned methodological systems seem to navigate their way through an array of phenomena and, in the process, generate surface descriptions of some of the dynamics which are manifested through those phenomena.”

Leslie paused for a moment, and, then, said: “Let me conclude my remarks by briefly addressing the zero point energy aspect of Professor Whitehouse’s question.

“To begin with, there are some significant problems surrounding the notion of zero-point energy, and these problems are, in part, due to the very different predictions which are made by general relativity and quantum theory concerning the amount of energy that is present in the vacuum of space. The size of this predictive difference has been calculated, depending on one’s theory and methodology, as being anywhere between 60 and 120 orders of magnitude.

“Carrie mentioned the issue of virtual particles in her presentation. If one accepts the theory that on the level of the Planck length (which is about 10^{-35} meters and if this is converted into the form of a volume, then, there are about 5.6 x 10^{59} Planck volumes in a proton), then, according to the theory of virtual particles, such entities are constantly being generated and destroyed throughout so-called empty space, and this collective condition gives expression to the vacuum's lowest, state of energy which is referred to as the zero point, and the energy associated with that lowest state of the vacuum's potential is known as zero-point energy.

"Planck energy is the unit which is used to calculate the amount of energy that is contained in the zero point state, and this has a value of 1.96 x 10^9 Joules. When all is said and done after using the Planck energy unit to calculate energies for all wavelengths in the zero-point state, then, quantum dynamics predicts that the energy of the vacuum is infinite in nature.

"In order to avoid the problem of infinities, scientists usually cut off the size of the wavelengths whose energies are to be calculated in order to be added to the amount of zero-point energy which has been calculated to be present at all of the other wavelengths that occupy the vacuum state of the Universe. Nevertheless, even when this sort of fudging of the results is permitted, one is still talking about a quantity of energy – when converted to mass density – which is approximately one hundred times 10^{18} (quintillion) greater than the amount of mass which has been calculated to be present in the visible universe.

"On the other hand, general relativity calculates that the amount of energy which is present in the vacuum state can be calculated to be approximately the amount of energy that is encompassed by 4 hydrogen atoms per cubic centimeter – and this is the magnitude of the force to which dark energy supposedly gives expression and which is believed to be responsible for the expansion of the universe – if this is, in fact, what is happening in the vacuum.

"The Casimir Effect approaches the foregoing issue of calculating the energy which might be present in the vacuum state from a slightly different direction. The force to which the Casimir effect gives expression can be detected when one brings two metal plates close together and, in the process, one will note that a force exists in conjunction with those plates which induces them to come together.

"In 1995 Steven Lamoreaux determined the magnitude of the Casimir force by measuring how much resistance was required to counter the presence of that force and, therefore, could prevent two gold-covered metal plates from making contact with one another. The magnitude of this force is quite small and is more like the very small magnitudes calculated using general relativity theory than they are like the infinite results for zero-point energy which are obtained through quantum mechanics.

"Whether one is talking about general relativity or quantum mechanics and irrespective of whatever the nature of the energy is that is calculated to exist in the vacuum or at the zero-point, no one has shown that such energy is a function of the dynamics of either time or space. Of course, there is much that is not known here, but, the different results which arise from the various calculations concerning zero-point energy leave open the possibility that those energies might indicate that another kind of dimension is responsible for the presence of those energies, and this would be consistent with Carrie's suggestion that maybe all forms of energy constitute the degrees of freedom which are made possible by a dimension of energy that interacts with time and space to help give rise to the phenomena of the universe … this could be the real form of a 3-D world rather than considering length, breadth, and height/depth as constituting a 3-D reality."

Leslie, who had been talking about massive topics at a light-like velocity, seemed to have transformed her inertial conceptual momentum into a controlled stoppage. I thanked her for her contribution, briefly checked the clock, turned my gaze back to the participants and, then, addressed Ben: "Since you are the only one in the class who has not, yet, spoken, I believe -- short of a fire-alarm, a sudden, catastrophic increase in the South-Atlantic Anomaly, or some other campus emergency -- that there is no way to avoid what comes next, and that would be the final question. Are you ready?"

Ben smiled and said: "For better or worse, I am as ready as I'll ever be. Please be gentle."

"Well," I responded: "I don't know how gentle the following might be, but I'm wondering how you might believe string theory fits into the issue of dimensionality.

Ben grimaced and his eyes opened wide in a mock display of stress and fear. He began with: "I see that I have you right where I want you."

For ten seconds, or so, he looked down at the table in front of him, and, then, slowly raised his head and started to speak. "One of the reasons why string theory came into being was to dispense with the infinities which kept rearing their ugly heads when calculations required one to approach zero as a limit in order to solve one or another problem -- problems such as trying to determine the actual mass or charge of an electron without having calculations blow up in infinities due to the way in which the virtual particles that were alleged to surround electrons mathematically interfered with one's ability to obtain a naked reading of an electron's actual properties.

"In practice, researchers often just did the best they could to act as if the infinities were not there, but the math kept bringing them back to the same condition of embarrassment. After all, having the math take one on a journey toward some sort of infinity is one thing, but, then, one is faced with the rather awkward question of what do such infinities have to do with the dynamics of every-day life which do not seem to be entangled in Zeno-like paradoxes in which thrown spears can never reach their destination because one could keep describing the distance across which the spear needs to travel in terms of a process of division that showed that since the distance between the thrown spear and the target could be continuously divided in an infinite manner, it was not possible for the spear to ever be able to hit its target due to the infinite distances which supposedly had to be traversed by the spear.

"In quantum mechanics, one fix for the infinity problem that was introduced had to do with the idea of renormalization. Essentially, this provided an off-ramp when making calculations that permitted one to stop short of having to go all the way to zero.

"An arbitrary close distance to zero is selected. If one picks the right distance, then, one can get calculations concerning an electron's mass and charge to agree with one another and, in the process, avoid having to deal with the problem of infinities.

"A number of researchers, including Paul Dirac, were uncomfortable with such a maneuver because they felt like it constituted an illegitimate way of removing the infinity problem from experimental and theoretical considerations. For example, many people – Paul Wigner in 1960 being just one of them -- talked about the incredible way in which mathematics can be used as a descriptive medium that leads to highly heuristically valuable as well as accurate descriptions and predictions concerning various kinds of dynamics, and, yet, if mathematics is saying that a given phenomenon has aspects which are calculated as being infinite in nature, then what happens to the unreasonable effectiveness of mathematics when those infinities cannot be reconciled with what appears to be the finite nature of actual events?

"However, as someone pointed out previously, scientists in general, and quantum physicists in particular, tend to operate in a very clinical-like manner. In other words, just as physicians are willing to ignore the fact that they might not know how a given off-label medicine works when that elixir is given in conjunction with a form of pathology for which the medicine was not initially approved because the medicine has had a clinical track record of solving the presenting problem of illness by helping to restore someone's health, so too, many scientists are willing to tolerate the fact that they don't necessarily know why a given piece of mathematics works as long as it resolves whatever difficulties are confronting them.

"Renormalization enables researchers to avoid the issue of infinities in a way that also permits scientists to move forward to be able to constructively engage other kinds of problems. The price for being able to continue in a heuristically valuable way seems small to most researchers – namely, one has to shelve questions which have to do with determining what the actual relationship is between mathematics and reality because, for the moment, one has no way of plausibly explaining why mathematics indicates that many kinds of dynamics are infinite in nature whereas actual experience of those dynamics suggests otherwise.

"String theory began to attract interest in the 1970s when researchers began to see it as, among other things, a way of resolving the problem of infinities. Strings – which were conceived as being a one-dimensional structure that was approximately 10^{-33} centimeters in size – were no longer the point-particles which led to all the problems with infinities as one tried to approach more and more closely to the naked particle.

"By describing particles, such as electrons, as being strings that vibrated in certain ways, the mathematics no longer became entangled in the mess of infinity. Renormalization was no longer needed.

"Various quantum entities could be described using the same basic structure of a string. What differentiated one string from another was the way in which it vibrated.

"However, as the saying goes: 'When one door closes, another one opens', and, this also is true with respect to string theory. While this perspective permitted one to close the door concerning the issue of infinity, it opened other doors which, among other things, led to questions that had to do with wondering how strings acquire different modalities of vibration, and, as it turns out, calculations have been made which indicate that there are 10^{500} possible ways of answering the foregoing question, and most, if not all, of these possibilities require one to have access to the kind of technology, space, and energy which far exceeds our ability to provide, and, therefore, most, if not all, of those possibilities are fairly resistant to the prospect of being experimentally tested … sort of an 'all hat and no cattle' kind of situation.

"Nonetheless, like researchers before them, string theorists were adept at putting aside what was problematic – e.g., from where do strings of different vibrational properties come -- and tried to focus on what might lead to constructive results. For example, some string enthusiasts felt that the tiny, foundational structure of their perspective might provide a way of resolving the singularity issue that tended to be associated with treating quantum entities as point particles which eventually led one to suppose that the future of black holes inevitably involved gravitational properties which worked their way to becoming singularities which were capable of tearing holes in the fabric of time and space – assuming, of course, that gravitation actually has any way of dynamically interacting with, and affecting, either time or space.

"Instead of descending into the depths of singularities which tore holes in the fabric of time and space, some forms of string theory led to the expansion of black holes. So, I suppose, one can pick one's poison as to which sort of fate one wishes will be awaiting us – singularities which turn space and time into tattered remnants of whatever they are, or imperialistically-inclined black holes which seek to extend their hegemony over the entire universe, one galaxy at a time.

"The capacity of various forms of string theory to resolve the problem of infinities in quantum physics, as well as to be able to resolve the problems which arise in general relativity by removing singularities that tear holes in the fabric of time and space from the Universe, those successes began to hint at a further possibility. More specifically, perhaps string theory could be used to develop a theory of everything.

"However, the mathematical construction of such a theory required one to suppose that reality consisted of ten dimensions. The postulating of such dimensions was necessary to make the mathematics come out in a defensible manner.

"If four of those ten dimensions were taken up with length, breadth, height or depth, and time, what did the other six dimensions involve? Moreover, why weren't those six other dimensions capable of being experienced or sensed like the previously noted four, more concrete dimensions were able to be experienced or sensed?

"One answer to the latter question rests with the notion of 'compactification'. The six other dimensions cannot be seen because they exist in a state that is the result of having been folded up or compactified to such an extent that they no longer are visible.

"For instance, a perspective which has attracted a lot of interest with respect to such a state of compactification comes in the form of what is known as a 6-dimensional Calabi-Yau manifold or Calabi-Yau space which possesses a number of properties which are useful for describing various aspects of the dynamics which occur in quantum phenomena. The name of this manifold comes from Eugenio Calabi who, first, began to theorize about the properties of such configurations in the mid-1950s, together with Shing-Tung Yau who was able to mathematically confirm Calabi's initial conjecture in the late 1970s.

"Calabi-Yau spaces often play a very prominent role in what is known as superstring theory. The term "superstring" is a shortened version of the phrase: “supersymmetric string theory” which seeks to provide a comprehensive account of fermions – which encompass all sub-atomic quantum entities, such as leptons like electrons and neutrinos, that exhibit the property of having what is referred to as half-integer forms of spin and which also comply with the Pauli exclusion principle – as well as bosons – which consist of sub-atomic quantum entities that exhibit spins that come in the form of different kinds of whole-integer spin and many of which are associated with the carriers of force, such as the photon that communicates electromagnetic properties or the gluon which gives expression to the strong force that, among things, holds quarks together.

“In addition supersymmetric string theory also seeks to integrate gravitational effects into the mix with bosons and fermions through the idea of supersymmetry. This latter idea proposes that for every known quantum entity there is a super partner with different spin properties, and together, these quantum entities engage in dynamics through which demonstrate that quantum forces can be shown to be equivalent to quantum masses … or, at least, the equations for such dynamics appear to indicate this.

“The problem with superstring theory is that evidence consistent with any of the hypothesized super partners has never shown up in the bowels of any collider system. This absence of evidence concerning the existence of such super partners has persisted despite the fact that the energies necessary to generate them are within the capabilities of, say, the colliders at CERN, and, consequently, the failure to be able to reveal the presence of such super partners at energy levels where they, or their decay debris, should be detectable with presently available technology constitutes a huge cloud hanging over the head of the viability of superstring theories.

“The first so-called string theory revolution led to the positing of five different superstring models known as: Type I, Type IIA, Type IIB, HO, and HE. Nonetheless, as indicated earlier, none of those theories have been verified.

A second so-called string theory revolution occurred when Ed Whitten proposed the notion of an 11-dimension string theory model in 1995 in which the five 10-dimension editions noted earlier were considered to be seen limited expressions of a more basic 11-

dimension theory which came to be known as M-theory. Like its predecessors, this new updating of string theory entails no evidence which is capable of justifying its existence despite the passage of thirty years.

"There are some problems which rend to stalk the extra six or seven dimensions that allegedly exist beyond the four which have been designated as: Length, breadth, depth or height, and time. To begin with, those six or seven other dimensions don't actually refer to anything of an ontological nature, but, instead, so far, they just exist for mathematical reasons and not necessarily because they successfully describe anything which actually exists in reality.

"A second potential problem concerning string theory – and many other theories as well – has to do with the manner in which dimensionality tends to be spatialized. Even time – which seems to be quite different from the notions of length, breadth, and height or depth -- is often treated as a spatial-like dimension … as Einstein tended to do did in general relativity when he tied time to space together and making the combination measurable in terms of various kinds of curvature.

"In addition, compactification is a process in which alleged dimensions are folded up into geometric, topological, and other mathematical forms which yield structures like Calabi-Yau manifolds that give expression to dimensions which are reduced to sizes that are so tiny that they are not readily visible to the human eye, and, to whatever extent their presence can be detected, those reduced dimensions appear to be like points. One-dimensional strings, spaces, manifolds, and points tend to be part of the vocabulary of space.

"Moreover, irrespective of whatever the nature of these other seven dimensions might be, no one has actually provided a plausible way of accounting for the specifics of the dynamics which are involved in the compactification process. Aside from some mathematical properties which have been built into these spaces – properties which have relevance to being able to describe certain facets of quantum phenomena – none of the seven dimensions beyond the three degrees of freedom which characterize the length, breadth, and height/depth of spatial entities have any kind of metric associated with them.

"As such, they are sort of like empty suits into which one can try to stuff almost anything. Indeed, the lack of specificity concerning the nature of those extra seven dimensions is one of the reasons why there are 10^{500} possible ways of arranging things in string theory and, unfortunately, string theory has not provided us with any way to be a able to identify which of those possibilities might be able to accurately describe the world in which we live or be able to make viable predictions concerning that world.

"I believe Carrie introduced the possibility that, maybe, dimensions are like affordances which have the capacity to penetrate our beings or the physical/material ecologies in which we are embedded and transmit various kinds of qualities and dynamics. Conceivably, existence is a very complicated Venn-diagram-like arrangement in which affordances or dimensions of, say: Time, space, energy, consciousness, life, intelligence, language, creativity, morality, will, emotion, and so on interact with one another according to an array of degrees of freedom as well as constraints, and each of these affordances or dimensions contributes to the collective dynamic in its own characteristic or unique manner such that none of the affordances or dimensions can be reduced to one or more of the other affordances or dimensions.

"String theorists and other researchers have been trying for quite some time to find a unified field theory or theory of everything, or supersymmetric framework which is capable of showing how everything comes from a set of material processes that emerge when some primordial symmetry is broken. However, not only are there still many physical and material phenomena which remain unresolved a or do not fit in easily into the Standard Model and theory of general relativity – whether considered individually or when combined in some fashion – but, as well, there are qualities of consciousness, language, intelligence, creativity, life, morality, emotion, will, and so on which seem to extend well beyond the capabilities of the Standard Model of quantum dynamics as well as the theory of general relativity.

What is being alluded to here is not meant to suggest that physical/material phenomena are unrelated to qualities such as consciousness, intelligence, language, creativity, life, will, and so on – because, obviously, there is a lot of scientific evidence indicating that there are varying degrees and kinds of physical/material phenomena which are related to all of the other dimensions which I mentioned earlier, but, whenever, one tries to treat those other dimensions in a reductionist manner, such efforts seem to be as if researchers were trying to fit a very complex set of phenomena into an extremely simple round or square hole, and, as a result, many of their theories tend to fall apart or, at best, have limited spheres of applicability."

Ben was about to go on when, after checking the clock on the wall, I indicated that we had run out of time. I thanked them all for their contributions in the current exercise as well as for their many contributions to class discussions throughout the semester, and, finally, I wished them well in their future explorations.

<u>Chapter 3</u>: Constant Implications

Arguably, among all the topics which are explored in this book, perhaps the one which seems most resonant – at least to me -- with the idea that something is more deeply hidden has to do with the notion of constants. Constants are the phenomena which give expression to fundamental aspects of the dynamic network that shapes and regulates much of what takes place in that which is considered to be the physical universe.

Currently, there are 26 constants which are believed to constitute the degrees of freedom and constraints which shape and govern the way the material universe operates. Some of these constants are encountered by the general public in the form of terms that, at varying times, people have heard – phrases and words such as: 'The speed of light'; 'electromagnetic forces', 'quantum dynamics', and 'gravitation'.

There are other phrases which have entered the lexicon over the last fifty years which have become popularized to some extent, but, are less well-known. This would involve ideas such as: The strong force (which governs the dynamics that glue together the constituents – i.e., quarks – of atoms) and the weak force (which is involved in the process of radioactive decay as well as is involved in various aspects of nuclear dynamics such as fission and fusion).

However, notwithstanding the importance of constants to the way in which physical reality operates, discussions concerning most of constants are rarely encountered by the general public. For example, there are fifteen particles which are listed in what is referred to as the Standard Model (which describes three of the four basic forces of nature – excluding gravity -- as well as the fundamental particles which are regulated by those forces).

The aforementioned particles involve: Six quarks (up, down, strange, charm, top and bottom -- protons and neutrons are a function of their dynamics), 6 leptons (particles, such as the electron, that are characterized by half-integer spin properties and which are not affected by the strong force), the Higgs boson (involved in particles acquiring mass by interacting with the Higgs field), and, finally, the W and Z particles (crucial to the weak force). Each of these particles has properties, such as rest mass, which characterize them, and various constants give expression to a number of properties that are associated with those particles.

In addition, there is what is known as mixing-parameters which govern how quarks can be mixed together during strong force dynamics. There also are mixing parameters for the three kinds of neutrinos (electron neutrino, muon neutrino, tau neutrino) that are electrically neutral and are affected, to varying degrees, by weak and gravitational forces.

One could add, as well, what is known as the "cosmological constant" to the foregoing set of constants. This is the constant which Einstein considered to be a blunder because in his general theory of relativity (i.e., theory of gravity) it was intended to help keep what he considered to be a steady-state universe, steady, and, the blunder aspect of his perspective arose when the Big Bang came into vogue and, as a result, a feature (i.e., cosmological constant) that was designed to keep a steady-state universe steady seemed out of place in a universe that might be expanding.

Currently, Einstein's cosmological constant for a steady-state universe has been re-imagined as a term which refers to the rate at which the universe supposedly undergoes expansion. The modern phrase which refers to this rate of expansion is "dark energy."

There is one theme which connects all of the 26 constants being alluded to in the foregoing discussion. More specifically, none of the 26 constants can be derived from first principles of physics.

Said in another way, none of what is known about the basic laws of physics is capable of predicting the value of any of the 26 constants. All of those 26 constants have to be determined experimentally.

There have been very precise determinations – to many decimal points -- concerning the measured value for each of the 26 constants. The problem is, no one has a clue as to why those constants have the values they have.

All of those values play fundamental roles in providing a certain level of detailed understanding concerning the dynamics governing many physical processes. Consequently, they serve as reliable standards for solving an array of problems, but the will-o'-the-wisp that hovers about those problem-solving computations which involve constants is that, in a very real sense, the people who employ those constants on a daily basis don't actually understand why the constants they use have the values that they do, and, therefore, in a fundamental sense, they don't actually understand why what they do works.

In this respect, physicists are like medical clinicians who use off-label drugs and procedures to resolve problems with which the latter individuals are confronted. Whether, or not, one understands what one is doing (and many off-label drugs have had, for unknown reasons, success in treating conditions for which the drug was not initially intended), what tends to count is whether, or not, something works.

A clinician – whether that individual is a medical doctor or a physicist -- proceeds with the hope that at some point one will develop a deeper insight into why what one does is capable of having a successful outcome. However, there have been many a clinician – both medical and physicist – who have lived their whole professional lives without finding out why the techniques that they use to solve various kinds of problems are successful.

Most people who have taken a high school course in physics know that the force or intensity of gravitational attraction falls off with the square of the distance. Such individuals also are likely to be familiar with other kinds of inverse square laws for electrical charge and magnetic forces in which the intensity of a given phenomenon decreases proportionately to the square of the distance.

The foregoing sorts of inverse square laws describe what occurs in a given set of circumstances. The descriptions are accurate.

Nonetheless, the actual dynamics concerning what is taking place appear to be largely unknown. The usual "explanation" which is given for inverse square phenomena is that they are functions of geometric or spatial considerations.

However, this sort of an explanation doesn't actually account for what is taking place. Why should any given force diminish with the square of the distance as opposed, to say, the cube of the distance, or some other factor?

What is it that is present in a given force that translates the square of distance traveled into a diminishing of the force by a certain amount? Or, what is there about spatial geometry that induces a given force to diminish its intensity by a set amount per distance transmitted? Or, what is there about the way that a force and the dimension of space interact with one another that enables the intensity of the force to lessen by a set amount?

I remember watching a 2003 lecture on constants given by John Barrow, an English mathematician and astrophysicist. At one point during his talk, he touched upon Kant's reflections concerning Newton's inverse square law.

More specifically, Kant wanted to know how and why that inverse square law worked. He wanted to know why it was an inverse square law and not an inverse-some-other factor law.

According to the chart that Professor Barrow put up on the screen, the answer that emerged for Kant had something to do with a formula in which the strength of the gravitational force between the centers of two objects was a function of the spatial dimensions in which the force was situated, and those dimensions were alluded to through the exponential configuration – namely, N-1 -- that was part of the mathematical expression that had been presented on the screen. In other words, for Kant, the constant of proportionality in Newton's gravitational force was an exponential function involving the number of spatial dimensions in which such a force resides, and since we allegedly live in a three-dimensional world, then, N (3) – 1 = 2, and, as a result, Kant apparently came to the conclusion that the reason Newton's inverse square law had an exponent of 2 -- rather than 3, 4, or some other factor -- is because we live in a three dimensional world.

Professor Barrow went on to maintain that what Kant had demonstrated was the following: There was an "intimate" link between the number of dimensions of space which characterized a given context, and the manner in which the laws of nature would manifest themselves in that context would be a function of the number of dimensions in which such a force was operating. For a number of reasons, whether, or not, Kant actually had demonstrated that which Professor Barrow claimed the famous philosopher had demonstrated concerning an "intimate" link between spatial dimensions and physical laws is questionable.

First of all, as was pointed out in the previous chapter, to consider height, width, and length to be separate spatial dimensions is problematic because that sort of an approach still leaves one in the dark not only with respect to trying to understand what is meant by the notion of dimensionality in general, but, as well, one is left in the dark in relation to trying to understand in what way height, width, and length are dimensions as opposed to being degrees of freedom and constraints within a more comprehensive medium known as space.

What is the fundamental nature of space that it can accommodate degrees of freedom and constraints known as height, width, and length? Is space a 'material something', and, if so, what is the nature of that "material something?"

Quantum physics is not necessarily any closer to answering questions concerning the nature of space than Kant was. Again, as noted previously, while some quantum physicists talk about the graininess of space as a function of energy dynamics that give expression to a foam-like vacuum condition which, according to some, supposedly marks the "outer" limits or boundary conditions of the spatial dimension, no one has shown that space is a function of energy.

Some individuals want to talk about space in terms of fundamental units of measurement such as the Planck length (1.616255 x 10^{-35} meters, with uncertainty surrounding the value of the decimal part of the number and this is about 20 orders of magnitude smaller than the size of a proton). However, the Planck length which is calculated as a function of three constants – namely, Planck's constant, the gravitational constant, and the speed of light – was never meant to serve as a form of measurement for the fundamental nature of space, but, instead, was created with the idea of simplifying calculations and, among other things, removing from calculations certain kinds of constants which might entail complicated computations or muddy the waters of understanding or, perhaps, a little of both.

Consequently, the Planck length, along with the Planck time and the Planck mass, were an attempt to provide a form of standardization, of sorts, for the computational process. The process was arbitrary, but it offered a framework of commonality through which to engage many physical processes on the quantum level, and it was all a function of, or rooted in, numbers (i.e., the constants) which had proven to be reliable guides.

So, let us return, once more, to Kant's approach to trying to explain why gravitational forces were governed by an inverse square law and whether, or not, Professor Barrow was justified in claiming that Kant had demonstrated that an "intimate" link existed between spatial dimensions and the laws of nature such as the inverse square law of Newton's gravitational theory. There certainly is a correlational link between space and the inverse square law, but whether that link is causal in nature, is another matter.

Following his discussion of Kant's approach to trying to understand the nature of the inverse square law for gravitation, Professor Barrow continued to develop the theme that natural laws are somehow intimately linked to the number of spatial dimensions in which they take place. More specifically, he claimed that none of the forces of nature will work if the number of spatial dimensions exceeds the three with which we are familiar, and, in addition, he claims that none of our physical laws will operate if the number of temporal dimensions which exist is more than the one that appears to characterize our world.

Leaving aside the previously noted point that height, width, and length are not necessarily different dimensions but, instead, could be considered to constitute a subset of the degrees of freedom which exist as potentials within a spatial dimension that gives expression to an affordance which has, to varying degrees, the capacity to accommodate, or permit, such degrees of freedom, Professor Barrow is about to take the hypothesis that there is a close connection between spatial dimensions and the laws of nature and export the hypothesis to more complex spatial dimensional contexts despite the fact that neither he nor Kant has shown how, for example, inverse square laws interact with spatial dimensions in such a way that the latter determines to what extent, and in what way, the laws of nature can be expressed.

There is observational evidence, precise measurements, and mathematical formulae which capture the superficial fact that the force of gravitation operates in accordance with the inverse square law between the centers of two bodies. There is nothing – in that evidence, those measurements, or the associated mathematics -- which demonstrates in what way the dimension of space is that which is responsible for what is being observed other than that such a dimension provides a 'space', so to speak, within which such a phenomenon can be observed.

How do height, breadth, and length act on the force of gravitation? Height, breadth, and length might well provide a space for one to see curvature be manifested in the manifold of dynamics which are occurring, but that curvature is a function of gravitation and is not a function of that which is being curved.

Curved space gives expression to gravitational-like effects which makes Einstein's theory about the general dynamics of acceleration rather than being tethered to frameworks which move with constant speed relative to one another that was being explored in the special theory of relativity. However, to say that space causes the inverse square law to be what it is seems to confuse effect with cause since the space did not curve itself.

To be sure, Einstein talks about the curvature of time-space in his general theory of relativity, but time-space appears to be more about the measurement of curvature rather than encompassing a concept which gives expression to the ontology of gravitation. The general theory of relativity is a mathematical system or model for describing the behavior of gravitational forces in a given context.

The notion of time-space is like a Wilson Cloud Chamber. It is a medium (like the condensation clouds in a Wilson Cloud Chamber) for revealing the presence and character of the impact which gravitation has in a given context.

By measuring curvature, one can deduce the strength of the gravitational force which is present. However, that curvature is the effect of something else.

That something else is what? To say that this underlying cause of gravitation is the acceleration which is brought about by the curvature of space-time through which bodies travel tends to entangle one in a circular form of logic, and, in addition, one tends to by-pass the most fundamental issue of gravitation – namely, what is it?

Einstein had found a way to develop a better model for describing the behavior of the force of gravitation than the one that had been put together by Newton. Nonetheless, neither Newton nor Einstein knew what gravitation is.

They knew about its presence and the sorts of impact which it could have in different circumstances. Both of them – each in their own manner – had developed a mathematical system for mapping the presence, intensity and nature of gravitational phenomena, but these were systems which described that behavior rather than explain it.

The gravitational constant was worked out by an English scientist, Henry Cavendish, during a complex experiment which was conducted in 1797 and 1798 and, to a considerable degree, was based on a design which had been drawn up by John Michell in 1783 who had died before being able to complete the experiment. The value which Cavendish generated came within one percent of the modern determination that was computed some 215 years later when the latter value was published by the Committee on Data for Science and Technology (CODATA) in 2014 – namely, (6.674 08 plus or minus 0.00031) x 10^{-11} $m^3\ kg^{-1}\ s^{-2}$ and which is characterized by an uncertainty value of 47 parts per million.(This uncertainty value is larger than the uncertainties associated with a number of other constants).

Newton's theory of gravitation was first published in 1687, more than a hundred years prior to Cavendish's calculation of the gravitational constant. Cavendish's value concerning the gravitational constant did not begin to be used until around the early part of the 1870s, approximately 75 years after the aforementioned experiment had taken place near the end of the 18th century.

One cannot derive the foregoing gravitational constant from either Newton's theory of gravitation nor can that value be derived from Einstein's theory of gravitation. Neither of two systems can explain why the gravitational constant has the value that it does.

How does Newtonian space impart a value of 6.674 08 (plus or minus 0.00031) x 10^{-11} $m^3\ kg^{-1}\ s^{-2}$ to gravitation? Why is Einstein's notion of space-time curved as a complex function of 6.674 08 plus or minus 0.00031) x 10^{-11} $m^3\ kg^{-1}\ s^{-2}$?

The mathematical systems devised by Newton and Einstein can describe the effect that the gravitational constant has on certain kinds of phenomena. Nonetheless, neither system can account for why gravitation impacts various circumstances with the precision that it does or account for the precise nature of the dynamic which causes gravitation to operate in accordance with an inverse square law.

Einstein had spent the last decades of his life trying to develop a unified field theory that incorporated electromagnetic and gravitational forces in a manner that would account for the origins of those two forces. A substantial part of the reason for the lack of success with respect to accomplishing his goal of unification might be due to the fact that while each of the forces he was trying to connect appeared to be fundamental, neither one of them could be reduced to the other, and, consequently, something more deeply hidden was missing from his considerations that could show in what way and to what extent -- if any -- the two theories could be unified.

During the aforementioned lecture, Professor Barrow adopted Kant's alleged insight that the reason why gravity follows an inverse square law has to do with the number of spatial dimensions which are present. As a result, Professor Barrow began to apply that perspective to so-called higher order spatial dimensions.

According to Professor Barrow, if one substitutes some number other than 3 in the previously noted N-1 exponent concerning the proportional nature of the inverse square law for gravitation, the result is that atoms or molecules will not be able to form, and, in addition, forces such as gravitation will not be able to operate. This is because by substituting any number other than 3 in the N-1 exponent noted earlier, one will alter the inverse square law.

For example, if one had four spatial dimensions, then, if one follows the logic of the Kantian-Barrow perspective, this would mean that gravitation would fall off with the cube of the distance [i.e., N (4)-1 = 3]. If one did this, then, when one worked through the various calculations concerning different kinds of physical laws, one would discover that stars, clusters of stars, and planets would not be able to form because as a result of the extra spatial dimensions the force of gravity would skew the gravitational dynamics in ways that would adversely affect the ability of such bodies to be able to form.

However, given that neither Kant nor Professor Barrow has actually determined what dimensions are, or what space is, or what gravity is, or why the gravitational constant has the value it does, or how spatial dimensions would affect the strength of gravitation, then, there is no basis for supposing that alleged higher-order spatial dimensions (that is, consisting of more than 3 dimensions) will necessarily have any impact at all on the inverse square law.

Conceivably, gravitation is a function of the affordance dynamics associated with some other kind of non-spatial dimension. When such a dimension interacts with the dimension of space, then, irrespective of how many spatial dimensions one is considering, gravity might be transmitted through each of those so-called spatial dimensions in precisely the same way.

In addition, one might suppose that if height, width, and length are not necessarily separate dimensions but degrees of freedom present in the nature of a single kind of spatial dimension, then, there is no reason to suppose that higher-order spatial dimensions (4 or more) are nothing but degrees of freedom which are present as potentials within the spatial dimension as a function of the sorts of geometric configurations which such a dimension might be able to accommodate. Gravity – whatever it is – might have the capacity to penetrate spatial dimensionality, and if this is actually the case, then, gravity would be able to penetrate every aspect of space without necessarily being affected by the latter.

Professor Barrow also contends that temporal dimensions might exist which, somehow, are different, supposedly, from the one with which we are familiar (different in a way that, perhaps, is somewhat analogous, in a hard to define manner, to the way in which height is different from width or length, and vice versa). Like excess spatial dimensions, he believes that such excess temporal dimensions would be capable of undermining or interfering with the way in which gravity is propagated. Nevertheless, as was the case in relation to the notion of excess spatial dimensions, Professor Barrow never explains what time is or what makes it possible or how time could interact with the dynamics of gravitational force and, thereby, alter the way that the gravitational force expresses itself.

If the number of dimensions is said to be greater than three and the temporal dimensions are considered to more than one, then, according to Professor Barrow, no stable, complex structures would be able to form due to the way that the extra dimensions of space and time would -- allegedly -- undermine the natural laws of the universe. Consequently, given the foregoing perspective, Professor Barrow maintains that the universe with which we all are familiar could not arise.

Having considered possible arrangements involving more than three dimensions of space and one dimension of time, Professor Barrow next turned his lecture attention to the possibility of two-dimensional and one-dimensional worlds. He doesn't indicate whether the 2-D worlds to which he alludes consist of one dimension of space and one dimension of time or two dimensions of space with no dimension of time, or whether the one dimensional world is a realm of just space or just time, but no matter how one parses his perspective, he hasn't shown how gravity is a function of time or space, no matter how those sorts of dimensions are configured.

Professor Barrow claimed that as we take more and more dimensions of time and space into consideration, then, everything becomes unpredictable. He stipulated that there can be no sense of order which can exist in such contexts, and, as a result, notions of causality become defunct, and, when principles of causality are lost, then, the past no longer determines the present, and the present is no longer able to shape the future.

All of the foregoing is said without evidence of any kind. Consequently, as his position stands, then, seemingly, his imagination has taken his mathematical, scientific, and logical sensibilities on a rather phantasmagorical ride.

In an attempt to right his conceptual ship, Professor Barrow, begins to talk about how string theories only seem to work mathematically when those frameworks are working with 10 or 11 dimensions. But, in order to get around the manner in which the laws of nature seem to be circumscribed by the need for no more than three dimensions of space and one dimension of time to play prominent roles in the processes of physical dynamics, he indicates that 7 or 8 of the alleged dimensions which govern string theory operate – to whatever extent they have some kind of physical functionality – on the level of the Planck length (1.616255×10^{-35} meters – more than twenty orders of magnitude smaller than the proton), and, therefore, are too small to be seen and, in addition, their alleged impact on forces like gravitation are, apparently, negligible.

Professor Barrow asks his audience to imagine that near to the beginning of the Universe, there were 10 dimensions of space which were present when things began to expand. Being able to justify why a member of the audience would want to imagine such a scenario is on somewhat shaky grounds because no reasons have been given to members of the audience during Professor Barrow's lecture why one should suppose that 10 such dimensions of space existed during the Big Bang because as the work of the astronomer Halton Arp suggests, and as advocates for an Electric Universe point out, and as a growing body of data which is being sent back by the James Webb telescope is suggesting, an expanding Big Bang narrative is not necessarily the slam-dunk that many people consider it to be.

The only statement which has been made by Professor Barrow in defense of string theories containing 10 dimensions is that the existence of those dimensions enables string theory to work – at least on a mathematical level. Nonetheless, regardless of such mathematical niceties, estimations have been made by reputable scientists that indicate there are 10^{500} ways in which a world containing those ten dimensions might be arranged, and, yet, there is absolutely no way at the present time, or in the foreseeable future, to be able to test any of those 10^{500} possibilities.

To a considerable degree, string theory seems – to borrow a term from Karl Popper – "unfalsifiable". In other words, there is no way to challenge that perspective with a test which could show the theory was true or false, and, therefore, string theory is not really a scientific theory, but gives expression to a philosophical model concerning the nature of reality.

In addition, Professor Barrow still has not provided a viable account concerning what the nature of the relationship is between those dimensions and physical reality. Moreover, he has provided no reason why we should suppose that 10 spatial dimensions existed at the time of, or near to the time of, the alleged Big Bang.

Notwithstanding the foregoing considerations, Professor Barrow wanted the members of the audience to further suppose that all of the alleged, ten spatial dimensions were somehow on an equal footing with one another so that no one of those dimensions had a special role of some kind that shaped the unfolding of events as a function of that dimension as the Universe was beginning to expand. Yet, according to Professor Barrow, for “some reason” an unknown set of phenomena enter, stage right, the Big Bang drama and, “somehow” those unknown phenomena select three of the ten dimensions to continue to expand while keeping the other seven dimensions tiny.

The foregoing scenario is a variation on the theme of how to hold on to your cake and eat it as well. Professor Barrow just got done explaining in his lecture that, on the one hand, theories involving more than 3 dimensions of space and one dimension of time lead to unstable, unworkable universes, while, on the other hand, he also indicated that, mathematically speaking, the only string theories that work are those containing 10 or 11 dimensions.

So, the way in which he purportedly resolved the foregoing contradiction in perspectives was to say that through a process which is unknown, three of the 10 dimensions that were present toward the beginning of the universe were, due to unknown reasons, selected for continued expansion during the periods of inflation, while, in a similarly unknown manner, the other 7 dimensions were de-coupled in some fashion from that inflationary process and, as a result, remained very, very tiny. According to Professor Barrow, this is how we get the four dimensional world in which we live while, at the same time, are able to construct a mathematical theory involving string theory which is logically consistent.

When I was growing up, my mother, on occasion, would read me stories about a character known as “Uncle Wiggily” – an older, gentleman rabbit who is both very resourceful and kind … despite a touch of rheumatism which, sometimes, rendered him crotchety. Often times, the way that the end of one chapter in those books would transition into the next chapter is that a certain number of conditions would be listed that had to be fulfilled, and if they were, then, the story could continue, and since the story did continue with the next chapter, then, presumably, all of the conditions which has been set at the end of the previous chapter had been satisfied in some unknown way between chapters, and, as a result, the story continued to unfold.

Unfortunately, there is a lot of Uncle Wiggily in string theory. All kinds of conditions are mentioned in Professor Barrow’s telling of the story which are in need of being resolved in some satisfactory way in order for the tale of strings to continue, and equally unfortunately, no explanation is ever given about how those conditions have been successfully resolved, and, yet, the story continues.

One of the issues which are never properly explained by Professor Barrow is why the compactification of dimensions should necessarily impact their alleged capacity to interfere with how the laws of nature are manifested. If spatial dimensions, per se, beyond the three usual suspects have the capacity to alter the way natural laws are manifested, then, what difference does it make if those extra spatial dimensions are compactified?

During his 2003 lecture or his related book on constants, Professor Barrow fails to reveal the nature of the dynamics through which spatial dimensions supposedly interact with natural laws. Consequently, we have no reason to suppose that just because dimensions have become compactified that this would prevent those dimensions from continuing to interfere with the way in which natural laws are expressed because the manner of interference might have to do with some property of space other than it geometrical configuration.

At this point, Professor Barrow becomes somewhat Platonic-like in his commentary because he makes a rather mysterious claim. He indicates that if there are, in fact, seven extra spatial dimensions beyond the three with which we are familiar, then whatever is measured in our laboratories are but shadows of the true constants that might have existed prior to the time period during which the universe allegedly underwent expansion.

In other words, what we supposedly see on the 3-D spatial screen in which we reside are but flickering shadows that are being projected into our everyday world as a function of how the true, primeval, pre-Big Bang constants of the universe operated and, perhaps, might continue to operate on some level of the Universe within which our 3-D world is but an expanded shadow of that realm. However, the foregoing perspective seems to give expression to a non-sequitur – that is, the conclusion does not seem to follow from the premises on which it is reportedly based.

We don't know what the origin of constants is. We don't know why constants have the values that they currently do. We don't know what the nature of the relationship is, if any, between different spatial dimensions and the laws of nature? We don't know how, of if, compactification of spatial dimensions will affect the manner in which natural laws operate.

Nonetheless, given all of those unknowns, Professor Barrow believes that we can conclude there might be two sets of constants which are in existence. One set of constants gives expression to the true, primeval set, while the other set of constants are but shadow editions of the former set of constants, but the latter conclusion does not follow from the premises which Professor Barrow put forth during his lecture.

However, he seems to believe that the foregoing conclusion has been demonstrated in some fashion. As a result, he adds a further conjecture based on that conclusion.

More specifically, he says given the foregoing considerations, there is no reason why we shouldn't entertain the possibility that constants might vary as temporal and spatial conditions change. Yet, given (and this current "given" comes with supporting evidence) that Professor Barrow has not, yet, demonstrated how either time or space is capable of changing the nature of a constant, then, based on what he has said to this point, we actually have no reason to suppose that constants either (1) depart from their essential values as temporal and spatial conditions change or (2) that constants will change because temporal dimensions beyond one and spatial dimensions beyond three will interfere with the way in which natural laws – such as inverse square law – will operate.

Now, experimentally, results have been obtain which demonstrate that the fine structure constant (which captures the strength of the electromagnetic relationship between elementary charged particles) will increase from its normal value of 1/137.+ to 1/128.+ when the temperature is raised substantially within an experimental set-up that is meant to study the nature of fine structure constant. In other words, under certain conditions, some constants seem to be able to undergo transitions in value.

Nevertheless, entertaining the possibility that constants might change under certain conditions doesn't necessarily have anything to do with the sorts of temporal and spatial dimensions which Professor Barrow has been exploring in his lecture and book on constants. More specifically, there is no evidence which has been presented in the lecture or in his book on constants indicating that to whatever extent constants might vary in their primary value under different conditions, no evidence appears to exist that constants vary as a function of the number of temporal dimensions beyond one or the number of spatial dimensions beyond three.

According to Professor Barrow, the dynamics of cosmic inflation have the capacity to generate constants which exhibit specific values. He considers this process involving the generation of constants to be random in nature but is brought about by a process of symmetry breaking.

In normal parlance, symmetry refers to a context which is considered to be balanced and inclined to remain as it is unless that symmetry is broken in some fashion. For example, suppose one is having a dinner party for ten people.

The table tends to be set in a way in which drinking glasses have been placed to the right, and slightly nearer to the center of the table than the plate. Each plate sits between, on the right side, knives and forks, while, on the left side, a number of spoons have been placed.

The dinner table has a symmetrical pattern. The first person who is sitting at the table and reaches for a glass is (statistically speaking) likely to be right-handed, and, as a result, the act of picking up the glass tends to break the symmetry and induce subsequent people to pick up the drinking glass to their right.

However, if the first person who picks up a glass is left-handed, and if that individual were unfamiliar with the etiquette of dining, and, therefore, reaches for the glass to the left of that person's plate, then, the symmetry is again broken, but this time in a more complicated fashion since a lot of people at the table might be right-handed and if the person who was next to pick up a drinking glass were right-handed and sat to the left of the initial individual, there is likely to be a certain amount of awkwardness experienced by the second individual and, as a result, that second person needs to either reach with a right hand across the plate in order to pick up the nearest drinking glass, or that glass on the left must be picked up with the second individual's left hand.

Of course, left-handed people have had to negotiate the foregoing sorts of situations for a long time and had to deal with the ensuing sense of awkwardness that attends having to do things with one's non-dominant hand. Some of the foregoing awkwardness could be avoided if the drinking glasses were placed neither to the right nor left of plates, but near to the center portion of the outer rim of the plate and slightly toward the center of the table.

Irrespective of whether the glasses are placed to the right of the primary plate, or to the left of a primary plate, or near to the center of the outer perimeter of the primary plates, once the first person picks up a glass, the original symmetry has been broken. This sort of symmetry is not what is meant when the term "symmetry" is used in physics.

In the latter case, symmetry exists when an object can be transformed in some way and, yet, the object remains the same as it had been despite undergoing a process of transformation. For instance, if four people were to take the foregoing dinner table which was fully set, lifted it up, and, then, rotated the table for a quarter of, or for a half of, or for three-quarters of, or for a full rotation, or more, of the table, then, the table would have undergone some sort of rotational transformation, but the top of the table would look the same as it did before and, in that sense, the table top has remained invariant under the transformation of rotation.

The symmetry operations in physics are often more complex than the foregoing example. Nonetheless, the foregoing scenario illustrates the basic principles of such operations – that is, (1) a transformational operation of some kind must be conducted, and, following that transformation, (2) the object being subjected to such an operation must remain the same or invariant, in some sense, as it was before.

When Professor Barrow asked his audience during his lecture to imagine a time near to the start of the alleged Big Bang when ten dimensions were being hypothesized to exist, and he described those dimensions as being like one another and, therefore, not playing any unique role in what was taking place, he was asking the members of the audience to imagine a symmetry arrangement involving those dimensions, as if they were drinking glasses near to ten plate settings. When he further introduced the idea of a mysterious 'something' that occurred during the early expansion of the Big Bang, he was alluding to some sort of symmetry breaking operation which induced three of the ten dimensions to continue expanding while the other seven remained small.

He didn't explain what caused such a transformation to take place. He merely described what he claimed happened when the process of symmetry-breaking that he was introducing took place -- namely, three dimensions continued to expand and seven dimensions remained very tiny.

Similarly, when – as indicated previously – Professor Barrow maintained that inflation has the capacity to generate constants with different properties through a random process of symmetry-breaking, he didn't provide any explanation concerning how inflation had the capacity to create constants with various properties. In a sense, he was just assuming his conclusions.

In addition, he didn't provide an explanation for what he meant by the idea of a random process. Just because we don't know how something came about doesn't make that unknown process random.

To begin with, Professor Barrow is assuming that there are certain kinds of symmetry-breaking operations that already are in existence near to the beginning of Big Bang expansion which are capable of allowing three spatial dimensions to expand while holding seven other spatial dimensions constant. He offers no proof that this is the case, but, instead, he has asked his audience to imagine such a possibility.

In addition, he is claiming that the operation which leads to the emergence of constants involves a process of symmetry-breaking. Again, he offers no evidence in support of such an idea

Furthermore, he is claiming that the dynamic which leads to the generation of constants is a random process. How does he know that the process is random?

In truth, he doesn't know this but assumes that it is the case. Nevertheless, by invoking the idea of randomness, he might believe – as many people seem to -- that he has been freed from having to provide an explanation for how the process works because random processes are, at least by reputation, unpredictable and, yet, whatever one needs to make one's theory work just, somehow, often magically emerges.

A person cannot actually prove that something is random in nature. All one can do is admit that one does not know whether, or not, there is an algorithm or set of algorithms which exists and which can fully account for some given dynamic or event.

Perhaps, an admission of ignorance under such circumstances might be the most prudent and honest stance. However, when one claims that some given process is random, one is injecting a whole ontology into the proceedings because one is saying that what occurs is a function of a universe that is inherently random – something which has not, yet, been shown to be the case and something which can never be definitively claimed.

During his 2003 lecture, Professor Barrow was conceptually leveraging the possibility of a form of random, inflationary dynamics that has the capacity to generate constants, of one kind or another. In effect, he was saying (like Archimedes), if you give me a set up a conceptual fulcrum (or physical fulcrum), one could use it to move the world in any way that one likes.

According to Professor Barrow, the inflationary theory of the universe explains an array of features concerning the manner in which the universe unfolded over time. Within such an explanation, one finds claims that the inflationary theory puts forth some very precise predictions concerning the dynamical character of the cosmological unfolding dynamic.

The first thing that should be noted in relation to the foregoing perspective is that an explanation – no matter how plausible it might sound – doesn't actually explain anything until one can bring forth evidence that substantiates such an explanation. Elsewhere, I – and others -- have written about some of the questions which arise in conjunction with the inflationary theory, and, if interested, one could consult the Bibliography for a list of relevant materials.

What follows just touches on a few issues concerning the topic. Hopefully, enough to provide the reader with some of the possibilities which one might want to consider and critically reflect upon.

To begin with, Professor Barrow maintains that the inflationary theory accounts for why galaxies exist and why the universe unfolds or expands in the way that it allegedly does. If what he says is true, then how would he account (which went on its mission several decades after Professor gave his lecture) for the relatively recent findings of the James Webb Telescope that more than ten galaxies have been observed which have a size, complexity, and brightness that such cosmological bodies should not have if the inflationary theory of the universes is true because those galaxies are considered to have arisen at a point during the expansion of the universe that was too close to the origin of the Big Bang to have had the necessary time to acquire the size, complexity, or brightness which they exhibit.

Moreover, Professor Barrow maintains that the inflationary theory makes specific predictions about the amount of lithium which should be observable in the universe. Unfortunately for inflationary theory, however, between what was predicted by the inflationary theory and what was actually found, there is a huge discrepancy with respect to the quantity of lithium (both near stars as well as in interstellar space) that seems to be present in the universe.

Or, let's consider another issue. More specifically, in order to accept the inflationary theory, one has to suppose that the redshift in the spectra of stars accurately reflects, in good Doppler fashion, the extent to which stars are allegedly moving away from us in an expanding universe at a rate that is allegedly fueled by dark energy. Nonetheless, in 1998 Halton Arp published a book entitled *Seeing Red: Redshifts, Cosmology and Academic Science* in which, among other things, he points out that there are any number of instances in which astronomical objects (for example, quasars and galaxies) that, supposedly, have similar distances from Earth were discovered to manifest radically different redshifts.

More specifically, the quasar Markarian 205 had a much higher redshift than the galaxy NGC 4319 with which it can be linked in a manner which indicates that the two objects are similar in their distance from the Earth. If redshifts are considered to be an indication that something is traveling away from us (and this belief is at the heart of a great deal of modern astrophysics, astronomy, and cosmology), then, Arp has put forth data which counters much of the modern narrative concerning the origin of the universe and the manner in which it evolves.

After all, if redshift is a Doppler phenomenon, then, why would two astronomical objects which are roughly similar in their distance from Earth have such radically different redshifts associated with them? Decades have passed in which many astronomers have continued to be so vociferous in their refusal to acknowledge the evidence with which they had been presented that they took steps to make sure that Arp would not have ready access to various modalities of astronomical technology, and, as well, some individuals also sought to ruin his career in a variety of ways.

When people try to save the appearances of their various theories by attacking a person rather than critically, sincerely, and judiciously engaging the evidence presented by that individual, then, one has some prima facie evidence which suggests that such people seem to be more interested in seeking to protect their conceptual fiefdoms rather than committed to seeking the truth concerning a given issue. Revoking someone's opportunity to have fair access to the equipment needed to research such issues is an expression of petulance rather than science.

The evolution of the universe is rooted in unstable conceptual ground. The evolution of stars is similarly problematic.

For instance, at one point during his lecture, Professor Barrow contends that stars come into being when the amount of gravitational force present in a coalescing mass of stellar dust becomes sufficiently large that it becomes able to initiate, and sustain, the thermonuclear fusion reactions which, supposedly, supply a star with all of its energy and power. The foregoing story has been making the rounds for more than a century when Sir Arthur Eddington argued that the sun's energy was due to the way in hydrogen atoms (under gravitational pressure) became fused into helium atoms which was accompanied by the release of a tremendous amount of energy.

Eddington was the individual who uncovered evidence which served as a crucial test for the viability of Einstein's theory of gravitation. Eddington's work during the solar eclipse of May 29, 1919 demonstrated that – as Einstein's theory predicted -- light waves exhibited curvature when traveling near a massive gravitational source (i.e., the sun).

Not too long after his expedition had been completed, Eddington summarily dismissed the possibility that the sun might acquire its power from external sources. Yet, the theory of the Electric Sun encompasses a perspective which is capable of accounting for many, if not most, of the elements of the so-called standard model of the sun, as well as many other factors which the standard model is unable to address in a scientifically satisfactory manner.

The standard model of the sun, for example -- which is rooted in a process of thermonuclear fusion reactions -- cannot explain why the tsunami of electron neutrinos that are predicted to be generated by the alleged thermonuclear fusion reactions taking place in the sun are, to a large extent missing. Based on actual measurements, two-thirds of the anticipated quantities of electron neutrinos have gone MIA, and the standard theory has no way to account for this experimental fact.

The Sudbury Neutrino Observatory in Ontario, Canada, announced in mid-2001 that they had discovered evidence that neutrinos not only had mass but they could change into two other flavors of neutrinos – the muon neutrino and the tau neutrino. As a result, some people began to speculate that, perhaps, the missing electron neutrinos had transformed into one or the other of the two additional flavors of neutrinos on their way to Earth.

To have any chance of demonstrating that the foregoing possibility is true, one would have to be able to do a 'before' and 'after' comparison concerning the kinds of neutrinos that were leaving the sun as well as the kinds of neutrinos which were reaching Earth. Ways of collecting the latter data, already had been established (which is how awareness of the missing neutrinos first came to light), but there was no known way to acquire an accurate assessment of the types of neutrinos which were leaving the sun.

To the foregoing consideration, one might add the following item. If the standard model of thermonuclear fusion of hydrogen into helium is the source of the sun's energy output, then the photosphere – the surface of the visible sun – should constitute the outermost layer of the alleged convection currents which takes energy on a 150,000 year journey that runs from the core to the surface.

However, beyond the photosphere (the so-called surface of the sun), there is another layer that is about 2-3,000 km deep. This is known as the chromosphere, and the standard model cannot account for its presence or its properties.

Beyond the chromosphere is another solar layer which can be seen during an eclipse and is known as the corona. The sun's corona, which constitutes a plasma medium, has been measured to be millions of times hotter than the surface of the sun, and that measurement cannot be reconciled with the standard model of the sun which is unable to account for why the corona exists or why it has the characteristics it does.

Further removed from the surface of the sun is a layer known as the plasmasphere. This solar layer extends to a distance which is many times greater than the orbit of Pluto.

The corona and the plasmasphere are both involved in the generation of the ion flux which is often referred to as a “solar wind.” In actuality, the so-called “solar wind” gives expression to an electrical current that flows throughout the solar system.

According to the theory of the Electric Sun, the sun is a capacitor. In other words, the sun has the capacity to store energy.

The Sun is hooked into electrical currents which run through our arm of the Milky Way galaxy and beyond. This network of electrical currents interacts with the significant voltage that exists in conjunction with the Sun’s capacitance.

An engineer by the name of Ralph Juergens calculated the total wattage (voltage multiplied by current) which would be available to the sun based on its voltage potential as a capacitor together with the amperage coming to it through electrical currents. Based on his insight into the plasma studies of a Scottish physicist and mathematician, together with some rigorous calculations, Juergens concluded that the energy available to the sun through the foregoing arrangement would be sufficient to account for the energy that is observed to be generated in conjunction with the sun.

As pointed our earlier, the standard model of the Sun cannot account for the existence of the previously mentioned chromosphere, nor can the standard model account for the existence of the Corona or its properties. The existence of the plasmasphere is also inconsistent with the standard model of the sun.

Furthermore, the existence of electric currents in the cosmos (usually referred to as ‘solar winds’) is not compatible with the thermonuclear fusion version of the Sun and, as a result, constitutes a phenomenon that cannot be explained by the standard model. Finally, the standard model cannot account for why something it predicts (e.g., the quantity of electron neutrinos which are generated by thermonuclear fusion reactions), does not appear to coincide with the quantity which is predicted.

WMAP – Wilkinson Microwave Anisotropy Probe – was launched in 2001. From its data, we allegedly possess a picture of the Cosmic Background Radiation which, supposedly, represents the residual, radiated effects of the unfolding of the Big Bang. According to Professor Barrow, the tiny variations in temperature which can be observed as one moves through the microwave mapping that is provided by WMAP data reflects what the inflationary theory predicts would give expression to the statistical pattern of those sorts of temperature variations if the inflationary theory were correct.

As touched upon in the foregoing discussion, there is credible evidence (from the James Webb Telescope) that galaxies do not necessarily evolve in the manner in which the inflationary theory of cosmology claims. In addition, the previous discussion also provided a brief overview of certain evidence indicating that the standard cosmological model does not necessarily understand how stars evolve.

There is also data which suggests that the standard cosmological model doesn't understand how planets evolve. For example, as Don Scott points out in his book *An Introduction to Cosmology for Beginners*, the planet Venus is much hotter than are claimed by the prevailing theories concerning our solar system -– 480 degrees Celsius (894 degrees Fahrenheit), and this is sufficiently hot to melt zinc and lead.

In addition, the atmosphere of the foregoing planet is much denser that had been anticipated by accepted models. Finally, and, perhaps, most problematically for the cosmological models which had been serving as the lenses through which researchers had been engaging both Venus and the Solar System, when astronomers were able to measure argon isotope ratios in the atmosphere of Venus, were much younger than had been predicted to be, and this meant that the understanding of astronomers concerning when and how the Solar System formed were flawed.

The cosmology of much of modern astronomy and astrophysics is dominated by the dynamics of gravity. This leads to a universe that is, to a large degree, shaped by the way in which gravitational fields interact with one another.

Yet, proponents of a Plasma Universe (out of which the notions of an Electric Universe and Electric Sun arise) indicate that 99% of the universe is a function of plasma dynamics. Research into the dynamics of plasma physics has led to ideas concerning the nature of the evolution of galaxies, stars, solar systems, and planets which are quite different from the standard cosmological models that tend to dominate much of the discourse in universities as well as in prestigious scientific publications.

In a Plasma Universe, gravity is not necessarily the dominant shaping force nor has gravity on its own been shown to be able to hold galaxies together. In a Plasma Universe dynamics are shaped to a considerable degree by electrical currents and magnetic forces.

There is the added scientific bonus that plasma physics can actually be studied in laboratories on Earth. The same cannot be said for the cosmological models that are being pursued by many astronomers and astrophysicists and which, to a considerable degrees, are relegated to just gathering data which, in many ways, cannot be experimentally tested.

Terms such as: “Dark matter”, “dark energy”, “black holes”, and “pulsars made of ‘strange’ matter,’ ” litter the landscape of the standard cosmological model. None of the theorists working with the Standard Model have any idea what makes the phenomena possible to which such terms allude, but the Plasma Universe Model has provided, and continues to provide, a variety of alternative possibilities concerning the foregoing mysterious terms, many of which can actually be tested in Earthly laboratories.

If one adds the foregoing data to the research of Halton Arp which might well demonstrate that the existence of a redshift does not necessarily mean that a given astronomical object is moving away from an individual, and if the data provided by the James Webb Telescope indicates – as it seems to suggest – that galaxies exist which are entirely at odds with what the inflationary theory would predict, and if no one can account for what enables constants to have the values they have, and if no one knows what the initial conditions were at the time of the alleged Big Bang, then, perhaps, the WMAP data doesn’t necessarily mean what people have interpreted it to mean. Perhaps the relatively well-known visual images that give expression to WMAP data is nothing more than a cosmic Rorschach card or something from a Thematic Apperception Test (sometimes known as Tell A Tale – TAT – test) which might reveal more about the beliefs and feelings of observers than it necessarily confirms a Big Bang inflationary theory.

There is nothing in the Standard Model of quantum physics which is capable of predicting what the values of constants will be or how they will come into existence. The foregoing statement sounds an awful lot like the idea that there is something more deeply hidden than can be accounted for by the Standard Model of quantum physics as currently understood.

String theorists are like Popeye's friend Wimpy who is often asking for a loan in order to buy a hamburger today for which Wimpey says that he will be very glad to pay back that loan next Tuesday. String theorists are forever asking for the loan of trust in their assumptions so that they can continue constructing their models, but like Wimpy, string theorists never seem to able to pay back the loan of trust concerning various assumptions on which they have been living for so many years.

Contrary to the narrative put forth by Professor Barrow in his 2003 talk as well as his subsequent book on constants we don't know what the initial conditions were which made our world possible. We don't know if there were inflationary symmetry-breaking conditions in existence toward the beginning of the alleged Big Bang that were capable of generating constants of various values. We don't know how constants acquire their precise values. We don't know whether, or not, the Big Bang happened or, if it happened, whether, or not, it unfolded in the way in which string theorists claim it did. We don't know if the dynamics of the universe are (or were), or are not (or were not), random. For the most part (other than the case of the fine structure constant) we don't know if constants are capable of changing, and, if so, to what extent do they change, or whether, or not, constants might change locally (not universally) but have a default position to which they return when not being subjected to certain extremes of energy or temperature

However, the Einsteinian theory of General Relativity is in the same boat as the Standard Model of quantum physics. Like the Standard Model, the General Theory of Relativity can neither predict the value of the gravitational constant nor derive that value from first principles of General Relativity.

Einstein was justified in mentioning the issue of hidden variables in relation to quantum physics. However, he also needed to stare into the mirror-like abyss which contains the same mysterious hidden variables with respect to his own perspective because he was missing an unknown number of hidden variables with respect to his theory of gravitation, and, perhaps, somewhere along the line while he was engaged in his project of trying to develop a unified field theory, he might have had an intuition or uncomfortable understanding that he was missing something which was more deeply hidden than he previously had supposed.

Before moving on to the following chapter which will critically engage, in a rather constrained fashion, various aspects concerning the issue of randomness, there are several more topics which touch upon the challenge of constants that should be addressed, and, hopefully, this will help to lend some nuance to what has been said already. One of those topics has to do with Planck's constant, while the other topic addresses certain facets of the fine-structure constant.

There is a certain amount of controversy concerning the role that Max Planck played in the quantum revolution. Part of this controversy is due to a possibility – backed by evidence -- that Planck didn't actually understand what he had done as being anything more than a way of salvaging a formula he had written in conjunction with his thermodynamic research that was predicting results which weren't reflecting the data which had been turning up in the laboratory. For four or more years, he remained quiet concerning the possible significance of his accidental discovery which could be construed as indicating that he didn't think he had happened upon anything of importance

Planck's autobiography suggests he was aware, on some level, that what he had come upon, while getting his formula to work, had the seeds for, among other things, overturning some 240 years of framing reality in continuous terms (due to the mathematical calculus which had been devised by Newton/Leibniz) and, instead, his discovery indicated that reality might actually have a discrete nature. However, based on things Planck had said and written prior to his autobiography, there is evidence which supports the idea that his autobiography might have been entangled in a bit of pseudo-history or false-memory syndrome involving certain aspects of his discovery.

Nonetheless, one can construct a counter narrative to the foregoing perspective by noting that Planck freely admitted that in many ways he was trying to come to grips with the meaning of what he discovered. He wasn't sure if what he had done was just a mathematical trick or whether it might have some physical significance beyond being able to salvage his formula.

He was a careful and rigorous researcher. He also was aware how premature statements that were later found to be false could destabilize a person's standing in the scientific career as well adversely affect a person's future career.

Keeping silent with respect to something about which he himself harbored serious doubts might account for both his years of silence as well as why he might have said a few things, from time to time, that were intended to provide a certain amount of cover in case what his gut might have been telling him concerning his discovery turned out to be wrong. One is skirting a potentially very slippery slope when one supposes that one understands what is going on in another individual's mind based on what that person, on occasion, might have said or based on what that individual does or doesn't do.

Human beings often calculate the angles of outcome for a situation. Consequently, what is put in motion during such situations often gives expression to a theory of navigation that incorporates some underlying strategy concerning how one believes one should proceed in order to get to where one wants to go.

Historians and philosophers of science might arrive at one set of conclusions about what is going on in the mind of another individual. Such conclusions might, or might not, accurately reflect what is taking place.

While Planck was trying to figure out whether, or not, his mathematical discovery had any physical significance, a number of things took place. First, other scientists began to use Planck's discovery and were obtaining experimental results that were consonant with predictions concerning whatever phenomenon was being studied, and while none of this scientific work revealed why his discovery was working in a variety of contexts, there was a growing amount of evidence indicating that Planck's discovery at the very least had heuristic value – that is, his finding was serving to assist further discovery as well as providing a means of helping to solve different kinds of problems … not exactly chopped liver.

The second event was more important. In 1905 Einstein released his paper on the 'photoelectric effect,' and, in the process, he demonstrated that light had particle-like properties which were being dispensed in accordance with packets of energy that were delineated in units of Planck's constant, but those packets of energy or quanta needed to have a certain frequency because the intensity of light, in and of itself, was not enough to dislodge electrons from a metal.

Einstein showed Planck –- as well as the rest of the world of physics – that Planck's constant was intimately rooted in physical reality. It gave expression to the way energy was being transmitted or manifested under a set of given conditions.

The so-called "standard" history concerning the discovery of the quantum tends to advance something similar to the following scenario. Supposedly, James Jeans and Lord Rayleigh had analyzed black-body radiation and discovered that the predicted results, based on classical modes of calculation, were catastrophically divergent in the ultraviolet range of frequencies from the actual results that had been obtain through laboratory experiments, and, as a result, this difference between predicted and experimental results was referred to as the "ultraviolet catastrophe."

According to the foregoing narrative, Planck decided to plunge into murky waters and try to locate a solution. Allegedly, he began making calculations in order to come up with an answer to the ultraviolet catastrophe crisis and, along the way, found the answer by introducing a constant value which, when worked out, came to give expression to what is known as Planck's constant – namely, 6.62607015 x 10^{-34} joule-hertz^{-1} (joule-seconds).

If one used classical techniques to address the ultraviolet catastrophe, they were continuous in nature (due to calculus). Unfortunately, this very feature of continuousness was at the heart of the problem.

However, when one worked Planck's discrete quanta into the problem, then, the abyss between predicted and experimental results largely disappeared. Supposedly, the ultraviolet catastrophe had been averted.

The foregoing account does not stand up to historical analysis. For example, Planck came up with his quantum constant in 1900. Yet, Rayleigh and Jeans did not introduce their analysis of black-body radiation until around 1905-1906, and the term "ultraviolet catastrophe" did not appear until 1911 when, in passing, Paul Ehrenfest alluded to the issue during that year's Solvay Conference. Go figure!

Planck made his discovery while pursuing his favorite topic – namely, thermodynamics. He was particularly interested in the second law of dynamics which revolved about the issue of entropy.

However, from the beginning, the second law of thermodynamics was a relatively slippery topic. Initially, scientists considered the second law to be encapsulated within the principle that nothing could be transferred from a colder body to a hotter body, and, consequently, there seemed to be a direction to the way in which certain kinds of energy – in this case, heat – could be transferred from one body to another.

In 1865, Rudolf Clausius coined the term entropy as a way of summarizing the second law of thermodynamics. He described entropy as that aspect of a closed or isolated system which either increased or remained constant across transactions.

But, what, exactly was either increasing or decreasing during such transactions. Moreover, one might not only wonder why entropy would only increase or remain constant in an isolated system, but, as well, one also might wonder about what happened to entropy in systems which were not isolated or closed.

Was entropy something that began to accumulate in some way within a closed system as a by-product of the transactions which were taking place in an isolated system? Or, was entropy some sort of potential of a system that became active when certain conditions were present – such as an isolated system – and, if this were the case, then, what activated that potential and why did it either increase or remain constant?

Planck, like Einstein, believed in the notion of an absolute universe in which all of the principles underlying physical reality would be accessible to the right kind of investigation, and this included the notion of entropy. During the time that Planck had begun to explore the issue of entropy, one of the dominant views concerning the second law of thermodynamics was the statistical theory of Ludwig Boltzmann.

Boltzmann's approach to the second law was rooted in the idea of the existence of atoms. He believed that the second law of thermodynamics was a function of the manner in which various atoms moved under certain conditions of, say, temperature and pressure.

Many scientists rejected Boltzmann's ideas about the existence of atoms because they believed that everything could be reduced to various kinds of energy dynamics. Among those scientists was Planck, but his primary reason for disagreeing with Boltzmann had to do with the latter's contention that the reality of a system was statistical in nature and had was not a partial expression of some sort of absolute set of physical laws.

However, at the time Planck tended to throw out the baby with the bathwater because he not only rejected Boltzmann's statistical approach to the second law of thermodynamics, but, as well, dismissed the notion of atoms on which it was based and, apparently, went with the tried and true notion that reality was a function of continuous processes which could be modeled through the mathematics of calculus. One should keep in mind that although Planck might have sensed that his quantum phenomenon had a potential which indicated that certain parts of reality might be discrete in nature rather than being continuous, nonetheless, for many years, the quantum was nothing more than a mathematical technique which allowed people to solve certain kinds of problems, and, therefore, he might have felt there was not enough evidence to support his possible intuition concerning the discrete aspect of reality and, as a result, for the sake of his career and standing in the scientific community, he decided to stick with the framework of continuous dynamics which characterized the classical world of physics that had been implemented by Newton.

A little later on, Planck was more willing to accept Boltzmann's notion of atoms. This is because the idea of an atom had a certain resonance with Planck's own notion of quanta which, like atoms, were operating at some fundamental level and, therefore had to do with the absolute way in which that foundational level of reality gave expression to the 3-D world with which we are familiar.

Ironically, in the same year that Einstein paper on the photoelectric effect provided support for Planck's perspective concerning the existence of quantum packets of energy, another paper by Einstein which was released in 1905 provided support for Boltzmann's notion of the atom -- the idea which Planck had rejected -- by providing an explanation for the phenomenon of Brownian motion that could be related to the existence of atoms of one kind or another.

In the last few years of the nineteenth century, Planck began to try to find a way to tie the issue of entropy -- especially, its aspect of apparent irreversibility – to fundamental principles of an absolute nature. Wien had come up with a law concerning such issues which Planck accepted, but Planck felt that Wien's derivation of that law was problematic because it did not seem to be sufficiently absolute and fundamental in nature.

In 1899, Planck developed a mathematical formula which reworked the dynamics of the oscillator on which Wien had based his understanding of entropy. This reworking of the original treatment by Wien was known as the Planck-Wien law.

Planck believed his work was done. However, although some initial laboratory experiments seemed to confirm the Planck-Wien formulation as long as one dealt just with lower energies, a variety of other experiments involving contexts characterized by higher-frequencies generated results which were substantially different than what Planck's formula would predict.

Planck required a number of months to salvage his mathematical formulation. In what Planck subsequently described as "an act of desperation," he introduced his quantum 'h' into his formulation, and, as is sometimes said, the rest is history.

The discovery which Planck made came in the form of: 6.62607015 x 10^{-34} joule-hertz^{-1} (joule-seconds). The foregoing figure made no sense to him except in one way – namely, when he began making calculations concerning what quantity might solve his problem then the foregoing value is what emerged.

For five years, Planck tried, without success, to understand what, if any, physical relevance his quantum had. Einstein saw the physical relevance of Planck's constant because it enabled Einstein to make sense of the photoelectric effect in which light of certain frequencies could be shown to have the capacity to knock out electrons from a metal in a very specific way.

However, neither Planck nor Einstein understood why the quantum had the value it did. Why did energy come in this kind of package – so precise (to 8, or so, decimals before uncertainty sets in), and, yet, utterly inexplicable in its precision as well as the "choice" of quantitative value?

Some individuals point to Planck as the father of the quantum revolution because of calculations that led, with little or no understanding, to the emergence of the constant which bears his name. Other people indicate that since Einstein was the first individual to provide the Planck constant with some physical clothing that he, not Planck, was the actual father of the quantum revolution.

However, if Planck had not discovered his constant – in however happenstance of a manner – would Einstein's paper on the photoelectric effect have ever been written? Notwithstanding the foregoing sorts of counterfactual considerations, what is ironic is that irrespective of which person one wishes to site as being the first one to begin exploring the quantum landscape, quantum research eventually went in a direction which was at cross-purposes with the belief to which both individuals were committed – namely, that reality was not a function of probabilistic considerations.

Over time, Planck was willing to make certain compromises with many aspects of quantum physics. Einstein never wavered.

The prevailing picture of the atom in the early 1900s following Einstein's paper on Brownian motion was largely the work of New Zealand's Ernest Rutherford. He had performed experiments which indicated that when atoms of gold foil were bombarded with alpha particles (which often arose as a result of the decay of helium atoms), sometimes a particular form of recoil would be observed in relation to the alpha particles.

This suggested that there seemed to be some sort of central entity present in atoms. Moreover, the size of the recoil indicated that the internal character of the atom appeared to be different from the plum-pudding model of the atom which earlier had been proposed by J.J. Thompson.

From Rutherford's experiments, a simple, solar-system like model of the atom emerged. Since at the time, the only particles which were known were the electron and the proton, the atom was considered to be an entity in which electrons orbited protons.

Interestingly enough, despite the relative dearth of particles that were believed to exist, the relationship between protons and electrons entailed another constant. More specifically, the mass of a proton is some 1836 times the mass of an electron, and, in passing, one might wish to reflect on why the masses of electrons and protons have this sort of numerical relationship rather than some other quantitative relationship.

Is this just a matter of coincidence? Or, is something of a deeper nature involved?

While Rutherford was pursuing his explorations of atomic structure, other individuals had begun to study the way in which electrons were emitted and absorbed during various kinds of dynamic interchanges. Niels Bohr, for example, had been exploring the spectral nature of electron emission and absorption properties in hydrogen atoms.

In 1912 he introduced his updated edition of the Rutherford atom. Although Bohr's conception was remained a solar-system like arrangement of electrons orbiting a nucleus similar to what had been proposed by Rutherford, it did incorporate one important difference. In other words, while in a solar-system oriented model, electrons would be free to adopt whatever speeds and radii were compatible with a stable atom, in the Bohr atom, electrons were only permitted to exist in certain energetic states.

The foregoing constraints which Bohr placed on the dynamics of electrons were used to explain, among other things, why electrons did not become involved in a death spiral into the nucleus as a result of the radiated energy which would be presumed to be lost while electrons sought to maintain their orbits. Bohr had not derived the foregoing principle from first principles but, somehow, intuited that by limiting the energy levels to which electrons could give expression, he could solve various kinds of issues which had been something of a mystery prior to his epiphany.

However, just as Planck stumbled into his constant, Bohr also had tumbled into the idea concerning the fixed properties associated with the behavior of electrons within an atom. Both ideas – that of Planck and that of Bohr – had heuristic value and, therefore, showed their value as a result of the sorts of problems that those ideas could help scientists to solve, but neither idea was rigorously rooted in first principles which could show one why Planck's constant and Bohr's rules concerning electron orbiting dynamics had the properties they did.

While exploring the nature of hydrogen atoms, Bohr also discovered that sometimes more than one energy level seemed to be present in the emission spectral lines of the hydrogen atom. If one did not zoom into the character of those lines, one might get the impression that there was just one level of energy which was being emitted, but upon closer inspection, a split in the emission line could be detected.

Arnold Sommerfeld (roughly 1916) had been attempting to extend and update Bohr's model of the atom (which, in turn, had been a renovation of Rutherford's ideas concerning the nature of an atom). Sommerfeld maintained that the splitting phenomenon gave expression to the fine structure constant associated with the splitting which took place in conjunction with the emission and absorption lines of electron spectral lines under certain conditions.

The split in the fine structure of the emission lines had actually been measured nearly 30 years earlier in 1887 by Michelson and Morley. It was shown to have a value of: .0072973525643 which can be re-configured as being approximately equal to 1/137.

However, the foregoing fraction has a "tail" of sorts attached to it because the value of the fraction is not exactly 1/137. The tail aspect of the quantity works out to be about: .035999177.

The term "about" is used above because, the last part of the decimal is immersed in a bit of a cloud of uncertainty. The uncertainty concerning the latter part of that decimal figure has been calculated to be: 1.6×10^{-10}.

So, here we have a very interesting fraction of 1/137 which is being modulated slightly by a decimal quantity of .035999177. Moreover, the latter quantity is enveloped in a cloud of uncertainty believed to be about 1.6 x 10^{-10}.

Yet, the foregoing constant plays a huge role in many aspects of the physics of everyday life. The dynamics of atoms, molecules, and life all are entangled with the fine structure constant, and if that constant were different than it is, then, the world that we know would not be the world that we know.

The property of electron spin is considered to be crucial to the phenomenon which gives expression to the splitting of emission lines. However, spin is immersed in a certain amount of mystery because what is called "spin" does not necessarily involve spin in any usual sense of the word in which a given body is revolving about its axis.

Electrons are considered to be point particles with no internal structure. Nonetheless, in unknown ways, they have mass, carry an electrical charge, and exhibit some sort of property which has been characterized as spin … perhaps because, mathematically speaking, that property can be described through calculations which are normally associated with the phenomenon of spin.

What causes spin is unknown. However, enough is understood about this property to know that if it does give expression to some sort of quality of spin in the usual sense, nonetheless, whatever spin actually turns out to be, this kind of spin has some anomalous features associated with it.

In any event, the spin of an electron appears to be responsible for the splitting of emission lines into more than one energy level. Why this happens and what regulates the way in which spin is used to induce splitting of emission lines is not fully understood, if it is understood at all.

Spin was one of the factors that led to Paul Dirac putting forth his equation that enabled researchers to correct for relativistic effects associated with the dynamics of electrons. Some problems that could not be handled by Schrödinger's so-called wave equation were able to be solved by using Dirac's equation which enabled scientists to make relativistic corrections to their calculations.

The fine-structure constant has to do with the strength of the electromagnetic coupling dynamic which exists between charged particles just as Newton's gravitational constant describes the strength of the gravitational relationship between masses. However, in the same way that no one seems to know why the gravitational constant has the quantitative value that it has, so too, no one seems to understand why the fine-structure constant has a value which is approximately 1/137.

Most constants come in the form of dimensions which reflect the measurements which are used to calculate them. The foregoing 1/137 value is dimensionless and can be derived from: $e^2/4\pi\varepsilon_0$ [planck] c, where e refers to the charge of an electron, [planck] gives expression to the Planck constant divided by 2π, c is the speed of light, and ε_0 concerns the permittivity of free space (which has to do with the way electrical fields are said to move through a vacuum).

When constants have dimensions associated with them, the constancy aspect inherent in the phenomenon with which such measurements are associated, nevertheless, the constancy aspect of the phenomenon will assert itself no matter what units of measurements one uses. Nevertheless, such units do provide the constant with a sort of context.

However, when units of measurement are absent from the 1/137 figure, then, what meaning is one to assign to such a value because one no longer has a context of measurements in which to situation a constant. One possible meaning of a dimensionless constant is that there must be something to which the numbers themselves are seeking to draw our attention.

1/137 would be intriguing in and of itself because one wonders why this number, rather than some other number, is giving expression to the strength of the electromagnetic coupling dynamic between charged particles. But, to such an intriguing wonderment, one must add the previously noted decimal tail to the foregoing fraction, and, then, one must factor in a source of uncertainty concerning the precise nature of the last portion of the decimal tail,

The foregoing precision resonates with the sort of fineness or closeness of fit which are present in the pyramids which involve tolerances in the placement of the stones that is beyond the capacity of modern technology to reproduce. Similarly -- although in an even more intricate manner -- something – i.e., the fine structure constant -- which shapes the way the world hangs together on a variety of levels entails tolerances of refinement which are so precise that one becomes overwhelmed with the "intricacy" of it.

Quantum field theory is a fusion, of sorts, between quantum physics and Einstein's equation $E = mc^2$. However, instead, of describing reality as being made up of particles, quantum field descriptions are a function of a set of interacting fields which give expression to various kinds of dynamics under different sorts of circumstances.

Every kind of particle has a field associated with it. The quantum field is the field of all physical fields that interact with one another.

Particles are like the ocean spray that is manifested above the ocean as a result of the underlying dynamics that occur in the ocean. The quantum field takes the part of the ocean when one talks about the way in which particles (which take the place of ocean spray) become manifest when the underlying dynamics of the quantum field is oriented in one way rather than another.

As far as scientists are concerned, quantum fields come with both advantages and disadvantages. One of the disadvantages of quantum field theory is that all fields (currents or eddies if you like) are capable of interacting with all other fields (currents/eddies) within the mother of all quantum fields – namely, the Universe, and, as a result, it becomes very difficult to keep track of all the ways in which different fields might contribute to the character of some given phenomenon.

In a context of relatively low energies, one can ignore, for the most part, what the collective nature of field interaction contributions will be in any given case (because most of those influences are so small that the final result will not be appreciably affected). Consequently, one is able to focus on the interactional relationship between, say, a photon and an electron as if they were not immersed in a quantum field that was, in subtle ways, altering the character of such relationships.

Under the conditions of low energies, the fine-structure constant has been measured in an array of contexts. Moreover, notwithstanding a certain amount of uncertainty concerning its precise nature, across a wide variety of circumstances -- both on Earth as well as far removed from Earth -- the value of the fine-structure constant has been determined to be pretty constant.

Yet, when a transition is made from low energies to high energies (such as at CERN) the nature of things with respect to the fine-structure constant seem to change. In this respect, one might read a paper by Harald Fritzsch entitled: “Fundamental Constants at High Energies” which was written in conjunction with the Theory Division at CERN.

At high energies, many of the fields that could be ignored at low energies when making calculations concerning, say, the electromagnetic interaction of a photon and an electron, and one’s calculations would not be appreciably affected, such additional fields can no longer be ignored.

For instance, under conditions of sufficiently high energy, the fine structure constant changes its fundamental value. In a sense, all of the fields which make up the quantum field serve as affordances for the fine-structure constant.

When those affordances change in character, this eventually envelops the dynamics of the fine structure constant. As a result, the coupling strength that characterizes the electromagnetic interaction between charged particles is affected.

However, it is important to note that the default value for the fine-structure constant remains the same throughout the universe under an array of circumstances. Yet, when that fine-structure value is subjected to extreme conditions, its value can change, and, therefore, if the fine-structure value had been represented by some other quantity early in the evolution universe, one wonders what set of circumstances, at some point, induced the fine-structure coupling strength to stabilize at the constant value of approximately 1/137.

The inflationary theory of the Big Bang might account for why the value of the fine structure coupling strength could become altered as the amount and form of energy changed during a transition from high energy to low energy conditions when the temperature of the universe allegedly dropped with time and expansion. However, what the inflationary theory cannot explain is why the fine-structure coupling relationship exists at all or why the apparent default value of the fine structure constant has the value it has and has been able to retain that precise value for billions of years.

In addition, what neither the inflationary theory, in general, nor the Big Bang theory, in particular, can explain is what the initial conditions were out of which, first, the Big Bang, and, then, inflationary forces emerged. There are those individuals who seem to believe that everything can be explained by just assuming that, in the beginning (assuming there was a beginning), energies were of such a high magnitude (which, presumably, is why some physicists like to mention how the fine-structure constant changes when the energy level is sufficiently high) that those energies – qua energies -- enabled everything in the universe – assuming there are things -- to be in an amorphous condition which is characterized – seemingly – by an indefinitely large number of degrees of freedom, and, consequently, if one, ala Archimedes, were provided with the right symmetry-breaking event (the fulcrum), then, all of the forces, fields, and constants which are supposedly present as potentials within the foregoing amorphous, singularity will be induced to self-organize and generate emergent properties as the levels of energy come down through the expansion of the universe.

Where the energy came from that is allegedly present in the singularity is unknown. Where the potential for fields, forces, constants and particles come from that are supposedly present in the degrees of freedom and constraint that are in the singularity is unknown? Whatever was responsible for making that set of degrees of freedom and constraints possible is unknown. Where the baryonic material came from that is allegedly present in the singularity is unknown? Whatever supposedly gave rise to the sorts of forces, if any, which made the foregoing sort of singularity possible and, in turn, what, if anything, made the initial forces possible which seem to regulate and maintain the condition of the singularity are unknown. What enabled inflationary forces of a just-so level of energy to turn on and off for specific durations of time is unknown. Whether, or not, space is subject to inflation is unknown because no one actually knows what space is.

Constants might be the boundary markers that give expression to the way affordances interact with one another. Affordances encompass the qualitative character of the dimensions (in both a non-spatial sense but as well, includes, at least, one spatial dimension) that shape the dynamics of the universe.

The dimensionalities of affordances are laid together with an even more nuanced precision than the manner in which the stones of the pyramids are put together, and this precision is exemplified in the way in which many decimal places, accompanied by considerations of uncertainty, are used to characterize a given constant. With respect to each dimension one might also entertain the possibility that there exist quanta of action which operate in ways that are diverse from Planck's constant but which might go to the heart of those qualitatively different dimensions (as time is qualitatively different from space) just as Planck's quantum of action goes to the heart of so much of physics. These quanta of action might well be the principles which make different dimensions operate in the way they do as well as exhibit the properties that they have.

<u>Chapter 4</u>: Random Models

Nearly two decades ago, I read a book by Nassim Nicholas Taleb entitled: *Fooled by Randomness: The Hidden Role of Chance in Life and in the Market*s. A few years later, I critically reflected upon a second work – namely, *The Black Swan: The Impact of the Highly Improbable* written by the same, previously mentioned author which seemed to be a sort of follow-up or companion volume to the earlier material.

In his own way, Taleb shares a lot in common with many quantum physicists. For example, he is very intelligent, insightful, well-read, quantitatively astute, erudite, and, as well, he appears to believe that, ultimately, randomness shapes many aspects the universe.

Nonetheless, he also seems to maintain (and, presumably, this might be one of the reasons why he decided to write the two books) that if one is careful with how one goes about one's critical analysis of experience, then, one will be able to establish various working principles, and, as well, one will be able to construct certain kinds of probabilistic models that have heuristic value. Even though, from the perspective of Nassim Nicholas Taleb, randomness shapes and modulates many aspects of our lives, nonetheless, according to him, while the dynamics of randomness often make fools of us all, nevertheless, there might be methods through which individuals can find ways, with varying degrees of success, that assist those individuals to negotiate the irreducibly unpredictable and dangerous forms of existential white water that randomness creates as it goes about its seemingly inexplicable dynamics.

There is one more characteristic that Nassim Nicholas Taleb appears to share with quantum physicists. More specifically, he seems to confuse randomness with ignorance, and, therefore, perhaps the title of his first book should not have been: *Fooled by Randomness: The Hidden Role of Chance in Life and in the Markets*, but: *Fooled by Ignorance: The Hidden Role of Choice in Life and in the Markets*.

Moreover, like quantum physicists, Nassim Nicholas Taleb appears to believe that he has some sort of handle on how many things work – at least within certain limits -- and, as a result, both he and the quantum physicists are able to generate what they consider to be constructive responses to any number of issues. However, notwithstanding their respective degrees of success, a case can be developed which suggests that he, like the physicists, has missed something more deeply hidden than randomness and probabilities.

In the Preface to the second edition of *Fooled by Randomness*, Taleb makes it very clear that he believes the universe is essentially random in nature. This perspective is given expression when he indicates that one of the issues through which he wanted to pursue a more rigorous form of critical reflection during the second edition than had been the case in the first edition, and this added focus has to do with the way the brains of human beings supposedly perceive the world through lenses that depict things as being far less random than Taleb believes is the actual case.

While brains might contribute to the processing of sensation, the jury is still out on whether perception is something that takes place in the brain or whether perception might be a function of the manner in which something other than the brain (intelligence, consciousness, imagination, intuition, and/or creativity) parses that which is being sensed and, during this dynamic of parsing sensory experience, this 'something' proceeds to assign various kinds of meanings, purposes, and significances to such sensations – hermeneutical activities which might not be a function of biological dynamics. One could also raise a question at this juncture about whether, or not, the process of sensation is entirely random in nature and, therefore, it can be shown to have nothing to do with those aspects of existence which has some sort of modulating effect upon the character of the sensation.

What is the nature of the linkage, if any, among environmental stimulus, sensation, and brain dynamics? If it is true – and I am not saying that it is true – that people view the world in a far less random manner than Taleb believes is actually the case, then, exactly how does the former sort of ordered picture of the world arise even if that understanding might be mistaken concerning the nature of things?

To suggest that, due to ignorance, a given individual might not understand the nature of the world is one thing. To claim that the nature of the world is random is an entirely different manner.

Both of the foregoing possibilities (ignorance and randomness) need to be proven through the use of evidence and reason. Consequently, irrespective of which of the foregoing possibilities might be the case or what combination involving those two possibilities might be true, knowledge, insight, and understanding of some kind is needed to construct a plausible perspective with which people can agree, and., if this is the case, then, I think Nassim Nicholas Taleb has his work cut out for him if he is to demonstrate how logic, reasoning, insight, intuition, critical reflection, and so on are able to emerge from the depths of the abyss of randomness which supposedly pervades every aspect of the universe.

In short, there seems to be something oxymoronic about claiming that things are random and, yet, simultaneously, contend that reasons, logic, mathematics, and evidence can be advanced which allegedly are capable of justifying that claims of a random universe are both plausible and defensible. Methodological randomness refers to one set of dynamics (which are philosophical and/or mathematical in nature), while ontological randomness alludes to something quite different concerning the fundamental nature of the universe, and by attempting to use the former in an end-around move that is intended to philosophically leverage one's way to allegedly proving that the latter perspective (i.e., randomness) is true seems to entirely ignore the transition problem that requires one, at a minimum, to be able to plausibly account to pretty much everyone – and not just those who already are operating in accordance with such a position -- how one can justifiably complete the conceptual and ontological journey from the fundamental property of randomness to the ordered conditions that are manifested on so many levels in so many aspects of the universe.

Taleb begins Part Two of *Fooled by Randomness* with a tale concerning an infinite number of monkeys. Although Taleb uses the narrative to pivot to something he considers to be more interesting, the monkey narrative in and of itself is important because it gives expression to the form of argument which is frequently use by those who wish to claim that randomness necessarily contains within itself the potential to generate all manner of ordered possibilities.

Notwithstanding the foregoing considerations, Taleb introduces an infinite set of monkeys who have been provided by someone with an infinite number of typewriters which have been constructed in an extra-rugged fashion, and Taleb, then, proceeds to claim that one might logically conclude that one of those monkeys will come up with a duplicate of the *Iliad*. Apparently, Taleb arrived at the foregoing conjecture entirely randomly because when one looks at the argument in the light of rational considerations, the assertion does not seem to hold together.

Let us take an allegedly infinite sequence or set of numbers – the so-called natural numbers. Let us compare that infinite set with another collection of infinite numbers known as the real numbers.

The natural numbers -- we will concede for the purpose of argument -- are infinite in nature and, yet, they exclude the vast majority of the real numbers. Indeed, the natural numbers are but an infinitesimally small sub-set of the infinitely greater set of real numbers.

If something can be said to be infinite in nature (e.g., the set of natural numbers) but can be shown to exclude most elements of another set (e.g., the real numbers), then, why couldn't one suppose that despite whatever infinite set of things that might be written by an infinite set of monkeys, nonetheless, one cannot automatically conclude that the former set of "literary" productions will necessarily contain the *Iliad* or any other classic work? Perhaps the "works" of the infinite set of monkeys is to the classics as the natural numbers are to those aspects of the real numbers that exist beyond the horizons of natural numbers.

One of the details which is absent from Taleb's foregoing exercise has to do with whether, or not, the keyboards for the typewriters are for a Greek or English edition of the *Iliad*. Obviously, if the task confronting the monkeys were to produce an actual copy of the Iliad, but the monkeys were given typewriters capable of only producing English words, then, if one of the monkeys produced an English version of the Iliad, would this count as a success?

Are the typewriters mechanical or electric? If they were electric, who is supplying the infinite amounts of energy which would be necessary to run an infinite number of machines (and how is such energy being supplied and at what cost), and if the typewriters are mechanical in nature, who will be mining, refining, manufacturing, assembling, and testing the infinite supply of components that are necessary for those typewriters?

Then, of course, there is the issue of translation. If the task of the exercise is for one of the monkeys to produce a copy of the Iliad, which translation does one have in mind because what constitutes an exact copy of one translation is unlikely to be an exact copy of some other translation?

In addition, Taleb only mentions an infinite set of moneys. He doesn't say anything about the length of time which is to be afforded those monkeys while performing their tasks?

For those who are interested, an interesting homework exercise might be to reflect on how to go about figuring out whether a copy of the *Iliad* could be produced by an infinite set of monkeys in a finite amount of time. Would the nature of the finite amount that is to be allotted to the monkeys make any difference, or, how would the foregoing problems be affected if one were to provide a supply of infinite monkeys but the length of time for which those monkeys lived was variable?

There are other considerations which could be added to the previous discussion. For example, what makes Taleb believe that an infinite set of monkeys will continue to be dedicated to the process of typing for a sufficiently long period of time to produce something that matches the length of the *Iliad* – even if the infinite set of monkeys were to be given an infinite amount of time in which to complete such a project?

Monkeys like to play, eat, fight, groom, engage in sexual activity, as well as, go about other kinds of activities (e.g., rest-room breaks). Who is supplying all the food that would be necessary to keep the monkeys going and who is going to clean up after an infinite set of monkeys has been let loose to live their lives?

What would induce monkeys to want to continue with the proposed typing project? Furthermore, no matter how sturdy the typewriters might be, one has to ask about whether, or not, the monkeys (or an infinite sub-set of those monkeys) would ever be able to learn how to: Locate the necessary paper that is needed for typing, feed that paper into the typewriter in a workable fashion at the appropriate times, change the ribbons or cartridges when necessary, and keep the pages which have been typed together in some sort of ordered nature to be able to form a duplicate copy of the Iliad?

Moreover, why should one suppose that an infinite set of monkeys wouldn't become involved in an infinite set of habitual patterns that might prevent all of the necessary keys being hit in the right sequences to produce a copy of the *Iliad*? Like the Jack Nicholson character who was serving as the winter caretaker at the Overlook Hotel in the movie version of *The Shining*, perhaps the infinite set of monkeys will just engage in typing the same lines again and again. Does an infinite set of monkeys necessarily entail an infinite diversity of output in which all possibilities are necessarily represented?

Of course, the whole foregoing infinite set of monkeys scenario is really only meant by Taleb to serve as prelude for introducing what he feels is a much more interesting and relevant question. More specifically, if one, or more, of the creatures in the infinite set of monkeys managed to produce a replica of the *Iliad*, then, to what extent can such a performance be considered as an accurate indicator concerning future performance? In other words, what is the likelihood that if one of the monkeys in the infinite set of typists succeeds in producing a replica of the *Iliad*, then, that same monkey will be able to produce an exact copy of some other literary classic (and could we expect such a second work in a reasonable amount of time), or what is the likelihood that some other monkey will produce such a copy, and, depending on the answer which is given to the foregoing questions, what implications do those answers carry for whether any of the literary creation by human beings – including the two books by Taleb – aren't just a variation on how – possibly -- monkey-see/monkey-do human beings write their books?

Taleb goes on to indicate that there is a great tendency among people who have some – or even a lot of – knowledge about probability to suppose that if one can build a profile of some sort concerning performance history in any given case, then, some – perhaps many -- individuals will interpret that performance profile through the lenses which are provided by such a history. Yet, Taleb suggests that sometimes having some understanding of probability places one in a more vulnerable situation than if one were completely clued out with respect to probabilistic considerations because the unanticipated can show up in all manner of unexpected ways that are capable of upending one's performance history.

None of the foregoing discussion has necessarily anything to do with the issue of randomness. It is entirely about the extent to which someone is ignorant about, or knowledgeable concerning, all of the many possible causal factors which are affecting, and which might affect, a given situation and, therefore, tends to lead in the direction of becoming entangled in the complex notion of causality mentioned previously in conjunction with Morton White.

The unanticipated is not necessarily an expression of chance, random events. The unanticipated is that which falls beyond the boundaries of one's current epistemological and hermeneutic understanding.

Randomness is not entering the picture through the dynamics of the unanticipated. The unanticipated is a function of one's ignorance concerning the nature of a given situation.

Probabilities do not explain the unanticipated, because if they did, what is being called the unanticipated would not constitute an expression of the unanticipated. The unanticipated means that one's probability or hermeneutical model has not been able to assign a suitable weight to that which is unanticipated due to one's lack of understanding concerning a given situation.

People make choices based on their understanding. If something turns out in a way that was not anticipated by the expectations which are rooted in one's world-view, paradigm, model, theory, framework, and so one, then, randomness has not necessarily manifested itself, but, rather, one might simply have made a bad choice based on a faulty understanding.

Just as many kinds of questions could be raised in conjunction with the infinite monkey challenge, many other kinds of questions could be raised (and some of these sorts of questions already have been raised in material presented earlier in the book) with respect to any scientific and mathematical theory which seeks to claim that randomness, like the infinite set of monkeys, is capable of generating every modality of physical possibility, and, therefore, one might conclude, as Taleb encourages his readers to do, that the world we encounter – irrespective of how ordered it appears to be – is just the product of random dynamics since, obviously, if monkeys supposedly can create literary masterpieces, then, random dynamics must be able to generate their own editions of creative classics in the form of the forces, particles, and laws of nature which seem to govern what transpires within and around us.

Life is a puzzle palace. We enter life to the sounds, sights, feelings, smells, and so on of an array of the pieces of the puzzle that are being scattered about us with additional components being added throughout the minutes, hours, days, and years of our lives. We have an unknown amount of time to try to put the puzzle together or, at least, to put enough pieces of the puzzle together to provide one with a sense of what the puzzle might be depicting or trying to tell us.

And, oh yes, the puzzle appears to be multi-dimensional in nature. We spend much of existence trying, for better or worse, to become familiar with various aspects of the, relatively speaking, more accessible fruits of spatial and temporal dimensionality, but, at some point, we might, or might not, come to understand that space and time are not necessarily sufficient to account for what is transpiring in our lives.

As we go about putting the puzzle together (if we haven't already discontinued attempting to do so because it can be a very frustrating and irritating process), we try to learn how to distinguish between noise and signal with respect to that which has, on the one hand, significance, value, and reliability, and, on the other hand, what seems irrelevant, valueless, and unreliable. We tend to treat something as signal if it seems to be able to assist us with making progress with the puzzle challenge – even though such a "signal" might, ultimately, turn out to be noise and we discover that we have been trying to force-fit a piece into the puzzle in a way that, for any number of reasons, does not work, while, on the other hand, we might treat other possibilities as noise because we have difficulty making sense of its presence and it doesn't seem relevant to anything one is trying to do, and, yet, at some point what has been considered to be noise might begin to comes into focus as something other than what we previously had considered it to be.

Experience is thin-sliced via judgments which tend to be oriented in a limited number of ways. One of the choices we have is to treat an experience as an expression of noise, and, therefore, we try to discard it, ignore it, suppress it, or forget about it.

Simultaneously, there are arrays of other kinds of experiences which we sift through as we seek to discover experiences which seem to entail some degree of an often ineffable quality that we treat as a signal of some kind which might have relevance to our interests and needs. In addition, there are numerous forms of experiential data which we can't quite decide as to whether, or not, they are noise or signal.

The process of thin-slicing entails a process of cognitive abstraction in which an individual parses experience into data packets that serve to section or partition experience into slices of understanding that may, or may not, provide one with enough grasp of a situation to – potentially -- enable a person to form heuristic judgments concerning the character, relationship, significance, and/or relevance of a given experience or set of experiences with respect to one's interests, purposes, motives, and/or intentions. We know that something like thin-slicing takes place because we tend to be overwhelmed by not only the wealth of data which makes up our experiential lives, but, as well, we are overwhelmed by the realization – to whatever degree we have this -- that there is an additional set of treasure troves of data which shapes the experiential phenomenology of billions of other lives, and, in addition, we are overwhelmed by whatever consideration we might give to the seemingly inescapable presence of an indefinitely large ocean of potential data which lies beyond the boundaries of everyone's collective experiences and which could play a significant role in helping to make possible the character of the experiential data that flows in a more, or less, constant manner through the causeways and byways of the existential networks in which human beings are immersed.

We engage in the process of thin-slicing because dealing with the whole seems to be beyond our capacity to accomplish. Nonetheless, because thin-slicing constitutes a form of sampling in which different features are, for better or worse, weighted in a variety of different ways -- which might, or might not, be justified -- there are all manner of doubts and degrees of uncertainty which tend to envelop the thin-slicing process in a cloud of confusing epistemology and hermeneutics.

Consequently, thin-slicing doesn't guarantee that the way we go about parsing the world will be correct or lead to the truth. Thin-slicing is just the dynamic that is used by human beings as a coping strategy through which to try to deal with an overwhelming amount of experiential data – both actual and potential – in order to try to bring order to our lives … but an "order" which might not actually reflect the character of whatever order is present in reality.

Nassim Nicholas Taleb is quite right to point out that people have the capacity to make many problematic judgments concerning the manner in which they characterize any given experience as being a form of noise or signal. He is also quite right to show how many of those mistakes in judgment have to do with our failure to understand that, for example, probability models are nothing more than maps of experiential country through which we travel, and, therefore, they should not be mistaken for the reality of the existential country that is being traversed.

However, Taleb seems to have failed to understand how his claim that, in essence, existence is a function of random phenomena, may well be committing the same kind of error in judgment about which he is seeking to warn his readers in the aforementioned two books. More specifically, the notion of randomness is a thin-sliced judgment concerning the nature of reality based on how Taleb has parsed a certain amount of his own experience, as well as how he has processed various aspects of the experience of others, and, as a result, he has come to the conclusion that many people want to treat what he considers to be random events as actually giving expression to data that has signal value, and, unfortunately, according to Taleb, by considering the noise of randomness to have value as a signal, people put together models that distort or miss-characterize what is taking place, and consequently, they are led into existentially hazardous wastelands which are replete with an array of hard-to-recognize pockets of quicksand into which people blunder and which, eventually, might suck those individuals under – psychologically, financially, politically, socially, economically, militarily, educationally, philosophically, and/or in other ways as well.

Nevertheless, at no point in either of the aforementioned books does Taleb ever prove that existence is random. At no point in either of those works does he demonstrate that his perspective is anything more than a process of trying to map or represent a few of the topographical features that were sensed (perhaps, to some degree, correctly and perhaps, to some degree, incorrectly) as he performed his Lewis and Clark-like expedition through the multidimensional contours of an undiscovered existential country.

Nassim Nicholas Taleb is very good at thin-slicing a variety of issues – especially when dealing with financially and economically-oriented problems. He has a very good track-record in this respect, but, as he himself might say, past performance in the foregoing sorts of areas doesn't necessarily carry any significant weight with respect to the kinds of judgments he might make in conjunction with other topics – such as the issue of randomness.

He has assembled a set of mathematical, economic, statistical, probabilistic, financial, and experiential principles and parameters concerning how to not only survive but, as well, to be able to thrive in the world of economics, finance, corporations, government regulation, investment, banking, and the like. The foregoing principles and parameters were thin-sliced judgments which have parceled together in the form of a methodological philosophy which helps him to shape the thin-slicing activity that leads to his decisions concerning how to move on with his life.

Apparently, along the way, he has discovered some heuristically valuable ideas. For example, when one uses mathematical, statistical, probabilistic, rational, and logical tools in the right way with appropriate caution, then, those tools are often – but not always – able to help one to parse a given context in a manner that will permit one to identify how some forms of thin-slicing have a way of performing that is more consistent and, therefore more reliable, than other possible ways of engaging in thin-slicing dynamics.

Yet, no matter what one thinks one understands, one must always be on guard. This is because we often guard our ignorance like it is one of the Crown jewels.

Mathematics, statistics, and probability are descriptive maps that try to represent or model certain aspects of reality. However, those representational maps or models are no more necessarily able to say why reality has the properties that it does than poetry, music, art, or language necessarily has the capacity to provide such an explanation.

Poetry, music, art, and language provide other kinds of maps that are intended to help people navigate their way through life in a manner that frequently doesn't seem to fit – at least not without a certain amount of tension being generated -- with the way in which mathematics, statistics, and probability seek to help people navigate a path through life. Like their more methodologically-laden technical counterparts, music, poetry, and art give expression to heuristic forms of thin-slicing that have consequences – some positive and some less so.

To thin-slice experience for purposes of, developing pragmatic forms of coping strategies that are intended to deal with everyday contingencies – such as finance or investment -- is one thing. To thin-slice experience for purposes of allegedly revealing what the nature of reality is constitutes another kind of issue entirely. Moreover, to try to thin-slice experience in order to try to understand what so-called pragmatic issues have to do with the nature of our relationship with reality, or vice versa, constitutes a more nuanced set of problems.

Nassim Nicholas Taleb's thin-slicing of experience for purposes of finance, economics, investment, and the like has a resonance with the principles of clinical practice that are observed by both quantum physicists and medical doctors. In other words, in each of the foregoing cases, irrespective of whether, or not, the underlying reality of a given phenomenon is understood, what matters is whether, or not, what one does helps to solve certain kinds of problems while also, ideally, generating as limited a trickle or flow of so-called side-effects or unanticipated events as possible with respect to a given set of practices.

Medical doctors often use off-label drugs to treat pathological conditions for which those drugs were not originally intended. What matters is whether, or not, the use of those drugs in off-label situations has efficacy as well as whether, or not, the degree of unwanted, residual effects associated with such usage is acceptable (hopefully to the patient as well as the doctor).

Quantum physicists use, among other practices, quantum wave functions to calculate probabilities concerning various kinds of events for which they have no explanation as to why those events have the character they do but with respect to which some creative people have found a method for generating very precise answers concerning phenomena that none of the quantum physicists necessarily understand. Once again, as is true in the case of medical clinicians, what appears to be most important to quantum physicists is whether the methods used have efficacy in solving various kinds of problems with which they are presented, and, as a result, quantum physics depends, to a considerable degree, on off-label uses of techniques which work but no one is really certain why this is the case.

Similarly, Nassim Nicholas Taleb has discovered some thin-slicing techniques which have a certain degree of efficacy for dealing with various kinds of problems in economics, finance, investment, banking, and so on. Nonetheless, as is the case in medicine and physics, one has to be careful about the nature and degree of possible side-effects which might emerge in conjunction with one's use of those techniques because one can never be completely sure if they will work or what consequences might ensue from their usage, and the reason why one can never be sure how efficacious and/or problematic the techniques of such thin-slicing analysis will be is because one does not necessarily actually understand why reality unfolds in the way it does.

The map is not that which is being mapped. It is, at best, a model or representation of that to which an aspect of reality gives expression in the form of phenomena which might be describable but are not necessarily understood.

Randomness is a concept that is generated as the result of a judgment based on a form of thin-slicing that seeks to confer sense to that experience by characterizing what makes – or is believed to make -- such phenomena possible. Determining whether, or not, that which is being judged to be random in a conceptual sense actually is random in an ontological sense tends to require something more than a process of thin-slicing.

The notion of thin-slicing is one of the topics that are explored in Malcolm Gladwell's 2005 book: *Blink*. The subtitle for that book is: *The Power of Thinking Without Thinking*.

If thin-slicing is not a form of thinking, then, what is it? According to Gladwell, thin-slicing is an unconscious process which has the capacity to identify aspects of experience that have relevancy to some particular focal interest that is present at a given point of time.

Given the foregoing, one wonders why that which has the capacity to identify significance and value better and faster than the so-called conscious mind is being referred to as the unconscious? In what way does such a capacity qualify as being unconsciousness?

One would seem to be on safer grounds if one were to argue that what is actually unconscious would appear to be the so-called conscious mind. After all, for whatever reason, the conscious mind does not seem to be that which has been able to scan, identify, and use what has been selected in order to respond – often appropriately -- to an on-going existential need.

There are times in which deliberative conceptual processes might take place in the conscious mind when one critically reflects on some given issue. Nonetheless, to an extent that may well be considerably less than many people might believe to be the case, while the conscious mind might play a role in such processes, nevertheless, even in those situations, the conscious mind is being fed a constant array of insights, ideas, linkages, judgments, memories, characterizations, and understandings from something other than the conscious mind, and if it were not for this thin-slicing assistance, the conscious mind might only be capable of staring vacantly into a cloud of unknowing with an awkward sense of self-awareness that resonates with a cursor indicator that is blinking on and off while it waits to be directed with respect to how one should proceed.

Aspects of the conscious mind might wish to take credit for what is transpiring, but, clearly, something else, or someone else, is doing the heavy lifting. Insight, intuition, intelligence, creativity, imagination, memory, and language are all functions of something more deeply hidden than the conscious mind.

At the end of the last chapter, a paragraph appeared which alluded to the possibility that associated with each kind of non-spatial dimension was a quantum of action which played a similar role in those sorts of dimensions as Planck's quantum of action played with respect to the field or dimension of energy. Thin-slicing gives expression to such a quantum of action in conjunction with the dimension of reason, logic, interpretation, and understanding.

The foregoing quantum of action is a function of intelligence broadly construed. Each instance of thin-slicing is a form of 'seeing', 'perception', 'understanding', 'intuition,', or 'insight' which has the capacity -- within certain degrees of freedom -- to grasp, in a more holistic manner rather than in piecemeal fashion, the character, value, significance, or nature of the connection or connections between different facets of experience and the phenomenological field.

Thin-slicing has the capacity to generate links between various aspects of the phenomenological field and different facets of environmental dynamics that are considered to have significance or value, as well as provide logical links to different aspects of memory and relevant aspects of understanding. In effect, thin-slicing is putting together an understanding which shapes the way in which the so-called conscious mind will be existentially oriented.

The conscious-mind serves as sort of a short-term memory screen onto which all manner of thin-slicing processes can write their assessments. In a sense, the construct that is being put together on the screen of consciousness is the result of a massive process of parallel processing by an array of thin-slicing dynamics, and the understanding which is being constructed on the short-term memory of consciousness is constantly being updated and modulated according to contributions of an array of other modalities of thin-slicing (emotion, motivation, desire, morality, and so on) that are engaged in contributing to the construct of understanding which is being put together.

The screen of consciousness which is being modulated by tin-slicing dynamics is referred to as short-term memory because our intentional orientation only lasts for a relatively short-period of time. When that intentional orientation changes or is induced to change, the old construct either quickly dissipates or begins to lose traction, and a new construct of understanding begins to become manifested for as long as the new focus of intentionality holds sway.

Queries might arise in conjunction with what is being presented (perhaps a process of a subsequent thin-slicing of what already has been thin-sliced in another experiential context). The individual's response to such queries comes from additional instances of thin-slicing and does not come from overt acts of the so-called consciousness.

We often think that we are the one's asking the questions, but those questions often are a function of other kinds of thin-slicing dynamics. Some of those questions might pursue the truth of things, but other questions might serve the interests of something other than a pursuit of the truth.

Because there are different sources for thin-slicing activities within us, we are faced with a challenge. We are confronted with the problem of trying to figure out which forms of thin-slicing are in one's best interests, and this dilemma often plays out over the course of life.

Thin-slicing is not a process which thinks its way to a conclusion. Rather, it is a modality of understanding something directly – to varying degrees of depth and accuracy -- without needing to go through a process of rational, logical analysis which tends to be the hallmark of the way in which thinking is usually described as operating.

Just as energy dynamics are a function of the way in which packets of energy are emitted and absorbed while being measured in units of Planck's constant and, thereby, such packets shape energy dynamics, so too, the dynamics of thought are, to a degree, a function of the way in which the packets of thin-slicing which are generated through an individual tend to interact with one another and, as a result, modulate the dynamics of understanding. Furthermore, just as there are several unanswered questions concerning the nature of Planck's constant – namely, why does it have the value it does and how does it acquire such a value – so too, there are several unanswered questions concerning the nature of the thought quantum – namely, what is responsible for experience being thin-sliced in one way rather than another, and what, if anything, regulates the way in which thought quanta interact to give expression to a manifold of understanding?

As a result of a sequence of thin-slicing dynamics over the years, somewhere along the line, Nassim Nicholas Taleb arrived at the conclusion that the universe appears to be inherently random. Let's subject his conclusion to a bit of critical thinking.

For example, π is described as being a non-repeating decimal. This means it cannot be expressed as a fraction and, consequently, is considered to be irrational.

Non-repeating decimals are said to give expression to an infinite series of numbers that occupy the decimal places that are generated when such a number is calculated. Moreover, as the name of these kinds of numbers indicates, such decimals do not contain repeated sequences as repeating decimals do (for instance, 1/6 = .166666 … or 1/9 = .11111 …) such that, in the latter case, no matter how far one carries out a division, some specific number or set of number sequences will continue to appear one after the other, whereas in the case of the former irrational numbers, there are believed to be no repeated sequences which are present in the decimal part of such numbers no matter how far one carries out the process of producing additional digits.

As of July 2024, π has been worked out to roughly 2 trillion decimal places. There are no repeating sequences found in those 2 trillion decimal places.

However, what if I were to take a sequence of twenty numbers from, say, somewhere in the vicinity of 999 trillion decimal places of π (assuming, of course, that I had a way to feasibly accomplish this), and were to present that set of numbers to someone and ask whether this was a random sequence or a non-random sequence? Perhaps, after studying the number for a while, many people might conclude that the number appeared to be random. Yet, π is completely determinate because the method for generating the sequence of digits to which it gives expression is set from the very beginning.

Just because one does not know how a number – or anything -- is generated does not make it a function of randomness. Things that look as if they are random – for example, chaotic systems -- can emerge through determinate means, but we often are ignorant concerning the nature of those means and how what one might consider to be random is actually a function of those determinate means.

So-called random number generators are not random-number generators. They are arbitrary number generators which are designed (that is, use determinate means) to make a sequence of numbers unpredictable.

There are quantum physicists who are, or have been, influenced by Bohr's way of approaching issues who will insist that the probabilities to which the wave function gives expression constitute a fundamental level of reality. According to them, one can access nothing more physically fundamental, and, consequently, there are no hidden variables.

The perspective of Bohr is a form of scientific behaviorism akin to the approach to various scientific issues that was taken by Ernst Mach. For example, Mach took issue with, and denied, Ludwig Boltzmann's late-nineteenth century proposal that there were atoms which existed but could not be seen and, notwithstanding their invisibility, those entities were responsible for the statistical mechanics that could be calculated with respect to, for example, the behavior of gases.

Bohr sought to something similar to what Mach had done in conjunction with his differences with Einstein concerning the nature of reality. The former scientist tried to insist that there was nothing taking place beneath the probabilities which were showing up in connection with the wave function. Yet, Bohr's perspective didn't really make any sense – and this absence of "making sense" is at the heart of a great deal of the conceptual flotsam which clutters the waterways of quantum physics with respect to trying to figure out what the nature of the relationship is between quantum mechanics and reality.

In other words, one has difficulty not wanting to ask questions about what is the precise nature of the characteristics and properties of a given set of probabilities if those features are not a function of some kind of underlying dynamic? Bohr tried to convince scientists – and was quite successful in many cases (but not with Einstein) – that asking such questions was pointless, and, in effect, Bohr performed his version of: 'Pay no attention to the man behind the curtain.'

Some people tried to argue that consciousness -- in the form of observation or measurement -- is what shaped the probabilities of the wave-function. Nonetheless, no one understood how consciousness collapsed the wave function in one way rather than another, and, therefore, such a proposal was really nothing more than conjecture.

There are experiments which have been done which appear to show that the presence of consciousness of some kind can be correlated with changes involving the way quantum events are manifested when measured. Nonetheless, even if consciousness were involved in some way with inducing measured changes in quantum events, the way in which this is done remains a mystery, and, therefore, one can't be sure that it is consciousness which is affecting those outcomes rather than some additional, unknown factor that works through consciousness or, alternatively, which operates with consciousness as a modulating co-factor or simply operates in the presence of consciousness and he latter is considered to be a non-causal correlate with respect to such a possible hidden variable.

Similar to what Mach and Bohr sought to do – each in their respective manner -- Nassim Nicholas Taleb also appears to be engaged in promoting his own edition of a form of superficial behaviorism in which he claims, like some quantum physicists, that there is nothing but randomness enveloping events. However, he doesn't really account for how an array of ordered events arises from randomness – and, no, his infinite monkey narrative doesn't provide a possible escape from this dilemma.

In his book, *The Black Swan*, Taleb talks a little about Karl Popper. More specifically, Taleb notes that while many people know about the notion of falsification which was introduced by Popper as a way of distinguishing between science and non-science, Taleb laments the fact that far fewer people have taken note of what Taleb considers to be a more important theme which was explored by Popper, and this topic has to do with the issue of "skepticism."

In a sense, both of Taleb's aforementioned books are a collection of stories, anecdotes, experiences, observations, insights, principles, and analyses which are intended to give expression to lessons about how to be properly skeptical concerning many of the ways that human beings employ while they try to put together an understanding of the world that will enable them to move forward in life. Ironically, two of the things that Taleb doesn't appear to exercise much skepticism toward are the notions of skepticism and ontological randomness.

Do human beings commit all manner of errors in the way they go about thin-slicing reality? Yes, they do, and giving credit where credit is due, Taleb does a great job during his two books in pointing out many of those errors as well as the nature of the roles which various kinds of so-called parsing methodology (for example, probability and statistics) have played in giving rise to those sorts of errors.

An interesting aspect of the foregoing acknowledgment is that we seem to have the capacity to be able to: Detect error; show how illusions work; discern differences in the qualities which are present in, among other things, dreams states, psychotic episodes, hallucinatory experiences, drug-induced experiences, and anomalous experiences of uncertain nature or origin, as well as some of the ways in which a delusional condition might be tied to false beliefs. What makes all of the foregoing things of interest is that they all give expression to our capacity to differentiate -- to an unknown and, perhaps, to an uncertain degree – between what is true and what is not true in certain circumstances.

There would be absolutely no point for Taleb to write the books that he has if he did not believe that, within certain limits, human beings have a capacity to distinguish between what is true and what is false. His books are intended to help people to develop a better sense of how to go about determining what sorts of experiences and methods might have a modicum of reliability to them as well as what kinds of experiences seem to be enveloped in a dark cloud similar to the one which followed the Peanuts character Pig-Pen around except instead of dirt, the former cloud would be one of misinformation, disinformation, falsehoods, delusions, uncertainty, and unknowing.

Given the foregoing, it makes sense for Taleb to adopt a perspective characterized by a quality of rigorous skepticism. This critically reflective dynamic could go on until one encountered experiences that such a methodology is encountering more and more difficulty showing how certain kinds of experiences lack reliability or validity or defensible plausibility.

However, approached from another – skeptical – direction, one might come to the conclusion that all of the data put forth in *Fooled by Randomness* and *The Black Swan* not only serves to buttress his contention that the price of skepticism is eternal vigilance but, as well, the material in those two books creates something of a Maginot-like line of defenses which might be intended to prevent people from using critically reflective forms of probing that could reveal the presence of something of considerable importance – something that is present through its absence – namely, that Taleb doesn't seem to have much to offer which demonstrates how one might be able to grasp something concerning the nature of reality or existence which has the capacity to transcend the methodology of skepticism.

Scientists often warn people to avoid rejecting something as false when it is true, and, in addition, they indicate that individuals should avoid accepting something as true, when it is false. These are known as Type I and Type II errors.

Taleb tends to encourage readers of his two works to adopt – or, at least, take seriously -- the idea that there is much to suggest that ontological randomness might be a true characterization concerning the nature of reality. Moreover, he spends considerable time during the two aforementioned books illustrating why many of our judgments are rooted in our failure to understand all of the ways in which the unanticipated enters into and undermines our judgments.

One can agree with Taleb that the realm of the unanticipated often comes back to haunt us in all manner of problematic ways – as Robbie Burns has indicated: "… the best laid plans of mice and men gang aft agley." Nonetheless, the facticity of the unanticipated says absolutely nothing about its source or origin.

The unanticipated is consistent with a universe that is random in nature. On the other hand, the unanticipated is also consistent with a bevy of philosophical, spiritual, and scientific perspectives which contend that the universe is not inherently random however unanticipated its manifestations might be.

In effect, what Taleb is doing is putting forth a coping strategy for dealing with a universe which he considers to be unavoidably random. What he does not seem to have done is to put forth a credible defense for why one should believe him to be correct with respect to the way in which he has characterized the nature of the universe as being inherently random and, as a result, raises questions about whether, or not, the source of the unanticipated aspects of the world are a function of randomness, and, consequently, one of the mistakes that he makes as a result of his own lack of skepticism concerning his basic assumption of randomness is to fail to realize that a coping strategy, however well it might work for one's purposes, is not necessarily a viable account of ontology.

Psychosis and neuroses can be coping strategies – dysfunctional though they might be -- for dealing with the inexplicable dynamics which are transpiring within an individual. However, psychosis and neurosis are not necessarily accurate maps of that which is making such psychosis and neurosis possible.

Delusional behavior is also a coping strategy. Nonetheless, the essence of delusional behavior is that it is rooted in a false conception concerning the way that reality works.

To whatever extent a person is sincere with ontology, the question which tends to haunt such an individual tends to entail asking about the extent to which one's orientation toward life is delusional, psychotic, or neurotic in nature. Having a coping strategy might help one to meet, as well as work one's way through, the day, but coping strategies might only have a tangential or asymptotic relation with reality.

Meaning, purpose, goals, value, motivation, and desire may all help to organize life. Yet, such vectors do not necessarily have much, or even anything, to do with the actual nature of reality.

Lest one suppose that the foregoing observations are intended to indicate that I know what the nature of reality is while Nassim Nicholas Taleb does not, such individuals should take another kick at the can of criticism. I know that I don't know, but I also recognize the presence of such an absence in other individuals, one of whom is Nassim Nicholas Taleb.

Taleb is working his side of the ontological street, while I am working mine. We each are finding things of interest and possible value during our respective sojourns along the promenade, but we have different ideas about how those things are connected to the ontological street we are working.

At some point, his journey will end, and, at some point, my life-path will come to an end as well. One consideration about which I do have a sense of knowledge is the following: If Taleb is correct in his way of thinking about the inherently random nature of reality, when our respective journeys end, neither one of us will ever be cognizant of who has been right and who had has been mistaken, and, under such circumstances, all that might matter – while there are those who would reject the following possibility -- is whether, or not, we have tried to exercise our respective coping strategies with some degree of integrity, love, empathy, compassion, humility, gratitude, courage, judiciousness, and kindness. There are better and worse ways of being wrong.

With respect to those who believe that if the world is random in nature, then, this state of affairs means people are entitled to do whatever they like to whomever they like, one should note that irrespective of whatever the affordances are that might be present in reality, such degrees of freedom do not necessarily constitute a tacit permission for people to act with a sense of entitlement. Under such conditions, I believe Hume's argument might be applicable: namely, One cannot derive 'ought' from 'is'

If things are truly random, then, one is not entitled to anything. Indeed, if there is no inherent order to the nature of things, then, as Hume indicated, one cannot justifiably derive any kind of 'ought' (or, by implication, one might add 'entitlement') from 'is'. Irrespective of whether one believes ontology to be inherently random or inherently ordered in some fashion, people need to discover a means through which an array of different coping strategies will be able to accommodate one another in a constructive fashion because, otherwise – and I believe that Taleb, in his own inimical manner, might agree with me on this point -- the unanticipated could well come to play a much bigger role in our lives than already seems to be the case presently.

Randomness and chaos both give expression to the unanticipated. Nonetheless, the nature of the unanticipated which comes from impersonal randomness somehow seems less terrifying than are the unanticipated events which self-serving forms of entitled chaos lets loose in the world.

<u>Chapter 5</u>: Thermodynamic Order

Long before Michael Faraday, James Maxwell, and others showed up on the scene to provide a greater set of insights into the behavior of electricity (but not necessarily into the nature of electricity) there already was an established spectrum of vibrant exploratory and experimental work which had been taking place with respect to the phenomenon of electricity for more than a hundred years. To be sure, electricity is not the same thing as heat – which is that with which the "thermo" part of thermodynamics concerns itself – but both electricity and heat have something to do with the issue of energy, and while thermodynamics began its existence with the study of heat and, only after work with electricity had begun, eventually, the three laws which emerged from thermodynamic studies became general laws concerning the behavior of energy in general and, therefore, was not restricted to just the phenomenon of heat … and, so, somewhat counter-intuitively, perhaps, we have started this narrative with the issue of electricity.

Toward the mid-century mark of the 1700s, trepid investigators such as Musschenbroek, Kleist, Allamand, and Cunaeus, had caught the attention of many people in Europe with a capacity to generate shocks that no one understood but with which most everyone was becoming intrigued. Jean Antoine Nollet, a sort of French theological physicist, used a Leyden jar to provide people with a carnival side-show-like experience that enabled those individuals to know what it felt like to have a strange something-or-other coursing through them.

When, the demand of individuals for a shocking experience became overwhelming, Nollet devised a group plan. More specifically, he would gather hundreds of people together, have them hold hands, and, then, while being in physical contact with one end of that circle of people, he would touch the wire attached to the Leyden jar, and, then, almost instantaneously, the circuit would complete itself by means of the bodies of the people who were holding hands – a pre-computer version of load balancing and networking.

Although the initial hoopla surrounding the Leyden jar had to do with its capacity to generate shocks, soon, another facet of the phenomenon began to be explored. This new development had to do with some people's claim that health benefits could be derived from being exposed to the phenomenon associated with Leyden jars.

Commercial versions of the Leyden jar began to be offered to the general public. Various hospitals also devised alleged medical uses for those devices, and, as well, individuals who were not doctors also started to emerge here and there to be "treated" by such machines.

Benjamin Franklin was involved in this sort of treatment process to such an extent, that many people referred to that process as "franklinization." The founder of the Methodist church, John Wesley, praised the beneficial effects of electricity and began to apply it to thousands of people who had expressed interest in being exposed to such a phenomenon.

Soon, individuals from many different professions were venturing into the fray. Surgeons, mechanics, barbers, and many other individuals set up various kinds of electricity-generating devices for customers who came into their shops.

Some exposures to those electrical devices were associated with benefits of one kind or another. However, the experience of other individuals was decidedly otherwise as various forms of malaise, debilitation, and pathology often emerged subsequent to being exposed to electricity-generating contraptions.

Various practitioners started to develop a clinical approach to the use of electrical devices. In other words, if the electricity from such devices seemed to work in some beneficial manner, then, even if no one understood how electricity did what it did, people continued to offer those sorts of treatments. Yet, other individuals who had been first-hand witnesses to the problems which sometimes ensued from the use of different kinds of electrical treatment began to issue cautionary alarms.

No one knew what electricity was. No one knew how different intensities of exposure affected people. There were no standards governing the use of such machines.

Perhaps, more importantly, few, if any, individuals – at least in the Western world -- understood much about the human body. Therefore, no one had any understanding concerning how electricity actually interacted with biological organisms since the work of individuals such as Alessandro Volta and others were still in the future.

A person who walks across the right kind of carpet, with the right kind of shoes, under the right kind of atmospheric conditions can experience a shock which contains some 30,000 volts, and, yet, feel little more than a temporary, though intense, electrical shock. However, there were people who were being exposed to far less voltage than would be generated by a walk across the carpet who were encountering adverse biological reactions, and, consequently, there was something more going on with electrical phenomena than most, if not all Western, individuals understood.

Some of the individuals who were exposed to different forms of electrification treatments during the 1700s and 1800s experienced a variety of problematic symptoms. Among these were: Fatigue; depression; pains in an array of joints and muscles; dizziness; insomnia; irritability; headaches; heart palpitations; seizures; bowel difficulties; nausea, and breathing issues.

One might note in passing that many, if not all, of the foregoing symptoms have re-emerged in today's world. The cause of those symptoms is associated with the electronic smog that envelops most parts of the world and is a function of the many power lines, cell towers, smart meters, and electronic devices (including mobile phones, smart pads, and laptops) which are fairly ubiquitous and are linked up through radio frequency, blue tooth, wi-fi, and microwave technologies, and while such devices might not be generating ionizing radiation, nonetheless, as many studies have proven, the foregoing sorts of networks and devices do generate non-ionizing forms of radiation which can be just as problematic to the human body and its ability to function properly.

Serving as a sort of counter to some of the foregoing sorts of maladies that were arising in conjunction with the way in which electricity was being experienced by various human beings, there were also some significant successes. For example, as the recently departed Arthur Firstenberg indicated in his book *The Invisible Rainbow*, mid-way through the nineteenth century, Guillaume Benjamin Duchenne de Boulogne, a neurologist, was able to restore hearing to many individuals who -- to varying degrees of severity – were deaf, and

Duchenne solved these challenges by directing pulses of small currents to the chorda tympani that passes through the middle ear.

A hundred years before Duchenne, there had been a physician from Sweden by the name of Johann Lindhult who also had met with considerable success in treating deaf individuals. As would be the case a century later with the work of Duchenne, Lindhult applied small currents of electricity to certain aspects of the ears of his patients, and a variety of individuals, including a seven-year girl who had been deaf since birth, were the beneficiaries of his treatments.

Neither Lindhult nor Duchenne knew why what they did worked. They were adopting a clinical approach to treatment, and, therefore, as long as something seemed to work and appeared to have no significant drawbacks to its use, then, whether, or not, one understood the process was considered to be of secondary importance.

However, as indicated previously, notwithstanding the foregoing sorts of isolated pockets of success involving the use of externally applied electrical currents, there were many uses of electricity that did not have similarly felicitous outcomes. One of the primary reasons for such problems was because, for the most part, Western practitioners had little, or no, knowledge of the electrical properties of the human body.

The meridian system of electrical flow that exists in the human body has been known about by the Chinese and other areas of Asia for about approximately eight thousands years prior to the West even beginning to take an interest in things electrical – especially in a biological context. However, per usual, as a result of the West's false sense of its own alleged exceptionalism, much damage was done in the early days of electrical experimentation, and continues to occur today.

One possibility with respect to the foregoing considerations involving differences in outcome with respect to the interaction of electricity and the body is that the character of the electricity which comes from external sources does not necessarily have the same sort of properties as does the energy which naturally flows within human beings. If this is the case, then, problems might arise in the use of electricity that is, in a sense, somewhat similar to when one tries to use electrical devices which are designed for North American usage in situations that operate according to some other set of electrical standards.

Energy comes in different forms, with different properties and characteristics. Some individuals could have sensitivities to the presence of electricity, in different forms, which might not affect other people as easily as extensively, and, as well, different kinds of electricity might affect different people in different ways.

Alternating current does not work in the same way that direct current does. However, they both have the capacity to interact with biological systems in a variety of ways.

Furthermore, currents which are pulsed have different properties than do currents which are not pulsed, and the frequency at which a current is pulsed also affects what can happen when that kind of modulated electricity is used in conjunction with a biological organism. In addition, dirty electricity (which involves erratic spikes of electricity involving both radio frequencies and extremely low frequency electromagnetic fields that surge, from time to time, along lines of electrical transmission) has different effects on the human body than do forms of transmitted electricity in which such surges have been prevented or filtered out.

Finally, electromagnetic energy is only one of a number of different kinds of energy that exist. In one way, or another, all of the following energies interact with, or in, human beings.

Gravitation is frequently spoken of as a force that governs the strength of the gravitational attraction between any two entities (which have mass or its equivalent), and does so as a function of the gravitational constant. Nevertheless, this force gives expression to a form of energy which is different from, and much weaker than, electromagnetic energy, and, yet, as decades of data from astronauts has indicated -- both in terms of its presence as well as its relative absence – gravitation is capable of affecting biological functioning.

From a superficial perspective, the weak force seems to be very different kind of entity than the electromagnetic force appears to be. After all, the range of the weak force is restricted to the internal area of an atom, whereas the range of the electromagnetic force is quite expansive, and, furthermore, the strength of the weak force is approximately ten million times weaker than the electromagnetic force.

However, research conducted in the 1960s by individuals such as Steven Weinberg, Sheldon Glashow, and Abdus Salam developed a mathematical model which indicated that the electromagnetic force and the weak force might have emerged from an underlying electro-weak force when the symmetry of the latter was broken in some fashion somewhere along the line. Irrespective of whether, or not, the foregoing account proves to be, ultimately, correct, the weak force, as currently manifested, gives expression to a different kind of energy (involving, among other things, the decay of certain kinds of atoms) than does electromagnetism.

The strong force is responsible for holding quarks together which populate the inner sanctum of entities such as protons and neutrons, which means that the strong force is at work in every atom of a human body. While this phenomenon, like gravitation, is referred to in terms of force, this term is just another word that is used to refer to the presence of a form of energy which has certain kind of properties and qualities.

Then, there are so-called scalar waves. Depending on what one reads, or to whom one listens, scalar waves or Tesla waves are either a form of electromagnetic radiation that, currently, is not fully understood, or, alternatively, they are a form of energy which operates in its own inimitable fashion as a phenomenon which is non-Hertzian in nature (Hertzian waves are the vibrations which occur in an electromagnetic field), as well as longitudinal in character (that is, they are devoid of the transverse properties which characterize electromagnetism).

Some individuals have referred to scalar energy as being a form of 'pressure wave'. Other individuals understand scalar energy from a perspective that has to do with two different kinds of electromagnetic fields.

Of those field is referred to as the "far-field" form of EM, while the other edition of EM is known as the "near field" in which aspects of those near-field dynamics are out of phase with one another. As a result, such near-field dynamics have the tendency to cancel out certain modalities of manifestation in the near-field, and what remains is referred to as a scalar wave.

Scalar waves have been associated with the idea of directed weapons that are capable of interfering with biological functioning in a variety of ways. Whether, the strong and weak forces might be vulnerable to some sort of weaponization process is uncertain, but once certain aspects of a phenomenon are, to some degree, understood -- and this doesn't necessarily have to constitute a definitive understanding – then, the greedy, the incautious, the self-absorbed, the demented, as well as those who seek to control things and people begin to explore ways through which to manipulate forces of nature. This is the sort of research – if one can call it that – which is the bread and butter of entities like D.A.R.P.A. .

Moreover, while a fair amount might be known about the nature of the strong and weak forces within the relatively limited focal beams of interest which characterizes what transpires in places like C.E.R.N., one cannot automatically dismiss the possibility that there could be added layers of nuance which are possible in conjunction with, among other considerations, the nature and/or role of the strong force in a biological context. After all, given the way in which electrons have been shown, under certain conditions, to be capable of certain kinds of entanglement phenomena, then, perhaps, there are other forms of entanglement which are occurring in a biological context that have the capacity to shape various aspects of biological dynamics in subtle ways.

For example, when 'up'-type quarks (which includes quarks referred to by the names of "top" and "charm") are induced to absorb or emit a W boson, then, such 'up'-type quarks can change into a 'down'-type modality of quark (this includes "bottom" and "strange" quarks). This sort of transition is characteristic of beta decay in atoms, but, conceivably, there might be other modalities of quark-related changes that affect the sorts of frequencies which can be given off or received by hadrons (such as neutrons or protons) and, thereby, could affect biological communication in very subtle ways (and entanglement constitutes a form of communication).

There is another kind of energy that does seem to be reducible to any of the foregoing forms of energy. This sort of energy is known by different names in various cultural contexts.

In China, for instance, this form of energy is referred to as "qi," while in America it is called "ch'i." India uses the term "prana" to give expression to this form of energy, while those who are familiar with an Islamic perspective use the word "nur" to refer to this sort of phenomenon.

In each of the three foregoing cultural contexts, the phenomenon being alluded to gives expression to forms of dynamics that entail a kind of 'organizing intelligence'. Some individuals have referred to this sort of organizing intelligence as a modality of scalar energy.

Irrespective of whether, or not, qi/chi, prana, and nur can be considered to be a scalar form of energy is, at least for me, a non-issue. What appears to be of more significance is the quality of intelligent organizing which characterizes phenomena with which such energy is associated, and in later chapters of the book, this possibility will be explored in more detail.

The underlying phenomena to which the foregoing terms allude give expression to a complex perspective that has played, and continues to play, a fundamental role in the way a multiplicity of epistemological and medical frameworks have engaged certain aspects or dimensions of reality – a form of energy which appears to very different from the sorts of forces or energies which have been described over the last few pages and which, for the most part, shape much of the scientific understanding of Western science. To make referring to this kind of energy phenomenon somewhat easier, as well as to be able to retain a sense of the diversity of traditions in which such understandings are rooted, the term "prana-nur-qi" will be used to give expression to this notion of organizing intelligence."

There are other traditions around the world (e.g., indigenous peoples in New Zealand, Australia, and throughout the Americas) which have alternative ways of referring to this sort of energy phenomenon. However, to keep things as simple as possible while retaining a modicum of diversity, the term "prana-nur-qi" will be used to make collective reference to such forms of energy.

One could say that a great many – but not necessarily all -- of the subsequent chapters in this book will be directed toward exploring the possibility that there is something more deeply hidden than can be accounted for by Western approaches to: Energy, dynamics, fields biology, development, life, evolution, and so on. However, for now, all that can be offered is a promissory note, of sorts, that will require me to, first, work my way through a number of topics before the present journey will be in a position to arrive at the intended, and hoped for, destination.

The next step of that journey requires us to return to the issue that appears in the title of this chapter – namely, thermodynamics. While the following material is not intended to be a definitive treatment of this topic, hopefully, enough will be touched upon to provide one with some food-for-thought concerning future discussions.

There are three laws of thermodynamics. These have to do with (1) the conservation of energy; (2) the notion of entropy, and (3) the issue of absolute zero.

Some individuals – for example, Peter Atkins -- mention the idea of a fourth law of thermodynamics. This has to do with the notion of temperature and measurements concerning that property.

In what follows, there will be a limited exploration of (1) and (2) as well as some comments concerning the "fourth" law of thermodynamics. However, the third law is being shelved because, in many ways, it is not directly relevant to the perspective which is being delineated.

In thermodynamics, there are three kinds of systems. These are known as open, closed, and isolated systems.

If the boundaries which form the periphery of a system are permeable to material influences that exist outside of that system, then, the system is considered to be open. If those boundaries are impermeable with respect to such external material influences, then, the system is described as being closed, and, finally, if the boundaries of a system are impermeable to all material influences, then, it is said to be an isolated system.

There is an asterisk which should be used to mark the foregoing considerations. Open, closed, and isolated systems are a function of whether, or not, a given system is permeable to – specifically – 'material' influences of some kind.

Presumably, one of the reasons for including the term "material" is because material entities -- at least to the extent that we understand what materiality involves -- are amenable to being measured. However, if a system is permeable to influences which are not necessarily of an inherently material nature, then, obviously, such a system can no longer be considered open, closed, or isolated in any usual or traditional sense because something is present which has the capacity to influence those systems and, yet, such influences cannot necessarily be reduced to material dynamics or measured in accordance with protocols of measurement.

For example, space and time both seem to influence material dynamics. However, although individuals such as Einstein maintained in his special and general theories of relativity that both space and time can be altered by the dynamics of material phenomena, such individuals might have conflated methodology and measurement with ontology and, as a result, believed that because measurements changed in various ways as a function of material dynamics that this meant that space, per se, and time, per se, were being altered.

Contrary to what Einstein claims, time is not what a clock measures. Time is part of what makes clocks possible.

To be sure, clocks – material things -- are affected by velocity and gravity – both of which are material phenomena. Nonetheless, there is no direct, independent evidence which demonstrates that velocity and gravity alter space or time in any material manner.

Lorentz transformations concerning measurements involving inertial frames of reference in order to be able to preserve the laws of physics or time-space indices which provide a system for measuring curvature allow one to keep track of, or map, how one material system is related to another. Neither of those techniques, however, necessarily has anything to do with demonstrating that time and space have been altered in some fashion.

Consequently, while a system might be open, closed, or isolated with respect to various kinds of material phenomena, this does necessarily prevent other kinds of influences from being able to permeate such systems. In order to exist at all, material systems must be permeated by space and time, but we have very limited, if any real, understanding of the extent to which space and time affect the degrees of freedom and constraints within which material phenomena operate.

Are there other modalities of dimensionality which might be permeating the boundaries of any given material system? For instance, is energy, in general, or a given kind of energy, in particular, a form of dimensionality?

Could the previously noted phenomena of: Gravitation, strong, weak, electromagnetic, and, possibly, scalar forces give expression to various degrees of freedom and constraints which are present in some sort of dimension that enables energy dynamics of different kinds to become manifest under certain conditions? Are there other kinds of more subtle energy forms which are potentials with such a dimension?

Earlier, a reference had been made with respect to the work of Glashow, Salam, and Weinberg concerning the possibility – backed by rigorous mathematical considerations -- that despite the presence of, possibly, superficial differences with respect to properties when one compares how electromagnetic and weak forces seem to work, nonetheless, according to the aforementioned three individuals, both of those forces might be descendants of some more fundamental form of force which has undergone a modality of symmetry breaking at some point in time and, as a result, given the nature of that process of symmetry breaking and given the presence of one set of conditions rather than another, the original modality of force diverted into two streams which, currently, seem dissimilar but, initially, had a common origin.

Most 'theories of everything' envision a kind of primordial state of singularity in which an energy state of some kind underwent – somehow -- one, or more, symmetry breaking events that induced multiple streams of energy dynamics to come into being (i.e., gravitation, strong, weak, electromagnetic, and, possibly, scalar forces) and which populate the physical-material world with which we are familiar today. How do we know there weren't other, more subtle forms of energy dynamics which were released into existence during such a period of transition, or how do we know that the different forces with which we are familiar today aren't just some of the expressions of potential that are subsumed under the over-arching agency of a more comprehensive realm of dimensionality which is capable of giving rise to other forms of dimensionality, one of which has to do with the manifestation of energy.

Cosmological inflation of an unknown nature and dynamic which has been provided with the capacity to expand space – even though we don't actually know whether, or not, space is something that can be expanded – is invoked as necessary to make theories and calculations concerning the alleged Big Bang come out right. General Relativity theory is prepared to allow space and time to be curved in order to provide a canvas for charting measurements which make sense with respect to those calculations but tends to flounder with respect to matters of ontology.

Nothing is being said here other than that scientists don't necessarily understand anything about the nature of the forms of dimensionality which might intersect with the dimensions of space and time. Energy might be one of those dimensions, and if it is, then, conceivably, whatever might be said about thermodynamics within the limited context of the sorts of systems which tend to be studied from such a theoretical perspective, might have little, or nothing, to do with systems – such as life -- which could be dimensionally richer than the kinds of systems on which they tend to focus.

This is not to say that principles of thermodynamics have no applicability to contexts which might be dimensionally richer than such researchers tend to presume. Nonetheless, the problem of determining which systems might be open or closed in ways that could be more dimensionally complex that those researchers are prepared to admit does complicate issues somewhat, and, as a result, lends a certain amount of amorphousness and fuzziness to considerations

If matter and energy can neither be created nor destroyed, then, what made the singularity possible which consists of material components and energy of an unknown nature? Why does that alleged singularity seem to lend itself more readily to certain kinds of principles – for example, thermodynamics – than other kinds of principles?

How do we know it isn't the case that conditions for such a singularity are established through the way in which dimensions come together to interact with one another and that, as a result, when the right set of dimensional forms of interaction are present, matter and energy of various kinds become manifest, but when, for whatever reason, the necessary set of dimensional forms of interaction dissipate or disengage, then, particular forms of matter and energy disappear? Perhaps that which is being conserved – through the presence of a temporal dimension – is dimensional dynamics rather than specific forms of matter and energy.

Maybe, like the fields of physics, dimensional interactions and dynamics are fundamental, and, consequently, particular forms of energy and matter are a created function of underlying dynamics which make those particular forms of energy and matter possible, but when, for whatever reason, such underlying dimensional dynamics are no longer present, then, matter and energy disappear and no longer exist. If this were the case, then, thermodynamics is operating at a rather arbitrary level of exploration, and while what might be said on such a level could be quite true, those truths don't necessarily provide any essential insight into the ways things are in a fundamental sense.

Thermodynamic considerations remain relevant as long as they are supported by underlying dimensional dynamics. When those dynamics change, then, so too, do whatever thermodynamic laws that are being sustained by those sorts of dimensional dynamics.

Conservation laws exist only to the extent that they are conserved by whatever made those laws possible according to some set of initial conditions. Symmetry-breaking might have nothing to do with many current theories in which: Particular forms of matter are being generated in one way rather than another as energy levels drop, and, as a result, during this period of phase-transition, this, allegedly, results in particular kinds of forces and physical principles suddenly becoming operative to shape the way in which the universe begins to materially unfold.

Rather, symmetry-breaking might have to do with whatever induces a multiplicity of non-spatial dimensions to come together in conjunction with a spatial dimension in one arrangement rather than some other arrangement. Whatever laws of conservation emerge as a result of the way in which fundamental dimensions intersect with one another is entirely dependent on such an intersectional arrangement continuing on in the same manner.

Dimensions are the affordances (the degrees of permissibility -- or freedom -- and constraints) that make phenomena and manifestation possible. Particular forms of materiality, energy, natural laws, and principles of conversation are a function of those affordances, and when such affordances are removed or disappear, then so does everything which was dependent on those affordances,

One cannot necessarily even maintain that dimensionality is what is conserved rather than particular forms of energy and matter. After all, not only do we not have any critical insight into the nature of the dimensions of space and time, but, in addition, we have no idea what, if anything, made dimensionality – or their potentials -- possible and, therefore, we do not know whether, or not, dimensions are themselves dependent on something more deeply hidden.

Dissipative structures (generated through far from equilibrium dynamics), so-called self-organizing systems, and emergent properties all give expression to the affordances that are made possible through the way in which different dimensions permeate and/or interact with one another. Dissipative structures, self-organizing systems, and emergent properties are not – as evolutionists, among others, often wish to make them (more on this in chapter 7) -- open-ended check books which generate whatever one's imagination might desire to be possible in any given theoretical approach concerning the nature of reality but might, instead, be a function of the degrees of freedom and constraints that are generated when dimensionalities intersect and interact with one another in one way rather than another.

People often point with surprise at various kinds of emergent dynamics and dissipative structures which arise under different conditions and, then, proclaim that those sorts of phenomena are a function of the indefinitely large creative capacity of nature (sort of a variation on Nassim Nicholas Taleb's theme involving an infinite set of typing monkeys). What the foregoing sort of surprise is actually giving expression to might be nothing more than a person's ignorance about what is, and isn't, possible in a given set of circumstances and how those circumstances could be functionally dependent on the way in which dimensions intersect and interact with one another and, thereby, establish the potentials for whatever is possible under those conditions.

While working toward trying to finalize his general theory of relativity, Einstein had been searching for a mathematical formulation which would indicate how the total energy of the gravitational field in his updated expansion, or generalization, of the laws of physical motion would be preserved across transformations in that field. Initially, Einstein contended that the energy of the masses in such a field plus the energy of gravity in that same field would remain constant across changes in time and space.

However, in 1915, Emmy Noether was troubled with the way in which Einstein's initial field equation sought to conserve energy within the context of frames of reference that were moving with variable forms of acceleration and rotation relative to one another – that is, in a context of general, rather than, special relativity. Noether felt that his initial formulation concerning energy in general relativity had failed to conserve, in a fundamental manner, the laws of motion or physics with respect to non-inertial frames of reference involving variable forms of acceleration, as the laws of physics had been preserved, in a fundamental way, through the special theory of relativity in conjunction with inertial frames of motion that were moving with constant acceleration.

More specifically, Einstein had been using the mathematics of tensors to provide a way of showing how despite changes in co-ordinates, the underlying physics of motion would remain the same. Noether felt the problem inherent in Einstein's method revolved about his mathematical formulation for the energy of gravity term which appeared in Einstein's field equation.

According to Noether, Einstein's formulation for gravitational energy did not constitute a real tensor but, instead, gave expression to a 'pseudotensor'. This is because if one were to transfer such gravitational energy from one physical context to another, energy would not necessarily be conserved in the manner in which Einstein believed would be the case.

True tensors enable components within the tensor to change while other components in that tensor will adjust to those changes in a way that will enable the physical phenomenon to which such tensors are giving expression to retain its inherent dynamical character. However, pseudotensors are not able to conserve properties or principles by permitting appropriate adjustments to be made when change enters into the dynamic which such tensors supposedly are describing.

The principle of general covariance in Einstein's theory of gravitation requires that no matter what frame of reference one is using, the laws of physics will remain the same. Noether saw such covariance as an expression of symmetry because despite changes in framework, the laws of physics remained intact under the principle of covariance.

Emmy Noether developed the foregoing insight into a mathematical principle which maintains that whenever one finds a continuous symmetry, one also will find elements in that symmetry that link to some corresponding law of conservation that is associated with that kind of symmetry. Many individuals, perhaps including Noether herself, have understood this to mean that the source of, or origin for, all conservation laws are continuous symmetries when, instead, perhaps with respect to instances where various laws of physics are conserved, such symmetries exist because the degrees of freedom and constraints which are present in some physical dynamic remains the same despite certain kinds of changes in conditions to which such a dynamic is exposed … whatever symmetries are present merely reflect the affordances which are provided by the degrees of freedom and constraints to which such a dynamic gives expression under various conditions.

In other words, notwithstanding Noether's mathematical insight, symmetries don't necessarily make conservation laws possible. Rather, conservation laws might be manifested to whatever extent a set of ontological dynamics enable some feature, or features, to remain the same across whatever kinds of transformations take place, and, in the process, are, thereby, able to exhibit behavior which can be described through the lenses of certain kinds of symmetry operations.

Such symmetry operations are characteristic of dynamics which exhibit the property of conservation across a set of transformations. Nonetheless, those symmetry operations might have little to do with what makes such a property of conservation possible in a given set of circumstances, and, as such, they might be correlational in nature and not necessarily causal.

Equilateral triangles don't exist because they have certain symmetries of axis or rotation. Those potential symmetries exist because equilateral triangles have the form and properties that they do, and, as a result, when you put those triangles through various kinds of transformational changes, such as rotating them, then certain kinds of symmetry are manifested.

Moreover, energy is not necessarily conserved because it is a function of some sort of time symmetry (that is, the idea that a given law of physics will remain the same irrespective of the temporal frame of reference through which it is observed). Instead, energy exhibits time symmetry if it has the capacity to remain the same across temporal transformations, and, if this is the case, then, various modalities of symmetry arise out of the capacity of something to remain the same despite undergoing whatever might be entailed by such a transformation.

Similarly, conservation of momentum does not necessarily exist because there is a translational symmetry which exists that has the capacity to preserve momentum in the context of empty space which Noether was mathematically exploring. Translational symmetry exists because the conditions of empty space, together with the property of momentum which has been imparted to some object, exhibit dynamics which show translational symmetry for as long as such an object continues to move continuously in the same way, and if, for whatever reason, the property of momentum conservation disappears, then, the property of translational symmetry will disappear as well, but after the loss of some principle of conservation rather than prior to that sort of loss.

In addition, the conservation of angular momentum does not depend on something known as rotational symmetry. However, when angular momentum is conserved it exhibits the property of rotational symmetry since that is what the continuity of those dynamics entails.

Symmetries are often reified as if they were responsible for ontological dynamics having the properties they do. Nonetheless, because ontological dynamics have the properties they do, and because the conditions in which such dynamics occur have the properties that those conditions do, symmetries of various kinds can be used to describe the nature of what is taking place.

Symmetry is a mathematical way of describing certain potentials which are already present in a given context. Symmetry does not cause the ontology of something, but, rather, when a given ontological phenomenon is subject to certain kinds of transformation and remains the same, it is said to exhibit its capacity for symmetry with respect to some given kind of transformation.

Ontology is an affordance for symmetry. Symmetry is not an affordance for ontology.

Symmetry is not what enables ontology to occur. The character, nature, and properties of ontology are what make symmetry a useful tool for describing certain aspects of ontology.

Whatever dimensional dynamics might make various kinds of phenomena possible is also what provides those phenomena with the degrees of freedom and constraints which might, or might not, be exhibiting certain kinds of symmetries under various conditions of transformation. If this is the case, then, symmetries become a function of dimensional dynamics, and, as such, symmetries characterize the way in which dimensions interact with one another to enable phenomena to exhibit principles of conservation – to whatever extent they do -- under different conditions of transformation.

Symmetry-breaking – to whatever extent it takes place – occurs when the ontological character of a given dynamic is altered in some fashion and, as a result, certain sorts of symmetry which might have been present in that dynamic prior to the symmetry-breaking transformation, are no longer present, and, consequently, ontology is induced to be manifested in a different fashion that no longer exhibits certain kinds of symmetry.

Symmetries are ways of mapping whether, or not, principles of conservation are operative, or present, in a given context. However, to whatever extent such principles of conservation are present, the underlying dynamics of conservation are what make symmetries possible and not vice versa.

Noether's insight concerning symmetries and conservation laws were rooted in her mathematical analysis of what would happen if one were to reflect on such considerations in the context of empty space. Whether, or not, the relationship between symmetries and conservation laws would continue if one were to reflect on the way in which dynamics unfold in non-empty space could lead to different results.

However, if symmetries arise out of the affordances provided by the nature a dynamic of some kind in the context of a given set of conditions, then, perhaps, whether, or not, space is empty or non-empty would make little difference to the nature of the relationship between symmetries and conservation laws. This is because what matters is the nature of the dynamics as well the nature of the conditions in which such dynamics are ensconced since these will establish the affordances which either enable symmetries to become manifest or which prevent symmetries of one kind or another from becoming manifest because those symmetries are not consonant with the way dynamics unfold in such a context.

Noether's first mathematical theorem dealt with the relationship between symmetries and conservation laws in an empty universe, and, as a result, didn't solve Einstein's problem involving the pseudotensor component of his initial formulation of the field equation for general relativity. However, in her second mathematical theorem she showed that while local symmetries weren't necessarily associated with conservation laws as had been the case with her first theorem, nonetheless, the nature of local symmetries indicated that the laws of physics would be consistent from place to place despite undergoing various kinds of transformations, and this relationship between local symmetries and the continuity of physical law was reflected in Einstein's principle of covariance which played an important role in his general theory of relativity.

The continuity equations which Noether explored in her second mathematical theorem showed that, locally, energy could be conserved. Yet, this might not continue to be the case as the context being considered reached a point where although the laws of physics were continuing to be preserved, nevertheless, the conservation of energy might not hold, and this was especially the case in Einstein's general theory of relativity in which the packets of space-time to which curvature supposedly gave expression could result in energy leaking from the field – that is, energy might not be conserved.

Ironically, the understanding at which Noether arrived via her second mathematical theorem resonated with the conclusion which her mentor, David Hilbert, had reached when, previously, he had attended a series of lecture which Einstein had been giving at the University of Göttingen as the latter individual was working his way toward trying to finalize his general theory of relativity. After searching in vain for a way to ensure that energy could be conserved in the theory of general relativity, Hilbert had cast aside the one solution that he had been able to develop because what he had come up with only dealt with the dynamics of empty space and, as a result, one still could not demonstrate how energy could be conserved under all circumstances of general relativity.

Hilbert had turned the unresolved problem over to his colleague, Noether. After expending a considerable effort toward trying to overcome the problem, Noether had arrived at the conclusion that, perhaps, the most that one might be able to establish would be to provide a way of showing, mathematically, how the laws of physical motion could be preserved in the context of local symmetries but that energy would not necessarily always be conserved due to the problems created by the curvature of space-time – and this conclusion was supported by her work on the two theorems concerning symmetry and the issue of conservation laws.

In the 1950s and beyond, Noether's work concerning symmetry and conservation laws led to, among other things, the discovery of new particles. On the problematic side of these sorts of discoveries the realization slowly began to dawn on many physicists that while three generation of particles had been discovered through the research at C.E.R.N. and other particle accelerators, physical reality only seems to employ just one of those generations of particles, and this realization tends to make one wonder if the other two generations of particles are merely the artificial inducement of potentials that are possible to generate -- under the right artificial, synthetic circumstances (e.g., a powerful accelerator) -- and, yet, for unknown reasons, such potentials seem to have no role to play in the realm of natural dynamics but only appear in the context of artificially generated dynamics.

Peter Atkins indicates in this book: *Four Laws That Drive the Universe*, that temperature -- which he refers to as the 0^{th} law – is a parameter that alludes to the way in which a number (the temperature) provides a summary of the most probable manner in which different levels of energy are distributed through a given population of a system at equilibrium. When the temperature of a system rises, then, a greater proportion of the population of atoms or molecules are induced to transition from a lesser energy state to a higher energy state, and when the temperature of that system lowers, then, a greater proportion of the population of atoms or molecules are induced to transition to a lower energy state, and, therefore, whether, or not, atoms move about with more energy or less energy depends on the way in which energy levels are distributed across a given population of atoms.

Atkins goes on to discuss how something called the "Boltzmann distribution" (which has to do with distribution of energy levels) is a more accurate way of talking about the state of a system rather than using units of Celsius, Fahrenheit, or Kelvin. However, because this notion of energy distribution is expressed in Joules, which is a unit measure of energy (1 Joule = 1kg m^2 s^{-2}), and because (due to convention and linguistic habit) such notions do not trip off the tongue and mind with the same ease as do notions of, for example, degrees of Celsius do, then, 'T' (temperature) tends to be used rather than the Boltzmann distribution configuration when describing the energy system of certain kinds of phase conditions (for example, gases), but, in passing, notwithstanding the complexity of the underlying issues, the reader might like to know, as just a piece of trivia, that each beat of the heart is said to require 1 Joule of energy – presumably under, or given, a particular set of standard conditions.

When the temperature of, say, a container of gas changes, which particular atoms or molecules in that gas will transition from one energy level to some other energy level is unknown in the same way that no one knows which atoms will decay in a radioactive substance at any given instance. Yet, just as radioactive substances decay in accordance with a determinate half-life principle of regulation despite the fact that no one knows which atoms will decay at any given time, so too, a system made up of atoms or molecules that are in a gaseous phase exhibit particularized ways of organizing the manner in which energy levels are distributed across the system so that there is a determinate way in which gases act under a given set of conditions of pressure and temperature despite the fact that no knows which atoms or molecules will transition to one, or another, energy level to accommodate changes in temperature.

We don't know what is responsible for the way in which energy levels are distributed in a system as a function of increases or decreases in temperature, but we do know, with a fair degree of precision, what the end result will be. Consequently, while the specific nature of the transition process is unknown for any given atom or molecule, nonetheless, one knows what will happen to the collective distributed populations of different energy levels because when one knows what the temperature of a given system is, one can work out what sort of distribution of energy levels is needed to generate that kind of temperature.

In other words, the foregoing dynamics are not random in nature. They operate in accordance with a set of determinate principles that organize the way energy levels are distributed so that the system as a whole is characterized by one kind of temperature rather than some other kind of temperature under certain conditions of pressure and so on.

The foregoing considerations will show up once again when the notion of entropy is discussed. For if systems give expression to changes in the manner in which there are transitions in the kinds and numbers of energy levels that will characterize a population of atoms or molecules, then -- as, hopefully, will be explored to some degree later in this chapter -- the idea that one can tie entropy to the number of ways in which molecules can be arranged in a given system may entail some difficulties because whatever the way is in which populations of different energy levels are distributed in the system, then, to argue that there are other ways in which things might be distributed is to be confronted by the reality of what is and, therefore, one can't help wonder if there really were other ways in which such different populations of energy levels might have been distributed in a given system. What might be theoretically possible is not necessarily at all a reflection of what is ontologically possible.

Temperature is a way to operationalize the energy state of a given state. The Boltzmann distribution is another way to operationalize the energy state of such a system.

The latter method might be a more precise way of capturing the energy state of a given system than the former method is. However, irrespective of the issue of precision, both methods indicate that the way in which populations of different energy levels transition as conditions change – such as temperature and pressure – then, this constitutes a determinate, and not a, random process.

The pressure, temperature, and so on which are being applied to a system are the affordances within which atoms or molecules operate. What occurs under those circumstances is a function of the way in which the properties of atoms and molecules interact with those affordances and generate, in determinate ways, one kind of energy state and/or phase state rather than another kind of energy and/or phase state.

To refine the foregoing considerations somewhat, the Boltzmann distribution of energy levels can be tied to a set of distribution patterns that give expression to the velocity or speed with which different molecules in a given system move, and this, in turn, can be tied to the temperature of the system. This set of relationships is encapsulated in something known as the 'Maxwell-Boltzmann distribution of speeds.

Maxwell had derived the foregoing set of relationships through a method that was different than the manner through which Boltzmann pursued energy issues. Nonetheless, notwithstanding their respective differences in methodological derivation, the bottom line for the Boltzmann and Maxwell conceptualizations of how energy is distributed in a given system indicates that temperature serves as a sort of index for the average speed of atoms or molecules which are present in a given system – a value which averages the collective set of energy levels that can be calculated to exist in such a system.

Just as temperature helps to operationalize the distribution of energy with respect to the so-called 0^{th} law of thermodynamics, so too, the first law of thermodynamics uses the notion of "work" to help operationalize the principle to which the first law gives expression. One way of characterizing the idea of 'work' is to refer to it as that which gives expression to a form of dynamics that has the capacity to resist or oppose some other form of dynamics or force.

However, if the foregoing notion of work -- which revolves about being able to oppose some form of force -- were, instead, used in a synergistic way with another kind of force, then, although, intuitively, one might feel that something is going on which seems to involve some kind of work or expenditure of energy, nonetheless, one might not be quite sure to what that synergistic arrangement is in opposition.

Maintaining the integrity of a potential often means that whatever that potential might be, the process of keeping its possibilities intact and/or engaging in dynamics which give expression to that potential in some way tends to place such a potential in opposition to a variety of forms of force or dynamic which might actively resist that potential from either continuing on as a potential or from becoming active in some manner. There are methods which are used to try to measure the foregoing kinds of activities, and those measurements seek to capture the "work" that is done during a given set of circumstances that involve such activities.

One system of measurement operates in units of Joules. These units of work or energy-expenditure involve a combination of kilograms and meters squared per seconds squared.

According to this way of measuring things, all work can be treated as, or considered to be, equivalent to what would be needed to raise a weight of a given description (measured in kilograms) a certain distance (measured in meters squared) in a given period of time (per seconds squared). Engaged through the foregoing lenses, many systems can be described as possessing a capacity for generating work, and this capacity goes to the heart of the second law of thermodynamics which has to do with the conservation of energy.

Previously, a piece of trivia was cited which indicated that each beat of the heart expends one Joule of energy. Joules are not only expressed in standard units of kilograms meters squared per seconds squared, but, as well Joules can defined in terms of the amount of energy which is dissipated in the form of heat when an electric current of one amp engages, or is engaged by, a resistance of one ohm for a period of one second.

If each beat of the heart is associated with one Joule, then how many Joules are required to screw in a single thought? Such a question, of course, presupposes that the sort of energy which makes thoughts possible can be converted into some sort of measurement involving Joules.

Assuming that such a conversion could be made, one might begin by noting that while the three pound universe that constitutes the brain represents only about two percent of a person's body's total weight, nonetheless, the brain consumes approximately 20% of the resting metabolic rate of that same body. If one were to assume a resting metabolic rate of, say, 1200-1300 kilocalories, this works out to be the equivalent of somewhere between 14 and 15 gram-calories per second, and this latter figure can be converted to a little over 60 joules per second which, in turn, is equivalent to approximately 60+ watts.

So, if the brain takes 20% of the foregoing action, then, it consumes about 12 watts of energy. This wattage would be distributed across brain activities in a variety of ways.

Are thoughts a function of neuronal activity? If thoughts are a function of neuronal activity, then, why does one kind of neuronal activity lead to a specific kind of thought, whereas another kind of neuronal activity leads to different kind of specific thought? What is the nature of the neuronal dynamic which gives rise to a thought?

If thoughts are a function of neuronal activity, do thoughts have a one-to-one relationship with neurons, or do a number of neurons have to join in some sort of synergistic arrangement to give expression to a thought, and if a synergistic arrangement of some kind is necessary for a thought to emerge, then, what organizes such an arrangement in one way rather than another?

Do complex thoughts require more neurons than do simple thoughts? Do complex thoughts necessarily require more energy than simple thoughts do?

Irrespective of how much energy might be required for a thought to occur, what organizes the way energy flows in conjunction with a thought? In other words, does energy, like a complex form of sculpting, somehow become drawn into a process of carving out thoughts based, in some fashion, on, say, sensory experience and memories, or do thoughts initially exist independently of energy-measured-in-joules and, at some point, calls upon a certain amount of that kind of energy in order, for example, to become expressed phenomenologically?

Is thinking a function of neuronal activity or are thoughts given expression through a particular arrangement of synaptic spaces involving one set of neurotransmitters rather than another? Are thoughts necessarily phenomenological in nature or are thoughts a matter of frequencies which get transduced into phenomenological manifestations, like particles running through a cloud chamber?

Is the brain a generator of thoughts, thinking, logic, reason, interpretation, understanding, and the like? Or, alternatively, is the brain a receiving-transduction process which converts thoughts and thinking -- which arise in some other fashion -- into a frequency and/or current format that can be projected onto the phenomenological screen of consciousness?

Energy consumption of one kind or another can be correlated with thoughts and thinking. However, we don't know if the energy being consumed by the brain plays any causal role in the generation of thought as opposed to, say, the role which energy might play with respect to the receiving and transduction of thought into a form which can be used by the brain.

Insight works how? Understanding works how? Memory works how? Imagination works how? Creativity and inventiveness work how? Consciousness is made possible by what? Learning works how? What do any of the foregoing considerations have to do with the activities of the brain, or vice versa?

In many ways, we interact with our mental lives in a manner that resonates with how medical clinicians and quantum physicists engage their respective professions. Thus, just as medical clinicians often have no idea why the off-label medicines they use work in particular circumstances, and just as quantum physicists have no idea why wave functions are able to produce the precise answers which they do or have any idea concerning what those precise answers have to do with that which makes them possible, so too, most humans have no idea how the mind works or what the nature of the relationship is between the mind and brain activity, and, yet, although we lack any deep knowledge about how mental activities are possible, like medical clinicians and quantum physicists, we have noted that there are certain aspects of what we do which have heuristic value and, as a result, we develop strategies for leveraging that value in ways which have practical uses in everyday life just as medical clinicians and quantum physicists leverage the value of their discoveries in their professional lives, despite the fact that none of the three groups of individuals necessarily has any deep insight into what makes any of their alleged successes possible.

To bring some degree of controversial concreteness to the foregoing array of considerations, one might reflect on the work of John Lorber, a British neurologist, who died nearly thirty years ago. Roger Lewin wrote an article for the journal: *Science*, which appeared in the December 1980 edition of that publication and was entitled: "*Is Your Brain Really Necessary?*" The article provided an overview of certain aspects of the clinical work conducted by a British neurologist, John Lorber (1915-1996).

One of the research interests of Professor Lorber (he was on faculty at Sheffield University in England) involved the condition of hydrocephalus in which -- usually for congenital reasons -- the cerebrospinal fluid of a person is prevented from circulating properly as it flows between the spinal column and the brain. As a result, over time, the cerebrospinal fluid begins to collect in one or more of the ventral spaces within the brain and, as a result, begins to exert an outward pressure which -- if this process is not countered with, for example, some sort of a shunt process that reroutes fluids within the circulatory loop involving ventricles and the spinal column – progressively squeezes the brain against the interior of the skull.

Professor Lorber divided people exhibiting some degree of the foregoing condition into four categories. First, there were those individuals whose brain scans indicated there had been only a minimal amount of enlargement of their ventricles (that is, the spaces containing cerebrospinal fluid) and, therefore, their scans were exhibiting minimal evidence that brain matter was being squeezed against the interior of the skull.

In addition there were three additional categories concerning the issue of ventricle enlargement in the brain cavity. These three categories of individuals had scans indicating, respectively, ventricles or spaces within the brain that occupied: (2) 50 to 70 percent of an individual's cranium; (3) 70 to 90 percent of a person's cranium space, and, finally, (4) 95% or more of the internal cranium space of an individual.

Professor Lorber indicated that the 'category-4' group constituted about 10% of the total set of people being studied. Many of these 'category-4' individuals – that is, individuals whose cranium is 95%, or more, filled with cerebrospinal fluid, and, therefore, possessed with very little brain material -- exhibited severe cognitive challenges and disabilities, and, yet, nonetheless, at least half of the individuals in that group were able to take an intelligence test and score 100, which matches the mean average score for that test.

Moreover, Professor Lorber also indicated there was one youngster from the previously mentioned 'category-4' group (that is, individuals whose brain scans indicated that 95%, or more, of the cavity where the brain normally is situated was filled with 95% , or more, cerebrospinal fluid rather than brain matter) who scored 126 on the IQ test and who, also, had obtained a first-class honors degree in mathematics. In addition, the social capabilities of that youngster were, in all respects, quite normal.

The reason why this particular young man showed up in Professor Lorber's study was because one of that individual's professors (who knew about Professor Lorber's work) had noted that the youth had a larger head size than other students in the class and, as a result, referred the student to Professor Lorber for possible inclusion in the latter's research study. When a brain scan was performed in conjunction with that student, instead of observing a thickness of 4.5 centimeters in the brain tissue that normally exists between the ventricles and the outer portion of the cortical surface, the researchers found just a thin sliver of brain material measuring approximately a millimeter, or so, in thickness to be present in the student's brain cavity.

With respect to the foregoing young student, Professor Lorber indicated that he (i.e., Professor Lorber) couldn't be sure whether the quantity of cerebral matter in the student's brain was 50 grams or 150 grams. However, one thing the pediatric neurologist was sure of is that irrespective of whatever the precise amount of cerebral material which might actually have been present in that person's brain cavity, nevertheless, it was substantially less -- by an order of magnitude or more -- than the 1.5 kilograms (1500 grams) that characterizes the weight of a normal brain.

Notwithstanding a cranium which is 95% filled with cerebrospinal fluid and the presence of brain material that is a millimeter, or so, in thickness (rather than the usual 4.5 centimeters of thickness), and which weighs roughly 1450 to 1350 grams less than a normal brain of some 1500 grams, the student graduated with a honors degree in mathematics. Furthermore, as indicated earlier, there were other individuals who were in the same 'Category-4' group who were able to score 100 on an intelligence test.

There were many clinicians and scientists at the time – and, subsequently, who, out of hand (that is, without bothering to rigorously engage the data or the issues) rejected Lorber's research. To my knowledge, no one has ever been able to debunk his findings or been able to establish that, in some way, he was a scientific fraud of some kind or lacked the requisite technical competence to understand the technology he was employing or had a various times, demonstrated an inability to read and understand the data which was being generated through the technology being used in his research project.

Whatever one knows, or believes one knows, concerning the nature of thought or thinking, unless one can account for Lorber's findings, then, there might be something more deeply hidden than one supposes concerning the nature of mental functioning. Furthermore, if thinking is not functionally dependent on a form of energy which can be translated into terms -- such as joules -- then, we have no way of trying to measure the "work" that such a process involves and, consequently, under such circumstances, we really have no way of scientifically thinking about the nature of thought because whatever that dynamic might involve, that dynamic takes place on the other side of the horizons which mark the current – and, perhaps, for some time to come – the boundaries of scientific understanding.

Lorber's findings are scientific in nature. However, like the discovery of the muon which induced Isidor I. Rabi to exclaim: "Who ordered that?" (since no one had any idea – and still don't – what role the muon plays in quantum and particle physics, and, therefore, don't know why it exists), so too, scientists don't know what significance to assign to Lorber's work, and, as a result, those findings tend to haunt the epistemological shadows surrounding other kinds of scientific research concerning the brain and the mind.

Problems of obscurity that pervade issues of "work," "energy," as well as the measurement units, such as "joules," are not necessarily restricted to the Lorber research. For example, how would one calculate the amount of work or energy which is expended by dimensions such as "space" or "time," and can one necessarily assume that the foregoing sorts of dimensions are, in some sense, a function of energy, and, if they were entangled with some form of energy, can one necessarily assume that such energy is among the list of energies about which we have some degree of familiarity?

In thermodynamics, when energy is transferred from one location to another due to a differential in temperature between those two locations, the process of transfer is referred to as heat. Heat is not a form of energy, but, rather, it gives expression to the process through which energy is transferred from one place to another by means of a temperature difference between two locations.

The foregoing considerations establish a basis for distinguishing between the energy of work and the property of heat. Work involves the process or means through which atoms containing useable forms of energy (free energy) are corralled into moving in a collective fashion that can be transduced or harnessed which can effect certain kinds of changes, whereas heat serves as an indication that there are atoms which are present which – because of their state of energy -- cannot be drawn into the set of atoms whose energy states qualify them as being capable to give expression to work.

As such, work constitutes a form of ordered dynamics. Heat, on the other hand, is described as indicating the presence of a disordered form of dynamics.

The foregoing way of describing the two kinds of dynamics – ordered and disordered -- seems rather arbitrary and appears to reflect the interests of those who are trying to find forms of energy efficiency that will serve their purposes. Atoms which have an energy state that is not capable of being corralled or organized to do work are not being turned into disordered entities.

Those atoms give expression to the state of their order. Those atoms remain atoms with a particular energy signature in which electrons are limited with respect to what sorts of activities the electrons can engage under a given set of circumstances.

To be sure, in a given set of circumstances, the foregoing modality of order might be unable to participate in the process of work. Nonetheless, this state of affairs does not make those atoms disordered any more than someone with a dissident political orientation necessarily becomes disordered simply because they do not go along with mainstream political activities.

If heat serves as an index for the presence of atoms that are not part of the attractor basin formed by the dynamics of work-capable atoms, then, heat is just a reminder of, or index for, what happens when potential possibilities which are present in the ordered potential of certain kinds of energy systems become activated. Heat indicates that the ratio between atoms with useable energy states and atoms without such energy states is changing in a determinate fashion.

The dynamics of nature are ordered in character. As more atoms enter into a state in which they are not capable of contributing to certain kinds of dynamics, then, the capacity of such a system to be able to do work diminishes to some degree.

This is not disorder. It is all part of the ordered properties which characterize the dynamics of such energy systems.

From a thermodynamic perspective, work is defined as a process of energy transfer that is tied to the nature of the energy states of the atoms or particles which are present in a given context. If time and space are not a function of atomic or particulate motions, then, does this mean that energy transfer is not possible in relation to such dimensions, and, therefore, work is not possible, or might it mean that the transfer dynamics of energy and work assume very different modalities of operation in conjunction with those dimensions than is the case in systems consisting of atoms?

Does thermodynamics conflate the nature of dimensions with the phenomena which might take place in conjunction with those dimensions? Space and time might both be necessary for the dynamics which are encompassed by thermodynamic phenomena, but those dimensions might be like a form of staging on which the play of phenomena takes place.

If the foregoing scenario were the case, then although in certain ways the staging setting or dynamic might constrain certain aspects of the kind of play that can take place in conjunction with that staging, nonetheless, the staging is only the medium or media through which the play takes place. The phenomenal manifestations or components of the play are a function of other kinds of dynamics which cannot be reduced to what the dimensions of space and time contribute in the way of being the sort of affordances which lend support to the staging of the play of phenomena.

Is the 2.73° Kelvin of the Cosmic Background Radiation some sort of measure involving space? Or, does that temperature give expression to various kinds of dynamics which are among the degrees of freedom and constraints that the dimensions of space and time permit?

Are space and time like catalytic agents that have a capacity to facilitate certain kinds of phenomena without being altered in the process? How do space and time find their way into phenomena, or how do phenomena find their way into space and time?

What is energy? What is work? What is the relationship between the two?

Is energy only a function of its capacity to do work? In turn, can one justifiably claim that all forms of work necessarily possess an equivalency involving a capacity to raise a weight over a given distance in a certain amount of time?

Does a hermeneutical or conceptual understanding, worldview, paradigm, or idea which organizes energy usage constitute a form of work in a thermodynamic sense? If it does, then, what is the equivalency capacity of such a condition of understanding with respect to being able to raise a weight over a given distance in a certain amount of time?

Can one necessarily suppose that whatever calories are being consumed by a given brain state that might be correlated with the dynamics entailed by a given hermeneutical understanding or idea accurately reflect -- when converted into joules -- whatever forms of energy have made such an understanding or idea possible? How did the expenditure of a certain amount of calories or joules become transitioned into, or associated with, an idea or understanding of one kind or another?

What is the nature of the equivalency between, on the one hand, an idea or understanding, and, on the other hand, the alleged capacity of such an idea or understanding to raise some kind of a weight over some kind of a distance in a given amount of time? What if the form of energy which is part of the process through which ideas and understanding are generated does not have an equivalency with the kind of energy which can be measured by noting the sort of weight which can be raised through a certain distance in a given amount of time?

What if the sorts of dynamics which go on in the mind do not give expression to work that can be considered to be thermodynamic in nature? What if mind cannot be reduced to brain states?

The kinds of energy and work which are explored through thermodynamics are those which are amenable to a certain modality of measurement. Thermodynamics is a process of describing the degrees of freedom and constraints which characterize the ways in which specific kinds of energy can be measured in terms that map what happens to those forms of energy during the process of being transitioned into work.

However, the foregoing way of engaging the issue of energy and work frames those dynamics in terms that arbitrarily limits what counts as energy, work, and measurement. However, there might be a more expansive, less restrictive, and, perhaps, more heuristically valuable way of approaching such issues.

More specifically, but still in general terms, energy is the capacity to induce changes in states, properties, or dynamics. Similarly, in general terms, work is the process through which such changes take place.

We can't always measure the foregoing sorts of changes. Nonetheless, we often can recognize, or acknowledge, the presence of change and know that changes in states, properties, and/or dynamics suggests the presence of some sort of energy and means (or medium of work) which play significant roles in being able to effect, or help bring about, the changes which are being observed.

Thermodynamics was originally rooted in explorations directed toward trying to understand the nature of phenomena involving transformations in energy systems that were characterized by notions of heat and temperature differentials, as well as transitions involving useable and non-usable forms of energy as far as certain kinds of work are concerned. Nonetheless, such notions might not be characteristic of all forms of energy dynamics, and, if so, then, perhaps, thermodynamics is either going to have to expand its horizons to include new possibilities, or, thermodynamics must be seen for what it is: An arbitrary and limited, but heuristically valuable historical and technological framework for exploring what happens over time to various kinds of energy systems that are coupled with forms of work that can transduce the energy in those systems to effect changes that are amendable to particular methods of measurement.

Unfortunately, there appears to be an array of phenomena that might involve forms of energy – and, therefore, work -- which do not necessarily fit into the framework of thermodynamics as traditionally understood. In other words, there might be forms of dimensional dynamics which fall outside the purview of thermodynamics as currently understood.

For example, is consciousness a dimension of its own? Does it have its own kind of internal energy system?

Is intelligence a function of neural, synaptic, and electrical activity? Perhaps, intelligence might be a separate dimension which is transduced into a biological format through the activities of synapses, neurotransmitters, and electrical currents.

Is mental tiredness a form of friction in which, conceivably, the receiving-transducing properties of the brain might be experiencing some kind of resistance to whatever could be transpiring in consciousness? Perhaps, consciousness is one thing and the cognitive processing of consciousness involves a different kind of dynamic?

Maybe cognitive processing requires a form of energy which can be measured in joules, whereas the dimensionality of consciousness serves as an affordance which influences how that which is being processed can be processed. Although the term "unconscious" is used to refer to that which is beyond the capacity of the so-called conscious mind to understand, nonetheless, there is an awareness present in that which is allegedly unconscious – as exemplified in an earlier discussion in this book concerning the dynamics of "thin slicing" – which puts the so-called conscious mind to shame, and, consequently, there might be degrees of freedom and constraints which are present in the dimension of consciousness which enable it to either partition itself or become partitioned in conjunction with changing circumstances and conditions.

Dimensions of: Time, space, energy, consciousness, intelligence, life, and an assortment of other kinds of possible dimensions might be brought together in a multiplicity of interactive ways that give expression to the manifestations that, collectively, are referred to as the universe. The title of the aforementioned book by Peter Atkins – namely, *Four Laws That Drive the Universe* – makes a fairly bold claim given that we don't necessarily know what the nature of the universe is and what all of its degrees of freedom and constraints might be.

For hundreds of years, the tendency of many scientists has been to suppose that one can reduce the universe down to a set of material phenomena which play out their possibilities on the stage provided by time and space. Yet, the origins of such phenomena are obscure because, among other things, we don't know where the constants come from which shape much of what can, and can't, happen with material phenomena.

Are constants among the degrees of freedom and constraints to which some sort of dimension of materiality is giving expression? Do certain kinds of constants emerge when dimensions of time, space, energy, materiality, plus an unknown number of other dimensions come together in certain interactive ways?

Do the four laws of thermodynamics drive the universe as Peter Atkins claims? Or, alternatively, are the four laws of thermodynamics a function of the way in which certain dimensions (for example, space, time, and energy) interact with one another, and, therefore, thermodynamic laws give expression to special cases which are functionally dependent on something more fundamental than those laws – such as dimensional dynamics?

Is the universe open or closed? Or, is the universe open in some ways while closed in others?

Could the universe be open in more ways than the so-called laws of thermodynamics are capable of handling? Could there be unknown degrees of freedom and constraints which might be present in the universe which constitute a potential source of Black Swan events for thermodynamic considerations as traditionally understood?

Do the laws of thermodynamics only drive the universe when aspects of that universe are closed in certain ways – such as the ways which are explored in books like the one written by Peter Atkins? In other words, when considered from the traditional perspective of physics, then, if a certain set of conditions are present, then, various, established kinds of thermodynamic principles have the capacity to provide useful descriptive expressions for the physical and chemical degrees of freedom or constraints which govern those conditions, but if the dynamics of dimensionality involve forms of energy which cannot be measured through the methodologies of thermodynamics, then, what relevance does thermodynamics have to those forms of energy?

We don't know what, if any, the thermodynamics of space are. We don't know what, if any, the thermodynamics of time are.

We don't know what, if any, the thermodynamics of either consciousness or intelligence are. We do not know whether, or not, any forms of thermodynamics were involved in the emergence of space, time, consciousness, intelligence, as well as other kinds of qualitative non-spatial forms of dimensionality.

Thermodynamically, entropy refers to a way of differentiating between the kinds of energy which are present in a system. In other words, a system which is characterized by low entropy contains, relatively speaking, much more of a form of energy that is capable of being converted to work and much less of a form of energy which is not capable of being converted to work, while a system that is characterized by high entropy gives expression to a shift in the foregoing sort of relationship, as the quantities of a form of energy which is not capable of being converted into work increase more substantially relative to the simultaneous decrease in the quantity of the form of energy which is capable of being converted into work.

The focus of early explorations concerning thermodynamic properties (one of which involved the notion of entropy) had to do with the operation of steam engines or, as they were sometimes called, "heat engines." Reduced down to their basic components, a steam engine/heat engine consists of: A means for generating heat through high temperatures; a mechanism (in the form of a turbine, piston, or the like) which is capable of converting the energy associated with heat into a productive form of work, and a cold sink (e.g., the immediate environment surrounding the work-generating aspects of the steam engine) which collects, or absorbs, whatever energy (which, in part, is being transferred in the form of heat) that is not capable of being converted into usable work.

In an early part of the nineteenth century, a French engineer, Sadi Carnot, began to investigate whether there were limits concerning the efficiency with which steam engines could operate. He discovered that quite independently of the kind of materials used to generate temperatures in a steam engine, the efficiency of a steam engine was a function of the ratio between, on the one hand, usable energy, and, on the other hand, the energy that was unused and/or was lost to a cold sink.

His work indicated that the foregoing ratio could never be 1. In other words, there were natural limits to the efficiency with which any steam engine could operate.

Later during the eighteenth century, and quite independency from the research of Carnot, Britain's Lord Kelvin also began to think about the operation of steam engines and came to a conclusion which was similar to that of Carnot. More specifically, he stipulated that there wasn't any way in which steam engines could be used to generate high temperatures and, then, convert one hundred percent of that energy in to some form of work.

Both Carnot and Kelvin were, each in his own way, alluding to a principle which, eventually, would become the second law of thermodynamics. In Berlin, another 18th century researcher – namely, Rudolf Clausius – who also had an interest in thermodynamic issues maintained that energy had the tendency to flow from bodies of higher temperature to conditions of lower temperature, and this tendency seemed to be built into the way the universe worked and, as a result, gave expression to a spontaneous dynamic (a potential that, due to circumstances, is not always realized) which had a directional component to it.

In addition, Clausius indicated that if the foregoing spontaneous directionality of the dynamics system were to be countered, then, energy would be necessary to generate a form of work which was capable of resisting or reversing such a tendency. This was another allusion to what would become the second law of thermodynamics.

Many individuals seem to believe that an inherent property of entropy involves a property of disorder. However, there would seem to be more than a tiny element of willful blindness associated with such an interpretation of the notion of entropy.

Entropy gives expression to a determinate ratio between usable and non-usable or discarded energy. Entropy gives expression to a spontaneous tendency of physical systems that can be resisted or reversed only through the introduction of some form of energy which is capable of doing work. Entropy gives expression to the directionality that is present in the way systems develop over time. Entropy gives expression to determinate limits concerning the efficiency with which certain kinds of systems of energy can operate.

Nonetheless, there doesn't appear to be any form of disorder present in any of the foregoing considerations. Everything about entropy appears to indicate there is an order to the manner in which systems of energy unfold over time, including with respect to whatever energy might be lost, in whatever way, during the dynamics of unfolding.

Let's consider a relatively concrete issue. For example, supposedly, the way in which energy as well as atoms or molecules are distributed in a gas constitutes a disorderly arrangement.

Yet, the energy and atoms or molecules which are present in a gas, together with the way in which those components are distributed as the gas interacts with its surroundings, respond in determinate ways involving pressure, temperature, processes of diffusion, conditions of equilibrium, and so on.

Statistical mechanics works because it provides a method for showing how ordered processes within a gas are capable of being assembled into a snap-shot that captures some of the dynamic properties of such a system. If the behavior of gases were truly random in nature, there would be nothing in the dynamics of such a system which statistical mechanics could average or mathematically treat in any meaningful way that would give expression to a determinate-like characterization of the behavioral tendencies of such a system since random systems have no predictable tendencies or properties.

The dynamics of atoms or molecules within a gas are not random in nature but are a function of the limited number of energy states which are possible for the atoms and molecules of gas in a given context of temperature and pressure. We might not know where any given atom or molecule is within such a system, but we know enough about the system that heuristically valuable projections can be made concerning some of the tendencies which can be assigned approximate, but determinate, non-random values.

Changes in the entropy of a given system have nothing to do with disorder. Rather, entropy has to do with changes in ratio between energy which is available for work and energy which is unavailable for work.

When entropy is low, then, the quantity of usable energy relative to unusable energy is high. When entropy is high, the quantity of usable energy relative to unusable energy is low.

Being unavailable for work does not make such energy disordered. Such energy is not available for work because the states which give expression to it are out of phase with usable forms of energy and, as a result, the former kind of energy (i.e., the unusable or unavailable kind) tends to serve as a modality of resistance to forming the dynamics of, or the flow within, the attractor basins that shape or fuel the work which is being done through a given system of energy.

To modulate an energy system through a process in which the loss of energy, in a usable or available form, alters the manner in which such a system operates, or to impose limits on the way such a system functions, or to influence the manner in which energy flows through a given system, or to give expression to a form of inertial presence which affects what can and can't be done in a given system of energy is not a manifestation of disorder … instead, the property of entropy is an expression of one of the forces or factors that shape the determinate way in which the nature of a system changes over time and under certain circumstances.

Irrespective of whether, or not, the entropy of a system goes up or down, the system remains ordered from beginning to end. The degree to which entropy is present in such a system is an integral part of that order.

When the entropy of a system is high, this will be reflected in the quantity and quality of energy states that give expression to the Boltzmann distribution for a system that is consonant with the condition of entropy since the latter notion gives expression to the degree to which certain kinds of energy states are present that are unavailable or unusable in a given set of circumstances. When the entropy of a system is low, then, this too will be reflected in the quantity and quality of energy states which are present in the Boltzmann distribution for that system and are consonant with a system which is capable of generating work.

Disorder does not play any role in the foregoing dynamics. Rather, the dynamics of a given system are an expression of the way in which the Boltzmann distribution changes over time and across conditions

Work gives expression to one set of Boltzmann distribution dynamics concerning the quantity and quality of the energy states which are present at a given time. Entropy gives expression to another set of Boltzmann distribution dynamics concerning the quantity and quality of the energy states that are present at a given time.

What is happening to the energy states of individual atoms and molecules at any given instance is unknown. What is happening to the energy system as a whole often can be calculated based on what is known about the collective properties of a given system.

For a variety of reasons – some of them ideological, entropy has been made into a mysterious form of disorder. However, entropy is neither mysterious nor an agent of disorder but, is, instead a spontaneous potential, with determinate properties, that is inherent in many kinds of systems of energy and is activated under an array of circumstances.

Max Planck had written his doctoral dissertation on the issue of entropy and the second law of thermodynamics. The constant which bears his name emerged out of his preoccupation with entropy and the second law of thermodynamics.

While, over time, his ideas concerning entropy went through a number of revisions and reformulations, beneath all of those conceptual transitions was not only a general conviction (which he shared with Einstein) that the nature of reality was absolute and determinate in nature, but, as well, he also was dedicated to the particular idea that entropy had a fundamental role to play in whatever the absolute, determinate nature of reality might turn out to be. Although I approach the topic of entropy in my own manner, I agree with Planck's sense of things that entropy is giving expression to something very fundamental concerning the nature of the physical universe.

Initially, Planck had disagreed with Boltzmann's ideas concerning the existence of atoms which the latter individual used as a theoretical basis for developing a mathematical way to describe the behavior or kinetics of gases. Among other things, Planck felt that Boltzmann's ideas concerning the possibility of atoms seemed inconsistent with the notion of continuous functions which had been used to describe physical phenomena since the time of Newton when calculus had been introduced as a way of solving various kinds of mathematical problems.

However, Planck also disliked Boltzmann's probabilistic method of describing the behavior of gases. Planck believed that reality was not a function of probabilities.

After a time, Planck was able to reconcile himself with probability as a practical, methodology mathematical means through which to be able to characterize and describe different facets of the macroscopic properties of gas behavior. However, he continued to reject the notion that reality or ontology was, somehow, probabilistic in nature.

At one point during his critical reflections concerning the nature of thermodynamics and entropy, Planck did advance a concept which he referred to as the 'principle of elementary disorder.' What ontological ramifications, if any, the aforementioned principle carried with respect to Planck's earlier commitment to a belief in the absolute, determinate nature of reality as well as the fundamental character of entropy is not clear?

Conceivably, the notion of 'disorder' which is present in the foregoing principle might have been more of an epistemologically and methodologically oriented notion which reflected certain aspects of Boltzmann's probabilistic approach to describing gas kinetics than it was a comment concerning the nature of ontology. However, whatever the ultimate import which the idea of elementary disorder might have held for Planck, while I share his belief that entropy gives expression to a fundamental aspect of physical dynamics, nonetheless, for me, disorder plays no role – either epistemologically or ontologically – in the phenomenon of entropy because, as discussed previously, entropy is part of the ordered nature which characterizes how systems of energy evolve over time.

Chapter 6: Informational Boundaries

From an early age, Claude Shannon was interested in various aspects of communication, including cryptography. For instance, as a youth, one of his favorite stories was Poe's work, *The Gold-Bug*, in which cryptanalysis played a key role, and when he was a youngster, he liked solving puzzles that involved encryption of some kind.

As a 17-year old, he earned his first publication credit. This credit was in recognition of his having solved a puzzle which appeared in an edition of the *American Mathematical Monthly*, and a few years later he earned another credit in the magazine for providing a solution to a new puzzle.

In addition, Shannon, like millions of other individuals in various localities which were not well-served by telephone services in the 1920s, had devised a system of communication involving wire fences, electricity, batteries, and other pieces of equipment that enabled people to make contact with one another across distances that, otherwise, might have prevented communication from taking place at all. When he was a boy scout, another facet of his interest in issues involving communication was manifested in the form of a first prize for exhibiting considerable competency with respect to being able to use a flag for transmitting messages in Morse code (a process known as wig-wag) faster than anyone else at the regional gathering.

While growing up in Gaylord, Michigan, he also gained a reputation for being able to fix radios – another dimension of communication. Apparently, many a radio that, for one reason or another, became dysfunctional in the town where he lived found their way into his hands where they were restored to working status.

While Shannon was very good in mathematics and was able to complete his high school education in three years, he was not necessarily the best all around student. With respect to the subjects in which he was interested, he did very well, but other subjects that did not capture his interest resulted in less stellar grades.

In 1932, Shannon began his studies at the University of Michigan in Ann Arbor. He enrolled in a double major program involving mathematics and engineering because he wasn't sure what he wanted to do later in life.

Among his courses were some that delved into issues involving communication engineering. This sort of topic appealed to him because of the way in which it brought practical issues and mathematics together.

A few years later, Shannon applied for a position in a master's program that was being given at the Massachusetts Institute of Technology. The program revolved about working with a differential analyzer – that is, an electromechanical analog device for solving differential equations.

The differential analyzer provided an electromechanical means for taking a variety of variables that impacted a given phenomenon -- such as the stability, and vulnerability, of power grids, or how a set of interacting forces would influence tides, or how electrons might scatter in an atom subjected to certain kinds of forces – and, then (through a combination of trial and error, intuition, and creativity), generating some sort of an analog process (involving shafts, wheels, and discs that rotated) which were capable of mimicking the mathematical process of differentiation that could be used to make useful calculations concerning complicated, dynamic, multifaceted conditions. Shannon was selected to oversee certain aspects of the foregoing process of setting up the electromechanical analogue device to be able to solve problems consisting of many variables – something that would prove to be very difficult, time-consuming and tedious to accomplish if those calculations were done by hand, with pencil and paper.

However, each new problem required the analog device to be taken apart and put together again to provide a way of translating mathematical issues into electromechanical, analog terms that conformed to the characteristics of the problem one was trying to solve. The manner in which components in the analog device were assembled had to be capable of reflecting or preserving the properties of the real-world characteristics which were inherent in whatever situation was being addressed.

Vannevar Bush, who was largely responsible for the presence of the differential analyzer at MIT, had approved Shannon's application to join the work being done in conjunction with the differential analyzer. Bush had long-dreamed about the possibility of being able to develop a device which could solve an array of problems without having to be taken apart and put back together again in order to be able to provide a process which would be capable of resolving the mathematical peculiarities that might be present in a given kind of physical problem, and, although he recognized the talent and capabilities which Shannon possessed – which was the reason why the kid from Michigan had been selected in the first place -- Bush had no idea that the young person he was hiring would play a crucial role in helping to bring Bush's notion of a generalized computing machine to fruition.

As Shannon sought to discover ways to organize an array of switching boxes to provide an analog device with the format or logic it needed to translate real-world physical problems into a format that would mimic the manner in which a human calculator might set up a problem or series of problems in a the language of differential equations, Shannon began to think about approaching those issues from another direction. More specifically, having taken a course in Boolean logic as an undergraduate, he began to sense that there might be a way to turn the switching operations for that kind of logic into a set of mathematical statements which would be capable of describing, or giving expression to, various arrangements of circuitry that could be used to represent or characterize certain kinds of real-world problems.

In the beginning, the possible relationships among mathematics, logic, and circuitry design were elusive. At some point, however, he began to realize that the operations of Boolean logic could be translated into a set of serial and parallel electrical circuits which could be opened and closed in ways which reflected the logic of a set of mathematical statements and that both sides of such a relationship could be given expression through sequences of 0's and 1's.

In 1937, after spending a summer at Bell Laboratories in New York learning about networks, he completed his master's thesis. It was entitled: "*A Symbolic Analysis of Relay and Switching Circuits*."

His thesis demonstrated how any electrical circuit could be described through a set of mathematical equations. In addition, his academic project showed how a calculus could be developed that, essentially, was algebraic in nature but which had properties that were homologous to processes that were present in certain forms of symbolic logic as "And," "Or" and "Not" operations.

The logical operations that are present in the symbolism being alluded to in the foregoing paragraph could be used to derive electrical circuits which could realize, in real-world terms, the mathematical structures that were entailed by that logical symbolism. Circuit design would no longer be a matter of trial and error or creative intuitions which could not be controlled but, instead, electrical circuitry design could be effectively developed through modalities of logic that could give expression to mathematical equations in symbolic forms that could be reduced to 0's and1's.

Networks containing the foregoing sorts of circuits could be used to represent very complex sets of relationships. Within a decade, Shannon's breakthrough – along with the work of Turing, von Neumann, and a few others – provided the insights which led to the differential analog analyzer becoming a relic of the past.

With his master's thesis completed, Shannon entered a doctoral program. In the process he went from the landmark work of his master's thesis at MIT and Bell Labs to a largely forgettable foray into genetics undertaken while spending time at the Cold Spring Harbor facility in New York.

Unlike his master's work which was rooted in Shannon's considerable experience with, and insight into, issues involving mathematics, engineering, analog devices, circuitry, and logic, his doctoral work on genetics was like being a stranger in a strange land. He had to learn a completely new field, and, while this only took him a year to accomplish, what emerged from those studies appeared, with a few exceptions, fairly pedestrian.

Shannon attempted to develop a calculus, of sorts, for genetics, just as he had done previously for electrical circuitry. Unfortunately, at the time he conducted his research, not only was too little known about genetics, DNA, and molecular biology to be able to provide Shannon with the sort of informed context that he needed to develop a form of algebraic genetics which might give expression to fundamental themes, but, in addition, his method for trying to codify genetics and evolution in a way that was capable of generating meaningful results required too much specific information and, as a result, a person would have considerable difficulty being able to distinguish patterns in the genetic forest amidst the distracting multiplicity of data which genetic interactions tended to generate over time in any given population.

In a sense, there was too much apparent noise in the genetic data which Shannon was trying to abstract into some sort of algebraic form of representation. Consequently, although he did enough to earn his doctorate, he was never able to come up with a reliable way for being able to identify useful genetic signals or patterns amidst the aforementioned noise of data in a manner that would constitute a heuristically valuable contribution to genetics.

He did create a complicated mathematical formulation for being able to keep track of the frequencies for any given set of three alleles over a series of generations. As a result, he could demonstrate how certain aspects of a population might developmentally unfold over a period of time, and, therefore, understanding the nature of such development might be able to help to predict certain trends in genetic dynamics, but this insight seemed limited in scope and, in a way, the algebraic genetics he had created appeared to resonate with the degree of difficulty which is said to be involved in trying to solve various equations in Einstein’s general theory of relativity.

Shannon was satisfied with what he had been able to accomplish, and there were others who were intrigued by what he had done in his doctoral research. However, given that no one subsequently tried to build on what Shannon had established through that research and given that Shannon, himself, never returned to his doctoral work, then, one might suppose that although what he had been able to do in such a short period of time was rather impressive, nonetheless, the long-term value of that work appeared to be of a fairly limited nature.

Vannevar Bush is the individual who had pushed Shannon to go in a radically different direction in conjunction with the latter’s doctoral research because Bush believed that becoming too specialized served to undermine the full potential of genius – a potential which Bush was convinced that Shannon possessed. Of course, what might have occurred if Shannon had been permitted to follow a research path for his doctoral thesis in which he actually was interested merely gives expression to the conjectural speculations of counterfactual thinking, but on the positive side of things, Shannon only lost a couple of years of temporal opportunities during the process of researching and writing his doctorate.

However, one interesting possibility that is present in connection with the foregoing considerations concerns a note that Shannon wrote to Bush while the young man was working toward finishing his doctoral research. The note indicated that Shannon had been thinking about how one might go about developing communication systems capable of producing reliable forms of signal transmission.

Nonetheless, Shannon's focused investigation into the properties, problems, and possibilities that pervaded the transmission of signals would have to wait. Before his breakthrough work concerning signal transmission emerged, he would become engaged in a variety of activities that each, in its own way, might have helped to induce Shannon to begin thinking more, and in different ways, about various facets of message transmission.

In 1940, Shannon returned to Bell Laboratories for a second summer. One of the problems on which he worked involved a mathematical problem that sought to determine what the least number of colors were that would need to be assigned to wires connected to an array of relays, switches, and devices of one kind or another so that the logical character of that network could be identified and mapped through such a coloring process.

Another problem on which he worked during that summer had to do with whether, or not, there was a way to improve Bell's current method for networking systems of relays. The solutions which Shannon generated for the problem drew on certain aspects of his master's thesis that had established links among algebra, Boolean logic, and electrical circuitry.

Following his brief summer stint at Bell Labs, Shannon was invited to join the Institute for Advanced Study which is associated with Princeton University. He had the opportunity to interact with individuals such as, among others, Hermann Weyl (a mathematician who was interested in symmetry, general relativity, quantum physics, as well as philosophy) and John von Neumann, a mathematical prodigy from Hungary who: Developed much of game theory, rooted quantum physics in a rigorous mathematical framework, and played a foundational role in helping to conceptually envision many facets of the structural features which would heavily influence the character of the architectural platforms that were used in early, and subsequent, editions of modern computers.

During his time at the Advanced Institute, Shannon had begun to see a parallel, of sorts, between some of the problems with which quantum mechanics was confronted and some of the difficulties which were plaguing various aspects of communication theory. As a result, he reflected on how both quantum physics and communication theory might be approached through stochastic forms of analysis which could be used to engage systems that appeared to be random-like in appearance but which could be treated effectively through probability models of one kind or another that were able to mathematically organize and constructively engage whatever currents of determinate order which might be present in those sorts of systems.

While at the Advanced Institute, the Selective Service was signed into law by Roosevelt. For a variety of reasons, Shannon was resistant to the idea of the draft, not the least of which was the anxiety he experienced when faced with the prospect of being forced into continued close contact with other people.

Shannon approached Thornton Fry, who had been a mentor of Shannon's when the latter individuals worked at Bell Labs, to see if there might be an alternative way of resolving Shannon's Selective Service concerns. Fry arranged for Shannon to work with the National Defense Research Committee as a mathematical analyst.

At the NDRC, Shannon was assigned to a group that was investigating various problems associated with fire control. Fire control entailed trying to figure out rapid, automated solutions for hitting targets which moved through the air at various speeds.

There were points of connectivity between the problem of trying to hit a target moving through the air and various aspects of communication engineering. For example, in the case of fire control, the problem was to try to accurately establish what the most likely point in time and space might be that a given target could be found, whereas in the case of communication, the problem would be to try to figure out what the most likely content of a message might be when the signal or message was embedded in a context of noise that obscured, interfered with, or degraded various facets of such communication.

Both sets of the foregoing problems were ones of intelligence. How could one use what one knew about a given issue to work out the most probable solution to a complex problem involving a variety of variables?

Shannon contributed to the fire control problem in significant ways. As a result, when his contract with the NDRC expired, his previous mentor, Thornton Fry, hired Shannon to engage in so-called mathematical research at Bell Labs, but, in reality, that research was code for finding ways to calculate solutions for an array of pragmatically oriented war-time problems.

That sort of research was not an exploration into the nature and foundations of mathematics. Rather, such research involved discovering ways to leverage the computational potentials which were present in various aspects of mathematics and apply them to matters of warfare.

While working at Bell Labs during the 1940s, Shannon spent much of his time on the issue of cryptography. One of his primary tasks was to determine that certain algorithms would be able to ensure that some form of intelligence, signal, data, or message could be reliably reconstructed when received, and this sort of work, along with other kinds of research he did in conjunction with cryptography would contribute to helping to lay the foundations out of which his subsequent theory of information would emerge.

Since approximately the mid-point of the nineteenth century, human beings had been trying to develop ways of quickly communicating with one another. One of the first efforts in this respect was the transatlantic telegraph cable which, for nearly a month, enabled mostly garbled messages to be sent in very sporadic fashion between North America and Europe.

One of problems with the foregoing sorts of efforts is that noise would often overwhelm whatever message might be present. For example, because of salt water's capacity to conduct electricity, any message which was sent through an underwater oceanic cable tended to would lose transmission integrity due to the way in which electricity would be lost to the watery environment and, therefore, not be available for maintaining the integrity of the message being sent.

The greater the distance over which a message was transmitted, the more opportunities there were for noise -- in the form of static or interference that had penetrated the insulation which was in use -- to be able to garble whatever signal was present. However, in addition to interference or static as sources of noise, the nature of the signal itself had to be taken into account as well because some kinds of messages or signal forms – having to do with, for example, the structural nature of a given content – were more vulnerable to noise than were other kinds of forms of messages and signals.

In the 1920s, a young Swedish immigrant to America by the name of Harry Nyquist advanced some heuristically valuable ideas concerning the transmission of signals or messages. For example, on the one hand, Nyquist indicated that there was an upper limit on the quantity of intelligence – that is, the letters, characters, or figures – which could be transmitted through a given channel of communication at a given speed, while, on the other hand, he maintained that the speed with which such intelligence could be transmitted depended on the number of discrete signals or current values which were used in any given transmission, and, therefore, the greater the density of the "intelligence" being transmitted through each signal, the more quickly such a transmission would take place.

For a decade, or more, Shannon used Nyquist's notion of intelligence to describe various aspects of communication. However, when, ten years of reflection, Shannon was ready to present his breakthrough ideas concerning the preservation of communication integrity, Shannon had switched over to a term that was used by Ralph Hartley who had had a deep influence on the way in which Shannon thought about issues of communication – that term, was "information," and for Hartley, as for Shannon, meaning was irrelevant to the nature of information.

The fact that Shannon had removed the notion of meaning from the dynamics of transmitting a message is a key to understanding what Shannon actually accomplished when he wrote his 70+ page 1948 paper entitled: "A Mathematical Theory of Communication." Many individuals claimed that Shannon ushered in the Information Age, but many people came to understand the notion of "information" differently from what Shannon had envisioned.

For instance, at one point during the late1940s and early 1950s, there had been a certain amount of controversy which arose with respect to being able to identify who might have intellectual priority with respect to having ushered in the "Information Age" – namely, Claude Shannon, by virtue of his 1948 paper on communication, or Norbert Wiener as a result of his 1948 book: *Cybernetics: Or Control and Communication In the Animal and Machine*.

Both of the foregoing works, each in its own way, spoke about information. Nonetheless, based on conversations which Shannon subsequently had with Wiener – with whom the former individual had taken a course when a graduate student at MIT – Shannon was of the opinion that either Wiener had never read Shannon's 1948 paper or if Wiener had read that paper, then, apparently, the latter individual had not understood what had been written because Wiener wanted to bring meaning into the conversation, while Shannon was adamant that the topic of meaning had no role to play in the communication process.

Because terms such as: 'Communication', 'message', 'information', 'signal', 'uncertainty', and 'learning' form important parts of Shannon's lexicon, many individuals have concluded that Shannon's perspective has ramifications beyond where Shannon actually wanted to take people. For Shannon, communication is, from beginning to end, a problem in engineering which revolves about the nature and dynamics of transmission.

According to Shannon, communication – or the transmission of a signal or message – involved six components. These were: (1) The information which constitutes a message; (2) a transmitter process that is capable of encoding the information which is to be sent; (3) a channel that serves as the means through which encoded information is to be transmitted; (4) the extent to which noise is present, and noise gives expression to forms of distortion and degradation with respect to whatever information is being sent; (5) a receiver that has the capacity to decode what has been encoded by the transmitter, and (6) the terminal or destination point to which an encoded message is being sent.

Let's consider a particular message: "Mary had a little lamb." Shannon wouldn't be preoccupied with what someone meant by this sentence – that is, whether, or not, someone meant that: Mary currently possessed a lamb which was little; or, that Mary had once had a little lamb but no longer possessed such a creature; or, that Mary had eaten a little lamb (cooked or uncooked); or, that Mary had, as a result of some sort of experiment in genetic modification, given birth to a little lamb; or, that Mary had given birth to a baby, and the baby was "a little lamb" (i.e., sweet, gentle, cute).

Shannon would not be concerned with what the sender meant by such a message. Nor, would he be concerned with whether, or not, the recipient of the foregoing message understood what the source of the message had intended.

Communication was about the process of transmission. Once one had information, that information had to be encoded in a manner which could be sent through a particular kind of channel that would not be distorted by, or overwhelmed as a result of, the nature of the ratio of noise to signal that might be present so that, at an appropriate point in the transmission process, the encoded message could be decoded and deposited at some terminal point to which the information was being transmitted.

For Shannon, communication is a function of: Messages understood as a measurable form of information; coding; transmission speed; efficiency; redundancy; channel capacity; noise, decoding, and reception. Meaning doesn't enter the process, and, therefore, when someone interprets the notion of information and the rest of the dynamics of communication as if the process were about meaning – as many people have been inclined to do – then, one begins to enter murky, troubling waters.

Shannon's mathematical theory of communication is a feat of engineering. His theory is about the development of a methodological approach for dealing with problems surrounding the problems of transmitting source information in the form of encoded packets to a given destination.

His perspective gives expression to a form of technology. It is not a technique for addressing, quantifying, or resolving all manner of ontological and/or epistemological issues.

The bit is a binary measure for encoding choices or probabilities concerning whether a given feature, characteristic, data point is: On or off; present or absent; opened or closed; a 'yes' or a 'no, a 0 or 1. A bit can't tell one whether a given something is: True or false, right or wrong, real or unreal; essential or unessential.

Bits are merely an arbitrary way of parsing phenomena and experiential data in the form of possibilities which are described as giving expression to binary options or choices. The packets of choice/probability which are encapsulated by a bit can be strung together in ways that give expression to an informational collective which structures and orients the morphology of a given kind of network or system of choices/probabilities, but whether, or not, that sort of a morphological arrangement which is giving expression to a network of bits of information is actually capable of reflecting the nature of reality is a separate matter.

As previously indicated, for Shannon, communication is about technological methodology. What is being communicated might, or might not, have much to do with the nature of reality.

As an engineer and mathematician, Shannon was searching for a unified way or technical method for grasping the process or dynamics of communication. The two theorems which he put forth in his 1948 paper concerning: "A Mathematical Theory of Communication" involved (a) channel capacity and (b) the issue of noise.

More specifically, in the foregoing paper, he proposed – and proved mathematically – that any channel of communication has a ceiling capacity with respect to what that sort of a channel could handle as measured in bits of digital, choice/probabilistic packets, and once that ceiling had been breached, then, the technology of communication or transmission dynamics would become vulnerable to different forms of dysfunctional possibilities. In addition, during his 1948 paper, Shannon demonstrated how – in principle -- there were methods of encoding information which would allow one to counter noise through a process of absorption and dissipation in which the coding process served like baffles in conjunction with whatever noise was present.

Shannon had established a mathematical basis for streaming information between any two points of 'source' and 'destination' in the form of parsed, sliced, encoded, or selected packets of digital: Text, images, sound, and videos. However, the precise character of the coding process needed to accomplish what Shannon had shown, in principle, was possible would require a separate set of technological accomplishments.

What Shannon had established mathematically also had ramifications for both engineers and the rest of humanity. As engineers ran with Shannon's accomplishment and came up with methods of coding that were capable of functionally underwriting the transmission of different modalities of informational bit-packets (in Shannon's sense) those forms of coding began to shape an array of technological, economic, financial, political, consumer, educational, medical, military, security, scientific, and cultural landscapes which, in turn, began to shape the human beings that were inhabiting those landscapes.

Establishing methodological protocols -- as Shannon did, not just once but twice (his master's thesis plus his 1948 paper) -- that could unify many aspects of engineering might also be the sort of technological breakthrough which could be leveraged to impose conditions of conformity and compliance on people. Acquiring technological capabilities which are rooted in a set of mathematical considerations that enable engineers to quantify and measure information for purposes of determining channel capacities with respect to the transmission of encoded, digital packets of probability with noise to signal ratios that can be completely controlled might serve the interests of engineers, but those sorts of capabilities don't necessarily serve the best interests of non-engineers.

Whatever the differences might have been with respect to how Shannon and Wiener understood the notion of information, their perspectives were capable of being synergistically connected and not necessarily in ways that would be in the best interests of humanity. Wiener was talking about cybernetic systems of control in animals and machines, while Shannon was talking about how to transmit information – including cybernetic messages that could be translated into transmissible packets – that could be sent from someone who desired control to someone who would be the target of such control.

Technocracy is functionally dependent on technologies of control which can be used to order society in one way rather than another. Without having any intention to do so, Shannon and Wiener had created tools that could be used synergistically in conjunction with one another by unscrupulous people who were interested in grooming human beings with respect to the ways of – among other things – technocracy … an exercise in social and behavioral engineering which has been going on for more than 75 years.

To borrow -- with a certain amount of alteration -- from another context, the wheels of technology grind slowly, but they grind exceedingly fine. Information, no matter how it is parsed, has a potential which transcends whatever its initial uses might be.

However, showing that something could be done is not necessarily equivalent to showing that something should be done. Whether one ought to possess the kind of technical capacity which can create tipping points that are able to move society in different directions at the discretion of self-serving entities such as corporations, governments, banks, intelligence agencies, military forces, research institutes, and ideologues – all of whom claim, despite a dearth of any persuasive form of proof, that they know what is best for society – is a moral issue, not an engineering problem, but, unfortunately, many engineers are individuals who believe that the better strategy for enabling them to do whatever they like -- if such a consideration even crosses their hearts and minds – is to ask for forgiveness rather than to seek permission.

Shannon's notion of information – devoid as it is of meaning – constituted a mathematically sound, functionally efficient, and heuristically valuable form of technological methodology. Nonetheless, the basic unit of measurement for information – the bit – gives expression to a characterization of a situation which in many ways is entirely arbitrary because apart from the task of assigning a choice/probability value to a given digital packet that is being used to transmit a message encoded in the form of such packets of probabilistic information, the basic unit of information can't reveal anything of value concerning the propriety of the nature of the relation of the network or system in which such a bit is ensconced with the surrounding ecosystem (consisting of everything other than the network or system to which the bit belongs) in which that bit-dependent network resides.

The 'bit' is an arbitrary and limited form of information measurement because it is entirely the function of a system that is dedicated to the transmission of a specific type of encoded probability packet from a source point to a point of destination. For purposes of transmission, any form of text, image, video, or sound can be translated into a set of probabilistic packets, but such a measure tells one nothing of a reliable nature about the value, significance, or relevance of what is being transmitted with respect to either the nature of reality or whether what is being transmitted is in the best interests of: The sender, the, receiver, or any other human being or organism which might be affected by such a transmission.

One can use a set of bits to represent any form any kind of network or system one likes. However, the choices and probabilities to which such a set of bits gives expression is not necessarily a reflection of the actual properties of reality but might only be a reflection of the nature of the sort of probabilistic framework which one is seeking to impose on people or which one is trying to induce other people to use as a lens or filter through which to engage phenomena.

Information in Shannon's sense is a method for parsing phenomena, events, dynamics, issues, ideas, behavior, and values into encoded, digital packets that are amendable to being transmitted or communicated from one point to another. As such, information in Shannon's sense is a process of framing and packaging something that, on the one hand, provides a quantitative way for resolving an array of technical problems in engineering, but, on the other hand, that methodology will also impact – often in unpredictable ways -- the manner in which people will be transformed through the use of such a methodology.

According to Shannon, information is a measure of freedom of choice and, in addition, he maintains that what makes the information in messages interesting is that choices are made in conjunction with an array of other possibilities. In other words, in order to send a message, one must be able to select relevant symbols from a pool of possible candidates, and in the act of choosing certain symbols, one automatically de-selects alternative possibilities.

Since, for Shannon, meaning plays no role in the process of communication, the notion of having freedom of choice has to be understood appropriately. Whatever freedom one has in such a process is entirely limited to the process of transmission dynamics.

Consequently, there is no modality of existential freedom which is present in such a context other than that which has to do with the technical requirements of transmission. However, if someone, in passing, were to hear that the notion of "information" is about freedom of choice yet failed to understand the nature of the original context which governed the manner in which that freedom is tied to a particular technical issue, then, one can imagine how the idea of 'information' could be stretched and broadened to include possibilities that are not actually part of the original conceptual context.

Shannon also contends that a crucial dimension of information is its probabilistic nature. As such, the amount of information that is present in the basic unit of measurement -- namely, the bit -- is a function of a choice between two, allegedly, equally likely options.

From Shannon's perspective, the significance of a bit is not a matter of what follows from the choice to which a bit of information gives expression, but, rather, what is important has to do with the number of choices out of which such a bit emerges, together with the probability or odds associated that a particular choice is being made in a given set of transmission circumstances. Nonetheless, the foregoing sorts of probabilities do not constitute a system for generating epistemological description concerning the nature of reality but are entirely about the decisions or choices which are made in conjunction with a given process of transmission, and, as such, there is an element of arbitrariness present in those probabilities because they are about choices that are being imposed on a transmission process rather than a discovery concerning the nature of some inherent dimension of reality independent of that sort of transmission process.

Shannon also indicates that information measures the uncertainty which can be removed from a given set of circumstances. Another way of stating the same thing is to maintain that information measures the chances of learning something that is new because, presumably, when new learning enters the picture, then, this might modulate whatever uncertainty is present.

Whatever uncertainty is overcome or reduced in Shannon's notion of 'information' is entirely about the dynamics of the transmission process. Whatever learning takes place is a function of that same transmission process.

To the casual observer, tying information to the removal of uncertainty and to the acquisition of new learning sounds as if it has an intriguing sort of epistemological potential. Such possibilities, however, do not extend beyond whatever uncertainty is removed or whatever new learning takes place as a result of resolving any technical problems which might be connected to communication understood as a process of transmission dynamics.

According to Shannon, whenever perfect certainty exists, there is no information which is present. If we set aside the issue of whether, or not, any claim of perfect certainty is something more than a claim, then, Shannon's perspective would seem to indicate that information has nothing to do with truth, and, indeed, such a possibility would be consistent with Shannon's insistence that meaning plays no role in information.

If meaning -- and, therefore, truth -- has nothing to do with information, then, one might ask what the nature is of that about which one could have perfect certainty in such circumstances. In this respect, Shannon claims that transmissions which are rooted in a context that gives expression to the widest range of possible symbols that are associated with the "fairest" odds and which are capable of reducing uncertainty to the greatest extent are considered by him to be the richest in information.

What are the criteria for determining what constitutes the 'fairest' odds in a given context, and what are the criteria for determining what reduces uncertainty to the greatest degree in such a context? Information which gives expression to the sorts of choices/probabilities for resolving the uncertainty concerning a given context of transmission is likely to entail the fairest odds, but if this is the case, then, the notions of: 'Fairest' probabilities, resolution of uncertainties, and 'richest' information are nothing more than a function of choices for resolving technical problems concerning an instance of transmission, and, as a result, considerations involving the resolution of uncertainty, fairest probabilities, or informational richness do not appear to have any wider application than to matters involving the transmission of messages.

As such, information is the method one uses to work toward a condition of acquiring perfect certainty concerning a given issue of transmission. In a sense, certainty concerning the foregoing sort of situation is what occurs when information fulfills its technological function, and in those situations in which certainty is not present, then, there are still questions about what is the best way to reduce uncertainties in such a set of circumstances as well as questions about what the fairest odds might be concerning the possibility of removing or overcoming such uncertainties and, therefore, be able to give expression to the richest kind of information.

In the book: *A Mind at Play: How Claude Shannon Invented the Information Age* by Jimmy Soni and Rob Goodman, the authors offer an example concerning a situation which supposedly provides an illustration of perfect certainty in which there is little, or no, information present. The example concerns the question, or one very like it, which is asked of witnesses in court trials – namely, "Do you swear to tell the truth, the whole truth, and nothing but the truth."

According to the aforementioned authors, only one answer is possible. Consequently, the answer – which, presumably, is "Yes," or "I will," or "I do," – gives expression to no new information and was entirely predictable – that is, we have perfect certainty concerning the answer.

Actually, we don't necessarily have perfect certainty concerning the precise nature of the answer that will be given by a given witness. There are three possibilities cited in the foregoing paragraph, and to those three possibilities, one might add: "Of course," or, maybe, the witness is mute and uses sign language as a response, or, maybe, the individual invokes the 5th, and, consequently, while we might have a good idea of what the general nature of a witnesses answer will be to the foregoing question, nonetheless, there is nothing like perfect certainty concerning what might said or indicated.

What if a person resents having been subpoenaed and, as a result, refuses to answer the question? Perhaps such an individual would rather risk being cited for contempt than being forced to testify.

Furthermore, what does it even mean to: 'tell the truth, the whole truth, and nothing but the truth'? A witness might not know what the actual truth of a matter is and simply has beliefs about some given issue based on that individual's interpretation of some sort of evidence, event, or phenomena to which the person had been exposed at some point. As a result, perhaps on being asked the question that is part of the swearing in process, a person understands the nuances of the question being asked and says: "I'll do my best."

Moreover, irrespective of whatever the witness-to-be might say in response to the foregoing question, the potential witness might be planning to lie or provide testimony that is biased in some sense or which is intended to make the witness look good or to protect that person's vested interests. So, why should one restrict one's focus to what might be said in response to the swearing in question, when, a person might say one thing but intend to do something else?

What are the "fairest" odds which are capable of reducing uncertainty to the greatest extent concerning how the swearing in question will be answered or what is actually meant by a potential witness' response." The example provided by Soni and Goodman as a way of illustrating how there is no information present in an alleged case of perfect certainty seems to be problematic.

A little later in Soni and Goodman's book concerning Shannon's life and ideas, the author's site an example that Shannon had recounted at some point which allegedly showed how redundancy is present in a great deal of language. More specifically, on one occasion, Shannon picked up a novel by Raymond Chandler, turned to a so-called random passage in story entitled: "Pickup on Noon Street," and came across a situation in which the task of one person – a male – was to read out the contents of a text letter by letter, while that individual's colleague was required to offer one, or more, guesses concerning the identity of the next letter. When the colleague correctly guessed the next letter in the text, the first individual would say the next letter, and, in turn, the colleague would have to engage in the guessing game again.

Before proceeding to the main conceptual issue, one might note in passing that describing Shannon's process of picking up a story by Raymond Chandler and, then, flicking through the story until reaching some random passage is not necessarily accurate. Shannon wanted to illustrate a point, and, therefore, he picked up a story by Raymond Chandler which was present for, perhaps, unknown reasons, and, then, flicked through the book until something within him brought the flicking process to a halt, and while Shannon might not have known what that something within him was that ended the page flicking process, one cannot necessarily call it random.

The outcome might have been unpredictable. Nevertheless, there were possible determinate factors which lead to a certain passage being selected, and, consequently, to label the process as being random is introducing an ontological coloring to the proceedings which might not be appropriate.

Notwithstanding the foregoing considerations and returning to the Raymond Chandler story, according to Soni and Goodman, the fictional exercise continued until the two characters in the story had produced the following set of letters – namely, "A S-M-A-L-L O-B-L-O-N-G R-E-A-D-I-N-G L-A-M-P O-N T-H-E D". The two authors claimed that the colleague would then be able to guess the next three letters in the exercise – that is, "-E-S-K."

Raymond Chandler often wrote complex mysteries which one couldn't always predict where they might go (e.g., *The Big Sleep*), and we might suppose that if one could predict where a mystery was going to end up, then, it really wasn't much of a mystery. Trying to guess where a mystery might go involves trying to differentiate between when a writer might be providing a clue or introducing an exercise in misdirection?

Before even addressing the issue of whether, or not, "E-S-K" is an obvious guess (as the Soni and Goodman appear to believe is the case) with respect to the letters which allegedly most likely follow the "D" in the foregoing series of letters, and, therefore, supposedly provide a good illustration of how redundancy is often built into language, one might ask the following question. How "small" of an oblong reading lamp are we talking about, and how oblong is "oblong"?

Small reading lamps come in a variety of sizes. Some are so small that they can be clamped onto a book.

However, even if one were to suppose that the reading lamp was small in some slightly larger sense, the letters following the 'D' in the foregoing series of letters that were being read out by the two fictional characters are not necessarily – or even most likely to be – "E-S-K." That 'D" could be the beginning of: "Davenport, diploma, disk, dead body, dragon, daisy, door knob, dusty chair, doughnut, dust pan, doubloon, dictionary, deceased, Dictaphone, dog, dentist, drunk, doll, dancer, dunce cap, dentures, and so on … any one of which might have had relevance concerning whatever mystery was being investigated.

According to Shannon, as well as Soni and Goodman, whenever a person can guess what comes next, then, such an individual is in the presence of redundancy. However, good creative writing – whether fictional or non-fictional in nature – often makes guessing what comes next difficult to do, and, therefore, language might not always be as redundant as some people might suppose is the case.

If language is as redundant as Soni and Goodman claim – for example, they suggested that Chandler had painted himself into a literary corner as soon as he arrived at the "T-H-E" prior to the final "D" in the aforementioned fictional guessing exercise – then, one wonders why no one was able to guess what Shannon was going to say in his 1948 paper concerning communication or why it took him ten years to be able to write that paper or why what he said took people completely by surprise. If language is so redundant, why is so much of what many good mathematicians, scientists, philosophers, researchers, theologians, poets, novelists, theorists, or investigators have to say often quite unpredictable?

Shannon maintains that the number of bits contained in a message revolves about the degree of uncertainty which is present in that message. Moreover, the extent to which a given outcome surprises one is due to the extent to which uncertainty characterizes the initial conditions, and such uncertainty tends to be maximized when the likelihood of those initial possibilities are relatively equal.

If a coin is flipped, and it turns out to be either heads or tails, why should either outcome be surprising? On the other hand, if someone wins a lottery at odds which have been calculated as being a million-to-one, then, this would seem to be far more surprising than the coin flip.

If the Celtics beat my seventh-grade basketball team, this would not be surprising. However, if my seventh-grade team were to beat the Celtics, then, despite the fact that the odds of this happening are far from equal, nonetheless, such an event would be quite surprising and, as a result, one has difficulty figuring out our how: Equal odds, uncertainty, and surprise fit together.

According to Shannon, by removing as much redundancy as possible from a message, the efficiency with which that message can be transmitted is increased. In fact, for Shannon, the most efficient message would be one which consisted of a series of symbols that were random-like in the sense that each new symbol would be as informative as well as surprising as possible.

Consider the sequence: “tqbfjoald” The foregoing sequence or series of letters appears to be random-like, but they are not, and despite being unpredictable prior to their being presented, the series of letters is not necessarily all that surprising.

All redundancy has been removed from the message. Each of the letters is quite informative, and, notwithstanding the efficiency with such a message can be sent, the informative dimension of those letters is not surprising in and of themselves.

The surprise comes when one discovers the meaning to which the foregoing message (“tqbfjoald”) gives expression – namely, “The quick, brown fox jumped over a lazy dog.” Once again, one has difficulty fitting surprise and information (as a transmissible message) together.

The foregoing example also points out that what appears to be random is not necessarily random. The appearance of randomness is really a function of ignorance rather than some ontological property of the universe.

For Shannon, efficiency is a function of the amount of the redundancy which can be removed from a potential message. However, what constitutes redundancy could be the result of an arbitrary choice.

“Half a league, half a league, half a league onward” is a line from Tennyson’s poem about the Battle of Balaclava during the Crimean War which took place in the early 1850s. In the context of the poem, none of the “half a leagues” is redundant, and, therefore, redundancy is not necessarily just a matter of the series of symbols that are used, but can also be a function of context … such as the rhythm which is embedded in a given series of symbols.

Is the second “o” in “loose” redundant? There is a difference between transmitting: “Let them loose” and “Let them lose.”

Nuance or subtlety is something which efficiency does not necessarily handle well. Efficiency is not necessarily just about redundancy but also concerns the nature of the relationship between a series of symbols and the context out of which those symbols emerge and, therefore, whether the process of transmission is counterproductive to the property of efficiency.

Supposedly, according to Shannon, as one becomes removed from relative equality among possible outcomes, then, the amount of uncertainty associated with such outcomes tends to dissipate as well. Yet, if we have a horse race involving eight horses, and the predicted probabilities for any given horse winning are not equal, nonetheless, isn’t there still a considerable amount of uncertainty surrounding which horse will win?

Shannon contends that during the process of communication, our freedom to choose the next letter tends to be severely restricted. As a result, information theory as conceived by Shannon tends to characterize language as being highly predictable and, as a result, relatively uninteresting.

In order to demonstrate what he had in mind with respect to the restrictive nature of language, Shannon engaged in an informal experiment in which he would generate English-like word structures by taking a series of randomly selected letters through several generations of stochastic manipulation. For example, he would open a book of random numbers, select one of the numbers on the page to which he had opened the book and write down one of the 27 alphabet symbols which was associated with such a number, and he referred to this initial generation of a series of alphabet symbols as being a “zero order approximation.”

Not to put too fine a point on the issue, but a so-called book of random numbers is really just a series of numbers which have been produced through an unknown set of determinate processes. While such a series of numbers might be unpredictable, they are not randomly generated but arbitrarily generated.

Shannon's selection of a particular page -- as well as his selection of a number on that page -- is not a random action. They are actions set in motion by Shannon's intention to arbitrarily pick up a near-by book that is being described as containing random numbers, and, then, deciding, intentionally, that he would, first, arbitrarily select a page, and, then, arbitrarily select a number on that page.

The number selected was associated with an alphabet-symbol. The existence of such an association is not random but pre-established -- although it is being engaged in a way that could not have been predicted before its selection -- and the fact that the alphabet-symbol was English in nature is also pre-arranged and not random.

Already, Shannon's experiment is conceptually biased in a variety of ways due to an apparent failure to distinguish between randomness and arbitrariness. The experiment is further biased when each of the alphabet symbols are considered to have equal odds of being selected which, supposedly, are associated with those symbols because such a claim constitutes an assumption rather than something which can be proven to be true.

Next, Shannon uses a table of letter frequencies in conjunction with his series of "random" numbers, and re-calculates the odds for each alphabet-symbol. He refers to this as the "first-order approximation."

By taking the foregoing steps, Shannon has further slanted his experiment because he is using a table of letter frequencies from a language which he has selected. If the alphabet-symbols were from an unknown language, then, he couldn't proceed since he would have no idea what the letter-frequencies might be for such a language, anymore than the Japanese were able to decode the Navajo "wind talkers" who were using a language with which the Japanese were unfamiliar.

At this point in his experiment, Shannon invokes a process that is based on the premise that the likelihood of certain two-letter combinations (in which particular letters are more likely to precede or follow certain other letters) could be used to further shape the

English-like word structures which he was generating. He termed this a "second-order approximation,"

By this point in the exercise, a number of English words began to show up within the series of letters. Shannon called this a "third-order approximation."

Shannon, then, takes the exercise through several more steps. With each succeeding procedure, he would take the series of letters with which he began and, by using properties such as the frequencies with which letters appear in the English language, together with the likely frequency of certain letter combinations, he was able to journey from an allegedly random series of letters to something which began to resemble English with increasing degrees of approximation following each step of his experimental procedure.

Yet, the content of what we choose to communicate and how we choose to go about doing so tends to shape which linguistic rules and spelling protocols will come into play. In other words, while the rules of syntax and spelling for a given language have the capacity to restrict how a person might go about trying to express something, nevertheless, what a person decides to communicate in the way of meaning will shape the nature of the rules – both syntactically as well as in terms of spelling -- which will be selected to give expression to such an underlying communicative intent.

As far as the foregoing experiment is concerned, Shannon didn't show that language, in general, is restrictive, predictable, and uninteresting. Rather, by limiting the aspect of language which he explored or engaged, he merely demonstrated that what he had accomplished was not necessarily all that interesting or relevant as far as the issue of meaning is concerned.

While he could show that there were stochastically predictable features present in certain facets of language, nevertheless, by failing to deal with the complexities of how meanings, understandings, and ideas are, first generated, and, then, failing to explore how people are able to find ways to fit their meanings into the restrictions of syntax and spelling in ways that can be grasped by other people, Shannon wound up exploring a dimension of language which might have stochastic properties, but those sorts of properties hardly constitute the be-all and end-all of linguistic potential. Seemingly, Shannon spent a lot of time trying to demonstrate something that had limited relevance to issues of predictability, restriction, and degree of interest which are entailed by the dynamics of meanings that are able to navigate their way through the restrictions or obstacles which syntax and spelling present to the potentials of semantics.

For Shannon, human communication requires redundancy because redundancy gives rise to predictability, and without predictability, meaning becomes elusive. Grasping or understanding someone's meaning is not necessarily the same as being able to predict what someone means before that person seeks to communicate a meaning. Syntax and spelling form a structural context through which semantic variability flows, and both structural predictability (or a certain amount of redundancy) as well as variability are necessary for substantive communication to be able to take place through linguistic means.

If communication is too predictable, recipients tend to lose interest in what is being said, and, as a result, they proceed to search for more variable and unpredictable content. Too much predictability is as problematic as too much variability, and people often tend to seek contexts of communication which have a ratio of variability to predictability with which they are comfortable and which they find most heuristically valuable.

As previously indicated, in 1939, Shannon had spent some time at the Institute for Advanced Study that is associated with Princeton. During this time, among the issues which he discussed with Hermann Wyle was the topic of information. At that time, Shannon sensed or intuited that information entailed characteristics which were neither completely indeterminate nor completely unpredictable – that is, information was probabilistic or stochastic in nature.

While the notion of information might be used to describe, quantify, and/or measure certain facets of what takes place during the process of communication, information is not necessarily what is being exchanged during such communication. Understandings, perspectives, frameworks, ideas, values, beliefs, observations, feelings, interpretations, responses, world views, experiences, judgments, and so on are being exchanged, and while there might be aspects of what is being communicated that require clarification, such ambiguity or uncertainty is not necessarily a matter of stochastic dynamics, and, furthermore, such ambiguity or uncertainty does not necessarily make that communication a function of indeterminate processes.

If an individual effectively communicates what such a person is trying to say, then, a recipient doesn't have to guess the nature of what is being said. Moreover, the recipient doesn't have to build stochastic models concerning what might be being communicated.

There is a difference between, on the one hand, treating communication as a dynamic means for transmitting packages of probability/choice that constitute efficient ways of parsing (digitalizing) and moving slices of videos, sounds, images, and texts between two points in time and space with a minimum amount of noise and, on the other hand, treating communication as a dynamic means for exchanging hermeneutical and epistemological orientations or understandings involving various existential experiences and phenomena which might, or might not, have relevance to the nature of reality. The former notion of communication might be best served through stochastic considerations in which there are elements which are neither completely determinate nor completely unpredictable, but the latter form of communication is not well served by stochastic considerations, indeterminate features, and too much redundancy.

Unfortunately, there tends to be a certain amount of lexical overlap when talking about the aforementioned two kinds of communication. As a result, many people often become confused about what Shannon has actually said, and, therefore, fail to understand that what Shannon means by the idea of information is tied to a particular kind of communication technology and, as such, cannot be exported to conceptual contexts which are not governed by the same set of technological principles.

Shannon contends that the idea of freedom of speech is largely illusory in nature. For example, he maintains that if we were truly free with respect to speech, then, we should be able to proclaim: XFOML RXKHRJFFJUJ, as an acceptable and constructive product of speech behavior, but he argues that we can't do this because rules of language and spelling place restrictions on the forms through which things can be said.

The foregoing perspective seems to confuse linguistic form and function. The same linguistic forms can be combined in an indefinite variety of ways to generate different meanings.

To claim that because the external forms through which, for instance, words are expressed are limited, then, therefore, we really don't have freedom of speech is like saying because the rules of chess or Go are limited in nature, then, the nature of what transpires in those two games, as well as their outcomes, deprive the players of their freedom to express creativity while seeking to navigate a path through the different scenarios which emerge during those games. To claim that the notion of free speech is largely illusory is like saying that all stories, poems, novels, and non-fictional works are largely the same.

Nothing which has been said in this chapter negates what Shannon has accomplished with respect to, among other things, his two mathematical theorems concerning: (a) the limit which exists in conjunction with a given channel's capacity to transmit bits of information, or (b) the potential of coding to be able to function like a baffle in relation to the presence of noise. Nonetheless, what has been explored in this chapter is some of the possible limits, cautions, questions, and considerations which might be critically reflected upon should someone suppose – wrongly I believe -- that Shannon's notion of information – which is solidly rooted in a form of communication that operates through a set of technological methods which quantify, measure and transmit messages independently of their meaning – is equally applicable to general kinds of existential, epistemological, and hermeneutical contexts involving issues of uncertainty, predictability, indeterminateness, learning, choice, freedom, and probability … and the material in this chapter has been offered as a demonstration, of sorts, that the foregoing claim is defensible.

<u>Chapter 7</u>: Evolution 2.0

Considerable interest and controversy has been generated over the last ten years, or so, involving an approach to the idea of evolution by, among others, Denis Noble. At the heart of his perspective is the notion of "biological relativity" which re-works aspects of earlier renditions concerning the issue of relativity and, in the process, -- seeks to demonstrate that just as scientists such as Galileo, Copernicus, and Einstein indicated, each in his own way, that there is no privileged position (such as the idea that the Earth is the center of the Universe) for engaging the phenomena which are explored through science, so too, the framework of molecular reductionism -- which, increasingly, has purported to serve as the foundations which shore-up the foundations of evolutionary theory over the past one-hundred and twenty-five years -- needs to be dislodged and replaced by a more complex, holistic, interactively rich framework in which many different levels of biological functioning come together to make evolution possible.

In short, according to Noble, evolution tends to encounter an array of explanatory problems as well as miss opportunities to broaden the sophistication and nuance of evolution-oriented perspectives when proponents restrict themselves to just the random machinations of genomic mutations and dynamics. Noble wants to show how genes, proteins, RNA networks, cells, sub-cellular dynamics, tissue processes, organelle and organ functioning, as well as ecological relationships all interact with one another in both linear and non-linear ways that shape the evolutionary process but do so in a way in which no particular level of biological dynamics can claim priority with respect to the issue of providing causal accounts concerning evolutionary dynamics.

Early on in his book: *Dance to the Tune of Life: Biological Relativity*, Denis Nobel talks about the importance of operating out of a framework of humility in which individuals recognize their ignorance concerning the ultimate nature of reality and, as a result, begin to develop an appreciation for how much of our way of engaging life is rooted in relativistic, working models that are nothing more than an attempt to approximate how different aspects of reality might operate. Consequently, for Noble, the questions we ask are relative to our state of ignorance, and, therefore, the condition of ignorance out of which questions are asked does not constitute a privileged position of understanding but, instead, gives expression to a thoroughly relativistic impression that is characterized by an epistemological orientation that is always a function of how our existential position vis-à-vis reality consists of a continuous set of processes which filter, frame, color, shape, and create the phenomenology which emerges in conjunction with our experiences.

Next, Noble offers a brief outline concerning how people's collective understanding with respect to an array of physical phenomena became relativized, and, in the process, went from a geocentric to a heliocentric perspective through the influence of both lesser known individuals such as: Nicole Oresme (who maintained that it was the Earth which revolved, not necessarily the heavens); Cardinal Nicholas of Cusa (who proposed that the world is that which has a center that is everywhere but which has a circumference that is nowhere), as well as, more well-known personages such as Copernicus and Galileo. Noble, then, goes on to note how individuals such as Newton and Laplace relativized our understanding of physical phenomena further by encouraging people to see everything through the lenses of a mechanistic form of thinking that sought to reduce physical events to clocklike dynamics, only to have that explanatory applecart disturbed, if not upset, by the emergence of quantum dynamics that sought to describe everything in terms of phenomena which, supposedly, were, ultimately, probabilistic in nature, notwithstanding Einstein's attempt to caution physicists that God does not engage in games of dice in conjunction with the universe.

Within a period of 60 years, the world went from: The absolutist overtones of Lord Kelvin who stated in 1900 that everything of significance concerning the nature of physics already had been discovered, to: The relativising observation of Richard Feynman that despite the incredible precision which had been achieved in physics, nonetheless, a person would be fairly safe in maintaining that no one understood quantum mechanics.

Through the special theory of relativity, Einstein was able to call into question the idea that there was any particular frame of reference which could be used to anchor measurements of, among other things, simultaneity. The 1887 experiment of Albert Michelson and Edward Morley which took place nearly two decades prior to the appearance of the special theory of relativity also seemed to rule out the idea that there was any ether which could be used as an absolute backdrop against which the phenomena of the universe – such as the speed of light – might be considered.

The General Theory of Relativity introduced the idea that space and time could be altered through gravitational effects. In addition, that same General Theory indicated that the geometric nature of the universe was not necessarily Euclidian in any absolute sense but was capable of being curved.

Progressively, across several thousand years of scientific inquiry, absolutist approaches to the nature of reality began to be questioned and replaced with frameworks that engaged reality through methods that relativized understanding (that is, removed the idea of a privileged point of view) in a variety of ways and, in the process, tended to proclaim that there were no epistemological perspectives which entailed a set of principles or mechanisms which were capable of successfully demonstrating that reality, in its entirety, was a function of such a small set of absolute-like principles. The goal of Denis Noble's book: *Dance to the Tune of Life: Biological Relativity* is to extend the foregoing sort of relativising process to the realm of evolutionary biology.

Central to the process of relativising biology is acknowledging that there are a number of different levels of organization which constitute living organisms. For example, one can journey across levels of organization which revolve about the functioning of: Atoms, molecules, cells, organelles, tissues, organs, as well as ecological considerations, and, then, one can further reflect on the manner in which those individual levels of organization interact with one another in a myriad of ways.

Organisms not only entail an array of levels of functionality, but, as well, they also are part of a set of scales which run, on the one hand, from the realm of the quark and gluon which are believed to give expression to the dynamics of protons and neutrons, to, on the other hand, the vastness of the universe with its multiplicity of galaxies and voids extending across billions of light years in distance and time.

Biological organisms exist somewhere in between the foregoing two extremes of scale.

According to Denis Noble, many scientists – especially biologists – have allowed themselves to be induced to accept the idea that there is a level of biological organization which provides a privileged lens through which to engage the nature of life. This alleged level of organizational privilege revolves about the gene – the entity (which Francis Crick supposedly bragged about discovering when whiling away his time in a Cambridge drinking establishment) that, supposedly, constitutes the 'secret of life.'

However, as Noble points out, whatever role genes might play in the mystery of life, they are completely passive in nature. In other words, unless genes are prodded into becoming expressed, then, they are merely inert combinations of four deoxyribonucleic acids, and, consequently, whatever is responsible for inducing or enabling a gene to be expressed constitutes the true active dimension of genetic activity.

The foregoing perspective characterizes the beginning of Noble's program for relativising biology and evolution. In other words, the gene is not necessarily the locus of control for what occurs in an organism.

We live in the age of atomic and particle physics. Many people suppose that this sort of physics provides human beings with a window into the soul of physical events, but Noble tends to disagree.

For example, six atoms make up the molecules that constitute 97% of the weight of a human body. These elements are: Hydrogen (which accounts for more than 62% of the atoms present in a human being), oxygen, carbon, nitrogen, sulfur, and phosphorus.

Five further kinds of atoms – namely, calcium, potassium, sodium, magnesium, and chlorine – add approximately 3% of additional weight to the human body. Moreover, there are other, more complex atoms – such as, iodine, iron, copper, manganese, zinc, cobalt, and selenium which are present in the human body in very small amounts – referred to as trace elements.

However, as far as causal dynamics are concerned, the foregoing set of atoms holds no more of a privileged position than genes do. To be sure, in order for biological dynamics to take place in a human being, both the aforementioned atoms as well as genes have causal roles to play, but, just as genes have to be activated through the presence of other aspects of biological dynamics (many of which are molecular in nature), so too, atoms require the presence of organizational considerations of various kinds to regulate how different atoms are to interact with one another in order to assist those atoms to constructively participate in human functioning … such as in the form of the deoxyribonucleic acid sequences that contain various facets of a human being's genomic potential.

The DNA that makes up the set of chromosomes which characterize a given kind or organism relies on the organizational work which is performed by different species of RNA (ribonucleic acid … for example, messenger-RNA, transfer-RNA, ribosomal-RNA, and micro-RNA). The constructive assistance which is provided by the foregoing sorts of RNA eventually converts DNA into amino acids which are assembled (with the help of ribosomes) into an array of proteins, both structural and enzymatic.

There are at least two mysteries present in the foregoing, very brief overview. The first mystery – which is fundamental to the whole idea of evolution – is how were five specific nucleic acid molecules (namely, guanine, thymine -- uracil --, cytosine, and adenine – each of which consists of a certain kind of **ribose sugar --** $C_5H_{10}O_5$, a **phosphate group – $[PO_4]^{3-}$**, and a **nitrogenous base – G,T,C, or A**) selected from among a much larger set of possible forms of DNA to serve as encoding surrogates for a specific set of 20 other molecules (namely, amino acids which consist of a **basic amino group – NH_2**, an **acidic carboxyl group -- COOH**, and an **organic side-chain which is unique for different amino acids**) which are entirely different in their structural and molecular character from nucleic acids?

Related to the foregoing question is how did a set of triplet codes consisting of 64 components involving the aforementioned five nucleic acids come to stand for just 20 particular amino acids -- after all, there are many more possible forms of amino acids than the 20 which are found in Earthly editions of life? Furthermore, why do various amino acids have different nucleic triplets coding for those same amino acids, and how did three nucleic acid codons or triplets come to stand for stop signals without representing an amino acid while the triplet AUG can stand for either a stop sign or the amino acid methionine?

Evolutionary theory does not have plausible, evidence-based answers for any of the foregoing questions. That is, evolutionary theory has absolutely no way to account for the origins of what should be the most essential feature of any such theory – namely, how did nucleic acids come to be incorporated into a 64-entry triplet encoding system (including stop signals) for amino acids, an entirely different kind of structural molecule.

Resorting to notions like: 'Chance happenings,' 'emergent properties,' 'self-organizing structures' is nothing more than a process of generating narratives that are, ultimately devoid of substance, but are made to sound as if they had explanatory value but, upon rigorous examination, can be shown to have no reliable, demonstrable basis in empirical fact and, as such, constitute nothing more than assumptions and conjectures.

Early on in the first chapter of *Dance to the Tune of Life*, Noble indicates that one cannot develop causal explanations without adopting some set of meaningful assumptions which can serve to modulate and constructively orient the lens of perception through which we engage, and seek to try to understand, the nature of experience. William of Ockham (1285-1347 or 1349) recommended that we should not posit possibilities beyond necessity.

Many people have claimed Ockham's razor means that the best theory is the simplest theory. However, a more careful reading of the principle indicates that William of Ockham is asking people to not only critically reflect on the nature of the assumptions which they make and whether, or not, those assumptions are necessary, but one is being asked to explore the issue of necessity.

While the notions of 'random mutations', 'chance events', 'emergent properties', and 'self-organizing systems' are clearly necessary to the process of trying to lend credibility to the conceptual appeal of evolutionary theory, there is no actual evidence capable of demonstrating that such notions are necessary dimensions of the truth of things. The foregoing notions are all exercises in positing for which no necessity has been shown to exist as far as the nature of reality (as opposed to the nature of conjecture) is concerned.

The second mystery which is present in the foregoing overview is the following consideration. Adding levels of complexity to a theory does not necessarily add anything to such a theory except additional complexity.

For example, to maintain that various forms of RNA assume different roles in helping to activate the biological potential which is present in DNA, does not fully explain what is transpiring. While it might be true that various modalities of RNA help to regulate or help to activate the expression of given sequences of DNA, nonetheless, making reference to the regulatory roles played by RNA still leaves a variety of important questions unanswered – such as, what directed the different varieties of RNA to regulate the parsing of DNA: In one way rather than another; at one time rather than another; in a given part of an organism rather than some other aspect of that same organism; in one amount rather than another; in one sequence rather than another, and for one function rather than another.

There is nothing wrong with making efforts, as Noble does in his aforementioned book, to show that biological functioning is more complex than, for example, reductionistic forms of molecular biology often seek to induce people to believe is the case. Furthermore, there is nothing wrong with wanting to relativize one's explanatory framework by demonstrating – as Noble does throughout his book -- that many different levels of functioning are causally contributing to biological dynamics and, in the process, reminding researchers that we all need to engage the process of exploration with humility as well as a willingness to acknowledge that whatever one believes one understands and however true what one believes might be, nevertheless, we should shy away from absolutist judgments concerning just how much of reality we actually understand.

Notwithstanding the foregoing considerations, perhaps, the purpose of trying to relativize our frameworks of understanding is to provide a network of conceptually constructive degrees of freedoms through which different kinds of evidential light and insights concerning the nature of truth – or some aspects of it -- might have the best opportunity to shine into our lives, minds, and hearts. In short, we should not transform the relativising project which Noble is proposing into just another sort of absolutist undertaking which prevents us from working, to the best of our abilities, to grasp whatever facets of reality might be present and which, in accordance with Ockham's razor, are necessary in relation to whatever assumptions we might have used as starting points in conjunction with our search for the truth concerning the nature of our relationship with the universe.

Necessity should be a function of reality. Necessity which serves only as a means of trying to save the appearances of a theoretical edifice is precisely the sort of positing which should not be multiplied beyond necessity – the necessity which is required in order for something actually to be true and not something which is required because we want that something to be true as a result of vested conceptual interests we might have in some theoretical edifice.

When introducing the notion of a system in the context of biological dynamics, Noble points out that a system is a set of interacting components. However, a system involves more than components which interact because unless those components interact in the right way, then, the fact that they interact has no biological value.

Noble mentions, in passing, how there are many tiny molecular forms of transmitters, hormones, and metabolites which – despite their small size – play important roles with respect to the manner in which different parts of a given life form communicate with one another. Earlier in his book, he referred to trace elements in the human body that are relatively rare but which have important roles to play in helping a body to function properly.

Additionally, he cited five atomic elements – namely, calcium, sodium, chlorine, magnesium, and potassium – that constitute only 3% a human body's weight. Yet, in their ionic forms, they fulfill a multiplicity of vital roles.

Moreover, Noble indicates that while hydrogen accounts for approximately 63% of the atoms which are present in the human body, the roles which hydrogen plays are diverse, and in any given context, what form hydrogen assumes has considerable importance. For example, the extent to which hydrogen ions – naked protons – are present in any given area of the body will determine the acidity of that area, and acidity levels affect the degree to which a human being can function effectively, but, as well, hydrogen ions play a fundamental role in how water is structured in any given cell or tissue.

All of the foregoing components interact with one another and, therefore, constitute a system. Nonetheless, unless those components interact with one another in precise ways, the system breaks down.

In a previous chapter of the current book, the work of Morton White was mentioned in conjunction with the notion of causality. The example which was presented to illustrate White's perspective in this regard had to do with the lighting of a match.

In order for a match to be lit, there are many conditions which have to be present. Issues involving: Oxygen content, wind speeds, dampness, temperature, quality of the manufacturing process through which matches come into being, and the nature of the surface against which a match is struck, all have a bearing on whether, or not a match will light.

On the one hand, the foregoing considerations indicate that the act of striking a match is only part of the cause of a match's lighting. On the other hand, unless the match is struck, then, the presence of just the right set of conditions is not necessarily sufficient for the match to light.

The lighting of a match constitutes a system because all of the requisite components interact with one another to help bring about the lighting of the match. Nonetheless, ultimately, that system depends on the regulatory role which is played by the person who strikes the match.

When Noble speaks about biological relativity is he merely trying to highlight the non-reductionistic, causal complexity of the dynamics which take place in relation to life forms, or is he alluding to the possibility that in biological systems there is no component which plays a regulatory role that is comparable to the one which is played by the individual who strikes a match in order to induce a match to light? Page 70 of *Dance to the Tune of Life* is occupied by a single image giving expression to a chart which is known as a Roche network that depicts the incredible complexity of metabolic pathways in a human being, and such a detailed chart actually tells only a small part of the dynamics of metabolic processes which, to be more accurate and complete, would require a chart that covers an area which would be a very significant multiple of the size of the chart on page 70 of Noble's book.

The aforementioned metabolic network or system chart is so intricately connected that one would need a magnifying glass to begin to try to make sense of how any of the components of that system are linked to one another. However, is such complexity the end of the story – something, for instance, that is intended to justify the notion of biological relativity -- or are there more fundamental regulatory considerations that are present which not only set such complexity in motion (like the individual who strikes the match) but also are responsible for maintaining that complexity in a way that sustains life (much like a person who strikes the match might shield the flame from environmental elements in order to help sustain the life of the flame)?

At one point during the second chapter of Noble's previously cited work, he spends a couple of pages talking about lipids. During this discussion, he notes that, in the 1960s, Alex Bangham, from England, was able to demonstrate how lipids spontaneously could form bilayered cell-like spheres or vesicles.

However, what Noble does not mention is that lipids are not all that easy to synthesize in the wild – that is, independently of cellular machinery. To generate lipid molecules outside of the cell, one requires an artificial process of manufacturing that involves, among other things, exposing specific kinds of molecules (for example, glycerin, butyric acid or gaseous forms of hydrogen chloride) to conditions involving high temperatures for a period of time.

Consequently, once one has lipids, then, one will be able to find ways to induce those molecules to form bilayered cell-like vesicles. Nevertheless, obtaining lipids independently of life forms does not necessarily take place spontaneously in a self-organizing way, and, as a result, the origin of lipids in the wild represents a problem for evolutionary scenarios.

Noble goes on to mention the importance roles which are played by transmitters, metabolites, and hormones in biological dynamics and states, in passing, that such small molecules must have been able to evolve within the confines of lipid vesicles since they do not spontaneously form outside of cells. Consequently, not only does

Noble assume his way into the evolutionary existence of lipids, but, as well, molecules such as hormones and transmitters -- which play important roles, among other forms of biological dynamics, in processes of intercellular communication -- are assumed into evolutionary existence as well.

Later on in *Dance to the Tune of Life* Noble will talk about some of the metabolic pathways through which lipids, hormones, transmitters, and metabolites are produced within living organisms. However, what is not explained later on that book is how any of those metabolic pathways came into existence in the first place.

In other words, one is often given the appearance of an explanation without the evidence which is needed to make such an alleged explanation substantive in character. Many of the key details that are necessary to construct a proper explanation often are missing or only alluded to as being present somewhere in a thicket of complexity which might serve as evidence for the reality of some degree of biological relativity but whose origins are lost in the mists of time as well as unknown or presumed conditions.

Denis Noble proceeds delineating his perspective by indicating that organisms are vast networks of molecules. He further indicates that such networks can be broken down into different levels which can help to make some aspects of biological dynamics more conceptually manageable.

Among the levels which are mentioned are: Organelles, cells, tissues, and organs. In addition, he points out that the foregoing levels are woven into a variety of biological sub-systems such as: The circulatory system, the respiratory system, the digestive system, the nervous system, the musculo-skeletal system, the immune and endocrine system, as well as systems involving skin or body armor in the form of an exoskeleton that serve as interfaces between a life form and the surrounding environment.

With respect to the foregoing considerations, Noble advises that one should direct questions toward those levels and sub-systems which are most appropriately related to being able to address such issues. However, what the criteria are for determining what constitutes 'appropriateness' in such a context is not always straightforward because – and as Noble indicates in his book – the metabolic pathways of an a human being are so complex that determining what is related to what and through what means and to what degree is not always easy to establish.

When discussing organelles, Noble stipulates that while simple organisms such as protists and prokaryotes tend to have simple interiors, most of the cells in the interiors of more complex eukaryotic organisms are populated with an array of organelles – that is, small, cell-like vesicles (such as the nucleus, mitochondria, Golgi bodies, endoplasmic reticulum, and lysosomes) within cells that carry out an array of specialized functions. Interestingly, aside from obvious questions concerning the evolutionary origins of such specialized organelles, one might also reflect on the term 'protists' which Noble uses to introduce the topic of organelles because 'protists' have murky evolutionary origins comparable to organelles.

More specifically, protists are eukaryotic organisms (that is, unlike prokaryotes, they have, among other properties, a true nucleus which is surrounded by a nuclear membrane) that are, usually, single-celled but have no clade. In other words, protists do not belong to any classificatory group of organisms which one can trace to a common ancestor.

Therefore, protists do not fit into any of the normal categories of animal, plant, bacteria, or fungi. As a result, there is a multiplicity of eukaryotic organisms (including amoeba, flagellates, kelp, slime molds, various species of unicellular green and red algae, as well as tens of thousands of other kinds of protists organisms) which have problematic, sketchy, and questionable evolutionary ancestries.

Some individuals might wish to argue that the evolutionary origins of organelles like mitochondria are not a mystery. Oftentimes, such a perspective is based on the theory of endosymbiosis which was developed by, among others, Lynn Margulis.

Endosymbiosis refers to the idea that certain prokaryotes (the alleged, more primitive, non-nucleated, precursors to eukaryotic life forms) were, somehow, able to gain access to the interior of a more developed life form and, then, over time, the two life forms established a symbiotic relationship with one another. The presence of mitochondria organelles in eukaryotic cells is cited as being an example of such a process of endosymbiosis.

What is not explained in any of the endosymbiotic examples (such as in the case of mitochondria) is an evidence-backed detailed, step-by-step account of how either of the two life forms that are involved in the dynamics of endosymbiosis each originally came into existence, or what the steps were that took place over time and made such a relationship of endosymbiosis possible.

Endosymbiosis is a narrative. It does not constitute science except in the minds of individuals who are desperate to save the appearances of evolutionary theory through whatever phantasmagorical means might serve such an appearance-saving project.

Once Noble is finished with his comments concerning organelles, then, he moves on to the realm of cells. Among other things in this regard, he indicates that there are some 200 different kinds of specialized cells in human beings.

Each of these 200, or so, cells have their own set of specialized metabolic pathways that produce, among other things, the unique proteins which help to underwrite the specialized dynamics of those cells. What is not mentioned in the foregoing section of Noble's book is any detailed account – either in evolutionary or embryological terms – concerning how any of those 200 cells acquired their unique set of metabolic pathways which makes their specialized capabilities possible.

When describing how cells aggregate together to form tissues, Noble indicates that such aggregation induces cells to interact with one another and through this process of aggregated interaction, the properties of cells are changed. This dynamic of aggregated interaction in which the activities of the whole set of cells changes the properties of different cells within that aggregation is an example of what Noble means by the idea of biological relativity in which no one component has a privileged role in the causal dynamics of the tissue and, as a result, the properties of both the tissue as well as cells within that tissue modulate one another.

What is absent from such a perspective is any account of why cells aggregate in one way rather than another to form tissue that gives expression to one set of properties rather than some other set of properties. Cells do not spontaneously aggregate together but, instead, are generated through an embryological process in which certain sets of genes are turned on and certain sets of genes are turned off to form specialized tissue regions that occupy particular spaces in fairly precise morphological ways, and, consequently, one can't help but wonder what is responsible for turning different genes on and off at particular times and in particular sequences for specific periods of time and in particular amounts.

The capacity of the whole (for example, a given aggregation of cells in the form of a certain kind of tissue) to constrain how individual cells within that aggregate behave might be an example of biological relativity. What such biological relativity does not explain is why the whole constrains individual cells in one way rather than another at any given point in time.

Of course, proponents of biological relativity might respond to the foregoing considerations by referring to the notion of a whole-body system. In other words, the collective set of organs, tissues, cells, organelles, and molecules interact with one another in ways that constrain the dynamics of that system in order to carry out an array of tasks that bring about, and sustain, certain kinds of biological functions which are conducive to life.

To be sure, the whole-body system might explain how different aspects of an organism interact with one another to generate viable forms of biological functioning. Nonetheless, what the whole-body system does not explain is how such a system initially acquired the capacity to be a functional system in which a highly complex and nuanced network of metabolic pathways had been enabled to interact with one another in co-operative ways that are precisely timed, in particular sequences, at specific locations, in appropriate amounts, for particular functional purposes.

The notion of a whole-body system is something that explains without actually explaining. In other words, it might be able to describe what happens, but that system doesn't account for how the capacity to bring about such happenings arose in the first place … that is, the system cannot explain its own existence, but, instead, it only provides a running commentary of what happens after such a system has arisen.

From Noble's perspective, if one tries to restrict one's focus to the biochemical networks within cells, then, one will be placing limits on the extent to which one will be able to understand how such cellular networks relate to various facets of a larger set of interacting systems. For example, he notes how all cells must operate within 50 μm (microns or 10^{-6} meters) of a regulated flow of blood in order to be able to continue functioning.

Consequently, as, say, human beings grow, a process known as angiogenesis takes place in which there will be new growth in the vascular system of a human being that will accompany whatever cellular growth occurs in a given kind of tissue so that all cells (both old and new) in that developing tissue will have ready access to the flow of blood. The foregoing systems account does offer a description concerning what takes place during growth, but that account does not provide any understanding of, or insight into, what regulates the foregoing process – not only in relation to when such a growth in the vascular system should either begin or stop, but, as well, where such vascular growth needs to take place.

The size of these vascular additions can vary, but the smallest editions are in the form of capillaries that are barely large enough for blood cells to flow through in single file. Therefore, a relevant question might be to inquire about what ensures that the interior diameter of such capillaries will be sufficiently large for blood cells to be able to flow though that sort of tubing?

Furthermore, just as there needs to be a means for blood to reach new areas of cellular growth in developing tissue, so too there must be a means for waste materials from cellular dynamics to be removed from the organism. Consequently, the growth of tissue requires a process that will be able to take metabolic waste products from a growing system to be detoxified elsewhere.

The interior diameter of arteries becomes smaller as the new additions work their way down to the size of capillaries. The reverse is true with respect to the new construction of veins whose interior dynamics become larger in size the more distant they become from the cells which are releasing metabolic waste materials into that system of veins, but one can raise similar sorts of questions in relation to the new growth of veins as one did in conjunction with the new growth of arteries – for instance, what regulates the interior diameter size of different sections of the new vein tubing as the latter tubing becomes part of a growing system of veins that are being introduced into newly developing tissue?

Angiogenesis and its reverse counterpart in veins describe the surface aspects of what happens during such growth. Nonetheless, nothing in those descriptions provides any sorts of insight into what the dynamics are which make the new growth of arteries and veins possible with one set of properties rather than some other set of properties.

While discussing another kind of system – namely, the nervous system – Noble notes that organisms need a way to sense or be sensitive to what is transpiring in their nearby ecological surroundings. He goes on to conjecture that mechanical sensitivity – that is, an organism's awareness that something which is non-organism has been encountered – might have been one of the very first kinds of sensitivity to develop in life forms through some of the receptors which are present in an organism's exterior surface.

However, Noble does not provide any account concerning how those receptors came to be developed in the first place or how they came to be deployed or instantiated on that organism's surface. Moreover, no explanation is provided with respect to how that organism came to develop, on some level, a capacity for being 'aware' of, or being able to interpret, whatever signals might be communicated through those receptors or how a capacity emerged in that organism which enabled the organism to respond in one way rather than other in conjunction with what is being sensed.

Similarly, during the same discussion of the nervous system, Denis Noble mentions how chemical levels can be used by organisms to determine that a food is present and where such nutrients can be located. However, what is missing from such a description is an explanation which accounts for how an organism develops the capacity to be able to identify what constitutes a food source or acquires the ability to determine that changes in concentration of chemicals associated with a food source can be used as a navigational tool for locating such nutrients.

Next, Noble goes on to talk about the dendrites and axons which form parts of certain kinds of brain cells. Such dendrites and axons often link to other, similar kinds of cells in complex forms of connectivity. Yet, nothing is said about how the capacity arises in an organism with respect to such complex forms of connectivity that enable the organism to be aware of, or sense, or grasp, or understand, or discern, or differentiate, or interpret what any kind of connectivity means, or what value it has, or what its significance is, or what responses follow from that sort of connectivity, or how the organism is to go about initiating one response rather than another.

During his discussion of various kinds of systems, Noble briefly touches on issues of immunity and the endocrine glands. He indicates that hormones are produced through the activity of such glands and that these specialized molecules serve as messengers that help direct the activity of certain aspects of different organs, associated systems, and molecular networks.

For a system of communication to work, there must be a way of sending signals, and a way of receiving such signals, and a way of sensing the significance of such a signal, and a functional way of responding to the presence of a signal once it has been received. Consequently, some relevant questions to ask in this respect are: How did the capacity to send an array of different messages or signals arise? How did the capacity to sense the presence of such signals and their significance arise? How did the capacity to respond to sensing the presence and significance of such signals or messages arise? And, finally, if all of the foregoing conditions are not present, then, what function, if any, do hormones have even if one were to suppose that, somehow, a set of metabolic pathways had been established in one, or another, endocrine gland which was capable of generating such molecules?

A systems approach might enable one to provide a description of the dynamics which take place in such a context as well as provide one with a way to show how one kind of dynamic is linked to other kinds of dynamics either within such a system or in conjunction with other systems. Nevertheless, systems don't explain the origin of their capabilities.

The author of *Dance to the Tune of Life* clearly indicates that he does not wish to do away with the many insights that emerged through the reductionistic paradigm of molecular biology. Rather, he wants to place those insights in a proper context of complexity … the sort of complexity which reductionistic molecular biology cannot explain.

Somewhat ironically, although Noble believes that a proper understanding concerning the notion of complexity will help to bring ballast to the aspects of the reductionistic paradigm that are threatening to sink various aspects of evolutionary biology, nevertheless, the issue of complexity might muddy epistemological waters more than it clarifies them. For example, Noble contends that one can explain the existence of complexity – even if one were to start from a set of initial conditions in which matter and energy were compressed into the narrow confines of a singularity of some kind – by noting that whatever kind of symmetry might have existed in the beginning, once symmetry is broken, then, various kinds of forces involving attraction and repulsion would create attractor basins that would randomly interact with one another and proceed to generate complex structures of distribution involving energy and matter that are self-organizing as a function of the dynamics which are entailed by the forces which are present.

In expressing the foregoing position, Noble seems to have been under the influence of a form of willful blindness with respect to the facet of the emergence of complexity that is most in need of being explained. More specifically, the issue is not really how does complexity arise but, instead, the issue is this: How did the complexity that characterizes the universe we see today come to have the particular features that it has?

Denis Noble admits that no one knows what the nature of the singularity might have been at the beginning of things. He also acknowledges that no one knows how such a singularity might have come to be, and, therefore, no one knows what the conditions were from which a singularity of some kind might have emerged, and, therefore, no one knows what the properties of any given symmetry might have been that could have characterized the singularity or what would have been necessary for such a symmetry to break in one way rather than another. And, finally, Noble admits that anything which might exist beyond the horizons of our capacity for sensory observation would fall outside our understanding because the light from such phenomena exist in a region of time-space that could not reach us.

When outlining the broad strokes of his starting point with respect to the issue of complexity, Noble has made a number of assumptions: (1) He assumes there was a beginning; (2) He assumes such a beginning was characterized by a singularity that was characterized by a condition of symmetry; (3) He assumes such a condition of symmetry was broken in some way that gave rise to forces of attraction and repulsion that generated structural and dynamics attractors of one kind or another which, in turn, interacted with each other that led to the emergence of complexity; (4) He assumes that the dynamics of the universe are shaped by purely random processes; (5) He assumes that whatever falls outside our sensory capacities is a function of space-time dynamics which emit light which will never reach us; (6) He assumes that space-time is an ontological reality rather than merely a mathematical way of capturing the extent of curvature which is present in a given gravitational field.

Noble can't actually prove that any of the foregoing assumptions are justified. He doesn't know whether the universe is open or closed, and he makes no provision for the possibility that there might be forces beyond the horizons of sensory capacities which are not a function of space-time dynamics or whatever forms of light that, supposedly, are being generated by those alleged dynamics.

Furthermore, neither he – nor anyone else – can demonstrate that randomness is ontologically woven into the fabric of the universe. This is because neither Noble nor anyone else has a means to differentiate between what is truly random and what is caused by determinate forces that we don't understand and, therefore, give expression to our ignorance about what makes such phenomena possible.

The notions of symmetry and symmetry-breaking are just arbitrarily selected ideas which have been invented to try to hide the extent of our collective ignorance concerning issues that bear upon the problem of origins. By using terms like "symmetry" and "symmetry-breaking", people are able to illicitly clear conceptual space wherein they can locate a fulcrum possessing fictional properties on which to rest their delusional lever that will enable them to theoretically manipulate what they don't actually either know about or understand.

The concept of biological oscillators is introduced by Noble as a way to help develop and illustrate his approach to the dynamics of complexity. He begins this discussion by noting that oscillators constitute a form of dynamic attractor that are active on all scales of the universe, from: Cosmological events, to: weather-related phenomena as well as the functioning of the human body on a cellular level.

In addition, he maintains that there are various indications that the phenomena which emerge from the dynamics of different kinds of oscillators that are operating on vastly different scales appear to share certain kinds of attractor dynamics in common such as a tendency to self-organize in one way rather than another. Furthermore, he notes that such attractors often interact with each other in ways that constrain, shape, and orient what takes place on any given scale of events.

However, once Noble is required to move away from generalities and toward trying to explain why concrete particulars have the properties they do, he admits that the journey begins to become problematic. For instance, he addresses the issue of how certain biological oscillators might have developed circadian rhythms, and, in the process, he suggests that very early on during the evolutionary process, networks of cells are likely to have been attracted toward oscillators which were in tune with the energy and light cycles of the sun, and, as a result, metabolic pathways arose in the aforementioned cellular networks that were driven by the way shifts in the energy and light of the sun affected cells that had developed the capacity to resonate with such daily cycles.

Noble doesn't explain how certain cells acquired the capacity to be attuned to daily cycles of energy and light. Moreover, he doesn't explain how other cellular networks would have become attracted by such circadian-oriented attractor systems. Finally, he doesn't explain how the circadian-oriented biological attractor and the cellular networks -- that, allegedly, for unknown reasons, early in the evolutionary process -- were drawn together in a way that would have been able to underwrite the sorts of metabolic pathways that would be capable of transforming solar light and energy into useful biological resources.

Noble goes on to admit that no one knows about how all of the foregoing events happened, but, we are able to describe in considerable detail what happens with respect to such dynamics once they arise. In effect, Noble can describe a great deal of biological functioning, but, unfortunately, he can explain almost nothing about how any of the foregoing considerations are possible as a function of concrete, evidence-based evolutionary dynamics.

Thus, he notes that in the brain there is a cluster of some 200, 000 cells which form the suprachiasmatic nucleus. This group of cells plays an important role in enabling an organism to operate in accordance with the circadian rhythms that are associated with the sun and the rotation of the Earth.

Noble states that experiments with fruit flies prove that the underlying mechanism of the capacity to operate in accordance with circadian rhythms is molecular in nature. In other words, if one induces a mutation to occur in the Period gene of a fruit fly, the capacity of such a mutated fruit fly to respond to such rhythms will be altered.

However, if one interferes with – i.e., mutates – some aspect of the electronic circuitry which makes a radio or television work and, as a result, the capacity of that radio or television to be able to respond to incoming signals is affected in some fashion, can one really say that such an issue is entirely electronic – that is, is entirely a function of such electronic circuitry? Or, is the electronic circuitry only one part of a much more complex dynamic that extends beyond the properties of a radio's or a television's electronic circuitry?

We can answer questions concerning how electronic circuitry comes into being. All we have to do is go down to a local manufacturing plant – which are not all that easy to find these days – and observe how radios and televisions are put together.

We don't know how the suprachiasmatic nucleus came into being or how the cells which make up that complex acquired the capacity to respond to circadian rhythms or why there are 200,000 cells in such a structure rather than some other number of those kinds of cells. All we know is that is that if you change some structural aspect of that nucleus, the capacity of an organism to respond to circadian rhythms will be affected.

Specific kinds of molecules seem to have a role to play with respect to circadian-oriented capabilities of certain cells. However, until one knows what makes circadian sensitivity possible, one is not actually in any position to say that such sensitivity is a function of just molecular considerations, per se, rather than, for example, the organizational dynamics that arrange molecules in a way that makes a given cell sensitive to circadian rhythms or which enable the entire suprachiasmatic nucleus to be sensitive to circadian rhythms.

In other words, perhaps what matters is not molecules in and of themselves but, rather, what matters is the regulatory character which shapes, orients, directs, and constrains what different molecules do within the context of a more complex set of biological dynamics. To be sure, if one alters the character of one of the molecules which is part of the foregoing sort of dynamic, then, the capacity of the organism to process circadian rhythms might be affected, but this is because the functioning of a given biological network or metabolic pathway has been undermined and, not because, one can reduce such a process down to whether, or not, a given molecule has, or has not, been mutated.

Without the regulatory and organizational framework provided by not only the cell within which a given molecule is located but, as well, provided by the rest of the suprachiasmatic nucleus, the molecule doesn't have any value in and of itself. It is the surrounding regulatory context that provides the molecule with a role to play, and, therefore, one cannot necessarily say that circadian rhythm sensitivity is a function of molecular biology.

One has to account for how such molecules are possible. However, one also has to account for how the regulatory capabilities in which such molecules are embedded came into being as well.

Noble does mention that such regulatory considerations are important. For instance, Noble stipulates that the degree to which the Period gene is expressed plays an essential role in the rhythm which is generated within whatever cell the Period gene is expressed.

More specifically, the Period gene is expressed and the protein which is generated through this process of genetic expression continues to be released from ribosomes in the cytoplasm until, eventually, by way of diffusion, some of these proteins find their way back into the nucleus where they bind to the promoter region of the gene which has been coding for their production and, this leads to a cessation of the gene's expression. At some point the inhibiting protein which is bound to the promoter region of the Period gene is removed, and, as a result, the production of the protein can begin again.

There are a number of details which are missing from the foregoing account. First, what is responsible for turning the Period gene on at a particular time?

Asking the foregoing question is not meant to serve as a way of alluding to whatever modulating molecular signal (e.g., a methyl group – three hydrogen atoms and a carbon atom) which needs to be sent to a particular part of the DNA sequence associated with the Period gene in order to initiate that gene's expression. Instead, what is being asked is this: What is responsible for sending – at the right time -- the appropriate kind of modulating molecular signal – such as, say, a methyl group or some other molecule with this kind of initiating function -- to connect to a specific part of the DNA sequence associated with the Period gene to initiate gene expression?

Moreover, how does that which is responsible for the foregoing form of communication "know" where to send the modulating molecule. Or, alternatively, how does the modulating molecule which is being sent to initiate gene expression "know" where to go as well as "know" what specific part of the Period gene must be accessed in order for gene expression to begin?

Why should one suppose that, at some point, the protein which was initially translated into mRNA within the nucleus and, then, becomes transferred to ribosomes in the cytoplasm in order to become transformed into proteins, then, randomly diffuses back into the nucleus and randomly their way back to the Period gene in order to inhibit production of that gene? Biological processes that are random seem inconsistent with dynamics that operate with a rhythm and, therefore, require some form of regular time-keeping system which goes off after a period of time has elapsed and, then, communicates with something in order to induce the release of the right kind of modulating molecule to start the process of gene expression once again.

Finally, what is responsible for removing the proteins which are inhibiting the expression of the Period gene? As indicated previously, the question being raised here is not about the nature of the specific molecules which are involved in the actual process of protein removal but, rather, the question being asked has to do with what is responsible for communicating whatever has to be communicated in order to set such a removal process in motion, and how does the removal mechanism that has been set in motion "know" where to go in order to be able to bring about such a removal?

Noble doesn't provide epistemological insights which are capable of answering any of the foregoing questions. He simply outlines the general features of the process, indicates that such processes are part of network of feedback loops which he claims are "self-contained" processes of regulation.

Use of the term "self-contained" makes it sound as if the foregoing dynamics are a natural, but random, form of self-organizing biological dynamics. Yet, every significant aspect of the foregoing form of regulatory activity is rooted in unknowns of one kind or another.

Consequently, one has difficulty understanding precisely what is meant by the idea that such feedback loops are "self-contained." This difficulty is due to the way in which the locus of control for such regulatory activities appears to depend on dynamics that are not necessarily molecular in nature even as the latter sorts of dynamics regulate the way in which different molecules go about business within cells and within organisms.

Noble maintains that developing mathematical models which are capable of accounting for feedback loop dynamics is quite easy to do. He contends that these kinds of models are both explanatory and rigorous in nature.

Irrespective of however rigorous the foregoing sorts of mathematical models might be, they don't seem to have much capacity for explaining many of the details that are present in those regulatory dynamics. To be sure, some combination of differential equations might be able to describe certain aspects of those dynamics, but describing something is not necessarily the same as explaining what is being described – that is, being able to explain things in a way that enables an individual to understand how each facet of the feedback loop which is being described has been made possible by regulatory dynamics that are external to those loops – regulatory dynamics which transcend, or run more deeply than, Noble's method of description which restricts focal considerations to just the surface aspects of those feedback loops.

On the next page of his book, Denis Noble points out that the Period gene does not act in isolation. At least 15 other genes interact, in various ways, with the rhythm phenomena.

Such an acknowledgment merely complicates the problem of trying to explain – as opposed to describing -- the phenomena of biological rhythms. Noble's foregoing acknowledgement means that all of the questions which have been raised previously over the last several pages of the current chapter -- but which were not addressed by Noble – have been multiplied by, at least, a factor of 15.

Noble goes on to indicate that the Period gene – and, presumably, other rhythm-related genes as well -- appears to play a role in the embryological dynamics of fruit-fly development, as well as contributes to the species-specific wing oscillation patterns (there are different patterns of oscillation for 5,000 species) that are used to attract appropriate mating partners. What is responsible for regulating the foregoing sorts of interactive dynamics across a number of different biological systems or networks is not indicated, and, therefore, per usual, Denis Noble sticks with surface descriptions and does not venture into the depths of explanations that would be capable of accounting for what makes possible the surface dynamics which are being described.

While noting the remarkable differences between the static properties of histology slides that he studied as a university student in the mid-1950s and the dynamic, three-dimensional films of an amoeba which he viewed many years later, Noble discusses how several pseudopodia – false feet – of the amoeba were able to operate with coordinated precision during a process of engulfing some sort of nutrient source which had been encountered along the organism's existential path, and once engulfed, that food would become digested.

Noble goes on to describe how the amoeba is able to detect the presence of food (possibly through chemical signals or frequencies of some kind) by means of various sensory receptors which are present in the organism's exterior membrane. In addition, he suggests that despite an absence of anything resembling nerves, the amoeba is presumed to have some kind of a nervous system which would enable the organism to process sensory signals concerning the presence of food which would lead, in some fashion, to a precisely coordinated engulfing movement involving the generating of two cytoplasmic-filled extensions from the organism's surface that would not only engulf a given nutrient but would start a digestion process which would transition something that was 'outside' into something that entered into the interior of the amoeba and was processed.

No aspect of Noble's discussion provides an account of how the membrane receptors of the amoeba came to have the capacity to detect the presence of nutrients and recognize that what was being encountered was worthy of being engulfed. Furthermore, there is no discussion of how the amoeba developed the capacity to induce cytoplasm to generate extensions that were capable of engulfing objects or how any of this is possible without a recognizable nervous system of any kind.

Moreover, while the amoeba's capacity for producing other amoebas is mentioned in passing, nothing is said about how amoeba's acquired this capacity for reproduction. However, what is mentioned is the idea that there must be some sort of network within the amoeba which is capable of interacting with DNA to look after all of the foregoing dynamics.

Let us assume that Noble is correct with respect to his foregoing conjecture concerning the existence of some sort of internal network which is capable of doing whatever is necessary for an amoeba to be able to continue to exist and reproduce. Notwithstanding the granting of such an assumption, one is still left with the need for an explanation concerning how that kind of a functional network initially came into being, and how such a potential – which is not likely to have been had any functionality right away -- would have been maintained until it reached some threshold of having the necessary, minimal functionality which would be capable of life.

How did a capacity arise which enabled deoxyribonucleic acid to be transduced into an entirely different kind of molecule (i.e., amino acids? How did messenger RNA (mRNA), transfer-RNA, and ribosomal

RNA come into being in a way that became coordinated in a functional manner?

How did the amoeba acquire the capacity to generate energy and establish the circuitry or pathways which would connect that energy with whatever required such an enabling medium? Noble keeps mentioning the idea of a biochemical network, but he often appears to believe – devoid of any sort of persuasive or definitive evidence -- that such networks will automatically arise through self-organizing processes.

Are cellular networks self-organizing phenomena? Or, are cellular networks a function of some sort of extra-biochemical dynamic which regulates what can and cannot happen biochemically within a cellular environment?

Conceivably, contrary to what Noble maintains, perhaps biochemical networks do not naturally organize themselves into functional units within an enclosed, membrane-bound environment. Perhaps, something other than biochemistry is needed to organize cellular dynamics into metabolic pathways which are capable of interacting with one another in functional, life-sustaining processes.

Over the last 75-plus years, we have witnessed the appearance of terms such as: "Chaotic dynamics", "dissipative structures", "emergent properties," "complexity phenomena," and "self-organizing systems." Among other things, these terms have been adopted by some individuals to suggest a possible way to explain how life might have begun and/or how to account for the complex intricacies that take place in different life forms, and, yet, the apparent early promise of the foregoing ideas have never really materialized, and, as a result, we are as much in the dark now concerning the nature of life's origins, as we have been since the notion of a "warm little pond" was proposed by Darwin in a letter to Joseph Hooker.

In his book *Dance to the Tune of Life*, Denis Noble provides a diagram outlining certain features of the phylogenic tree of life. He cites three groups: Bacteria, Archaea, and Eucarya.

Aside from the previously noted absence of any account within Noble's book which plausibly addresses the issue of how the first bacteria came into existence, Noble also doesn't indicate how aerobic forms of bacteria (oxygen-using) arose from their alleged anaerobic predecessors (for which oxygen takes on the role of a poison). In addition, he doesn't account for how life evolved from the chemotrophic progeny of – maybe -- hydrothermal vents to various species of light-oriented, autotrophic cyanobacteria that are capable of photosynthesis.

Noble mentions the 1977 publication of Carl Woese concerning the existence of a form of life – namely, Archaea – which is not bacterial or eukaryotic in nature and, yet, contains properties that are similar to features possessed by each of latter two forms of life. Nonetheless, one finds no account in Noble's presentation concerning how the genetic sequences which distinguish Archaea from both bacteria and eukaryotes arose (and these genetic sequences are what led Woese to his discoveries), nor is there any account with respect to how a variety of archaea developed their capacities to live in environments which are characterized by extremes of, among other possibilities: Temperature (both high and low), pressure, acidity, alkalinity, or radiation.

In addition, no account is provided by Noble that demonstrates how eukaryotic organisms – e.g., plants, fungi, and animals which, among other things, have a true nucleus as well as various organelles, such as Golgi bodies and lysosomes -- arose out of prokaryotic forms of life which do not possess a true nucleus or any of the other aforementioned organelles. Nor, is any account provided by Noble which plausibly bridges the differences between, on the one hand, the asexual forms of reproduction that existed early on during the ascendancy of life on Earth and, on the other hand, the sexual forms of reproduction which arose subsequently.

Noble does suggest that eukaryotes are the result of a process of endosymbiosis which occurred between different forms of prokaryotic life. However, the foregoing suggestion is never backed up with any evidence which would be capable of demonstrating that the suggestion is anything more than a conjecture.

When discussing the potential evolutionary development of bacteria, Noble points out that there are at least three ways for bacteria to exchange genetic information with one another. For example, bacteria can take control of DNA which is in their immediate environment and incorporate that genetic material into their genome.

However, nothing is said about what the likelihood might be that naked DNA would be able to remain viable for very long in any given external environment or about whether, or not, DNA would might be damaged during the process of becoming incorporated into the interior of a bacterium, or, once DNA becomes incorporated, whether, or not, such DNA would necessarily be integrated into the bacterium's genome, or even if integrated, whether, or not, such DNA would have any functionality. Until one can show that Noble's suggestion concerning the alleged capacity of bacteria to acquire new naked DNA from the environment that would be able to function in some genetic fashion once it is incorporated into a bacterium, then, one is merely dealing in hypotheticals and nothing more.

A second possibility mentioned by Noble with respect to ways in which bacteria might acquire new genetic material has to do with the relationship between bacteria and bacteriophages, these sorts of possibilities have been explored fairly extensively in *Toxic Knowledge* and in that work a lot of questions surrounding the nature of such possible exchanges are raised. Among other issues, the foregoing book indicates that there is little, or no, evidence indicating that whatever exchanges take place between bacteriophages and bacteria are necessarily open-ended in character and, therefore, are randomly capable of generating recombinant dynamics which would be capable, over time, of producing all manner of life forms.

Bacteriophages can have both a symbiotic and adversarial relationship with bacteria. Until one can establish what the functional contours of such symbiotic relationships are – and, for the most part, this has not been done yet – one is no position to claim that the way in which one goes from, say, prokaryotes to eukaryotes, or even from one kind of bacterial species to another, is through whatever exchanges take place between bacteriophages and bacteria.

Furthermore, before one can talk about what the relationship is between bacteriophages and bacteria, one must be able to account for how each side of that relationship came into existence in the first place and whether, or not, their origins are independent from one another. Moreover, if they do have independent origins with respect to one another, then we are confronted with the additional problem of accounting for how bacteriophages and bacteria were able to enter into symbiotic relationships with one another given that some bacteriophages have the capacity to destroy various species of bacteria.

Finally, Noble mentions the process of conjugation in which sequences of genetic material can be transferred from one kind of bacterium to another. As evolutionarily suggestive as the dynamics of conjugation might appear, one needs to ask whether this process is anything more than a variation on population genetics in which various potentials can be distributed in a variety of ways across any given population of organisms that thrive or flail as environmental conditions change, and, therefore, the question remains as to whether such an interactive process of population genetics and environmental variations ever leads to anything which is appreciably different from what already exists … creating a new species (that is, a form of life which is no longer capable of producing viable offspring with members of a population to which that form of life once belonged) is a far simpler process than creating a new genus, family, order, class, phylum, kingdom or domain.

The real problem for evolutionary theory is not the "origin of species." The real problem for evolutionary theory has to do with finding plausible, provable ways for explaining how totally new forms of: Protein structures, organelle or organ systems, energy production, metabolic pathways, sensory abilities, reproductive dynamics, behavioral capabilities, embryological phenomena, epigenetic regulation, and cognitive processing come into being.

Noble cites the acquisition of antibiotic resistance as an example that illustrates how something new is capable of showing up in a given species. However, this is not necessarily so much a matter of something new coming into existence as it is the result of a process that is going on already which generates a successful candidate for resisting antibiotics in some way.

In other words, a capacity for resisting antibiotics is already present because not all members of a bacterial population are equally susceptible to the presence of antibiotics. Consequently, nothing substantially new is necessarily being introduced when antibiotic resistance emerges in a given species of bacteria, but, rather, what is new is the degree of success which is being experienced as the result of a small change in an already existing dynamic.

Can one plausibly suppose that an indefinitely large series of such small changes will necessarily lead to all manner of new capabilities other than antibiotic resistance? Given that one can trace all manner of pathologies in human beings and other organisms to small changes in genetic processes (I don't know of one positive change that was ever introduced into the lives of -- among other experimental organisms -- fruit flies) can one suppose that whatever changes occur in an organism are highly likely to be necessarily constructive and additive in nature rather than problematic?

Can one necessarily suppose that whatever changes occur with respect to the foregoing sorts of small changes will automatically become incorporated into a functional dynamic and that there will be no constraints present in conjunction with the dynamics of on-going cellular regulation which can be imposed on how, of if, genetic material will be expressed. After all, one should recall that toward the beginning of *Dance to the Tune of Life*, Noble indicated that DNA is passive and has to be acted on in order for such DNA to be expressed, and, therefore, acquiring new DNA is not, in and of itself, sufficient to account for the emergence of new capabilities since there have to be epigenetic dynamics in place which are able to constructively activate whatever potential is present in given sequences of new DNA.

The capacity of bacteria and archaea to engage in various forms of horizontal gene transfer indicates there are degrees of freedom present with respect to how bacteria and archaea are able to function in different environments. However, no one has shown how the capacity for horizontal gene transfer can serve as an evolutionary force that will, in time, generate every kind of new biological function or property that has ever existed on Earth or that there aren't an array of fail-safe factors built into organisms which resist or constrain what can and can't happen in any given organism or cellular environment.

After noting that there are many problematic explanatory issues surrounding the idea that life started off with DNA, Noble introduces the notion of the RNA-world hypothesis. This perspective gives emphasis to the fact that in all known life-forms, RNA – in the form, for example, of mRNA, tRNA, ribosomal-RNA – is what is responsible for the heavy lifting that turns genetic potential into active functioning and, in addition, notes how some forms of RNA have been shown to have enzymatic capabilities and, consequently, might have been able to facilitate biochemical dynamics before the advent of either DNA or proteins.

While the RNA-world hypothesis does take care of certain problems which confront any attempt to account for the origins of life through dynamics which are rooted in DNA and proteins, the RNA-world hypothesis has problems of its own. For instance, relative to DNA, RNA is actually a much more fragile and unstable molecule, and, as a result, is more susceptible to being quickly degraded in an inorganic, pre-biotic wilderness.

Secondly, the RNA-world hypothesis cannot avoid the same fundamental problems which haunt a DNA-based evolutionary theory. More specifically, how did either DNA or RNA come to stand for, or represent, or mean, or constitute a code for an entirely different kind of organic material – namely, amino acids, and how did the triplet coding system of DNA come to stand for 20 specific amino acids from among the hundreds of more amino acid structures which are possible, and why are some amino acids represented by more different triplet codes than are other amino acids, and how did certain triplet codons come to mean “stop”?

In addition, to the foregoing problems, the RNA-world hypothesis is haunted by, yet, other kinds of difficulties. For instance, let’s assume that the RNA-world hypothesis is correct.

We don’t currently live in a RNA-world. We live in a DNA world that is activated by, among other processes, RNA dynamics, and, so, one might ask: What are the specific events which transitioned the world from an RNA-world to a DNA-world? Generally speaking, asking this question leads to nothing except the sound of crickets -- usually Jimmy Cricket, and his family, voicing the words: “When you wish upon a star …”

Noble follows up his brief discussion of the RNA-world hypothesis with a mention of viruses and their place in the evolutionary scheme of things. He claims that viruses are a form of life, yet, he never actually explains in what way viruses can be considered to be living.

He goes on to note how viruses can only be seen via electron microscopes. However, he does not explain how the static, micrographic images that are produced in conjunction with electron microscopic demonstrate the presence of viruses.

In other words, there are “objects” in the images which are designated to be viruses. Putting aside the issue of whether such “objects” might merely be artifacts of the complex conditions of chemistry, temperature, and radiation through which such images are acquired, one wonders whether, or not, anyone has: Taken the objects being depicted in the micrograph into a laboratory, opened them up, and confirmed there are sequences of DNA or RNA in them which can be shown to be capable of viral activity.

One doesn’t have to wonder very long about the foregoing issue. This is because no one actually has taken the objects being depicted in such micrographs and shown that they contain either DNA or RNA material which is capable of viral activities.

Back in the 1950s Nobel Prize winner John Enders performed various experiments with the alleged measles virus. For instance, he took samples from people there were diagnosed with measles and placed those samples in a concoction containing: Antibiotics, Vero kidney cells from African green monkeys, fetal bovine serum, and a few other ingredients, and, after a period of time observed a cytopathic effect occur in the kidney cells (i.e., they died) which was attributed to the presence of a measles virus.

However, a control experiment was also done which involved the same set of procedures except one. This exception had to do with using a biological sample that was taken from a healthy individual, and, then, proceeding in the same way as before.

The cytopathic effect was also observed in the control experiment. This meant that whatever was causing the cytopathic effect was not due to the presence of a measles virus and might have had more to do with the fact that the antibiotics used (to ensure that there were no bacteria present which might cause the cytopathic effect) have been shown to have the capacity to damage Vero kidney cells, and, in addition, the experiments were run in a nutrient-deprived condition, and this also could have helped to induce a cytopathic effect in the Vero monkey cells.

The foregoing experiments have been replicated by, among others, Stefan Lanka. Such individuals have demonstrated again and again that irrespective of whether one takes samples from a person who allegedly has measles or one uses a sample from a healthy individual, the kidney cells die, and, therefore, one cannot conclude that the reason that the kidney cells have died is because of the presence of a certain kind of virus.

Denis Noble indicates that although the evolutionary origins of viruses are shrouded in mystery, nonetheless, he believes they had a potentially important role to play in evolution due to their capacity for lateral transfer of DNA to whatever organisms might be "infected" by such a viral entity. Once again, however, he offers no specific, concrete proof concerning how such alleged lateral transfer led to evolutionarily significant changes in any given species.

Earlier in his book, while discussing the notion of the RNA-world hypothesis, he indicates that such an idea is rather far-fetched. He, then, goes on to confess that all that many aspects of evolutionary theory have is a lot of rather far-fetched ideas, none of which can be shown to be true or can be shown to be based on substantial, concrete, undeniable evidence.

Given that claims concerning the existence of viruses rest upon empirically shaky grounds (and only a small part of the evidence which runs contrary to the idea that viruses exist has been cited here), then, one might consider the possibility that to further entertain the idea that viruses might have played a significant role in evolutionary development as a result of the phenomenon of lateral transfer of DNA also might rest on a set of even shakier possibilities. No evidence is cited by Noble to show that the phenomenon of lateral transfer of DNA happened outside of – possibly -- the relationship between bacteriophages and bacteria or that the phenomenon of the lateral transfer of DNA happened in a way, or on enough occasions, to enable that process to play any kind of significant role in advancing the evolutionary dynamics of eukaryotic, prokaryotic, or archaea organisms.

At one point during his discussion of the possible evolutionary role of viruses, Noble proposes that, perhaps, viruses are "descendents" of protocells (an ordered, but, in certain ways, incomplete form of what would, subsequently, transition, somehow, into a fully functioning cell) which through an unknown process devolved into state in which it no longer could reproduce itself without the assistance of living cells.

This is not science. It is a narrative.

One often hears about the bravery and progressive vision of the young high school teacher, John Scopes, for being willing to take on the establishment in 1925 with respect to the issue of evolution. There is a third-party in the foregoing controversy which is neither the progressive high school visionary nor the establishment.

Just for a moment, one might also consider the students who are forced to operate in accordance with whatever either such alleged 'scientific' visionaries or the ideologically-invested establishment powers wish to foist on those young individuals who have no say in what is to be learned or how it is to be learned or under what set of circumstances it is to be learned. There is a multiplicity of ways that the educational process can be used to cripple students – often for life -- and, more often than not, this is because education is used as system of control (by teachers, administrations, governments, corporations, and the community) rather than being a venue for enhancing: Curiosity, creativity, legitimate inquiry and/or critical reflection.

Following a discussion concerning the intricacies of the cell cycle in which an array of interacting metabolic pathways (involving numerous proteins) work in concert with one another to bring about: A division of a cell's set of chromosomes, the dissipation of that cell's nuclear membrane, the separation of the aforementioned chromosomes, and the generation of two cells, Noble maintains that such a complex set of dynamics cannot be controlled by a set of genes but depends on a network of different levels of cellular activity – from molecular to epigenetic – all making their contributions at the right time, in the right sequence, in the right place, and in the right amounts for the foregoing process of mitosis to be able to take place. In short, Noble contends that the locus of biological causality is a function of the cellular networks that underlay such dynamics and cannot possibly be explained as the result of just a set of genes … in other words, according to Noble, genes – in and of themselves – cannot explain the cell cycle, but, rather, that phenomenon only makes sense in the context of the complex, interactive dynamics of a set of metabolic pathways (both anabolic and catabolic) that give expression to a layered network which regulates cell functions such as the cell-cycle.

The foregoing perspective is at the heart of Noble's notion of biological relativity. Contrary to the paradigm which has been dominating biology and evolution for the last one hundred years, or so, in which genes are described as constituting a blueprint of life, Noble wishes to maintain that biological and evolutionary causality is the result of a complex, interacting, multi-layered network in which genes play only a part and provide not privileged insight into why cellular dynamics occur in the way they do.

While Noble acknowledges that biological and evolutionary dynamics are causal in nature, nonetheless, he contends that a person cannot point to any one element of those dynamics as being "the" cause of what is taking place. Just as was indicated earlier in conjunction with Morton White that the causality of lighting a match is rooted in a whole set of interacting conditions and dynamics and cannot be reduced to the act of striking a match, so too, causality in a biological phenomenon like the cell cycle is rooted in an entire set of metabolic pathways which form a dynamic network that is referred to as a cell.

As has been demonstrated in a variety of ways throughout this chapter, Noble encounters a variety of difficulties when he seeks to provide a defensible account concerning how evolution might have given rise to the foregoing sort of cellular network because just as genes do not seem constitute the kind of whole which is able to account for what takes place in cells, so too, biological networks cannot be said to arise as fully functional systems like Athena was said to arise fully grown from the head of her father, Zeus. Genes cannot account for their existence, and biological networks cannot account for their own existence either.

In a sense, Noble – knowingly or unknowingly – is adopting a conceptual position which resonates with the manner in which Bohr went about engaging quantum mechanics. More specifically, Bohr was quite insistent – without any really good evidence or persuasive reasons to back him up – that the probabilities inherent in the wave function were as far as one could epistemologically penetrate into the nature of causality and ontology (i.e., there were no hidden variables). In a similar fashion, Denis Noble appears to be saying that the furthest that one can epistemologically and causally penetrate into the ontological character of biology and evolution is in the form of network dynamics where no one aspect of such a network is epistemologically or causally privileged and, therefore, capable of accounting for the network's properties and behavior.

Just as much of the previous several hundred-plus pages have been pointing out that there is considerable evidence indicating that there is something more deeply hidden than is suggested by many traditional ways of attempting to explain different aspects of reality, so too, the remainder of this book will be exploring a variety of issues which strongly suggest that there is something more deeply hidden than is indicated by Noble's principle of biological relativity.

The something more deeply hidden is like an extremely complex set of dominoes. In other words, once dominoes have been set in motion, one can become lost in the amazing intricacy of the dynamics which are unfolding before one's eyes and come to the conclusion that it is the network of dominoes which is the cause of what is transpiring, and in doing so, one might forget to ask: How did the dominoes come to be organized in a way that made such a dynamic network of falling dominoes possible, and in asking this question, one comes face-to-face with the possibility that the network is not necessarily the cause of those dynamics but, rather, whatever is responsible for the network of dominoes being organized in the way that it is gives expression to a causal phenomenon which is more fundamental than whatever is taking place as the falling dominoes go about their intricate, interacting pathways.

Biological networks do not explain themselves. They are a function of some set of regulatory activities which form the ecology in which a given biological network is rooted … an ecology which shapes, colors, orients, and moves networks to unfold and manifest themselves in the way they do.

Chapter 8: Béchamp's Blood

When Béchamp was 85, his final work was released to the world. The title of the publication – when translated into English -- is: *The Blood and its Third Element*.

Prior to the foregoing work, Béchamp had written extensively on a wide variety of scientific, biological, and medical issues. Among those works were research materials which revealed, among other things, that the alleged research of his contemporary Louis Pasteur concerning the germ theory was without merit.

Although medical and biological 'modernity' sing the praises of Pasteur, there is considerable evidence (for example, *Béchamp or Pasteur? A Lost Chapter in the History of Biology, Pasteur: Plagiarist, Imposter* -- by Ethel Douglas Hume and R.B. Pearson**)** indicating that Pasteur not only plagiarized aspects of Béchamp's work, but in the process, he often distorted the nature and significance of what had been plagiarized. Béchamp considered Pasteur's germ theory to be one of the silliest fictions to have emerged during the mid-nineteenth to early twentieth century era of scientific research, and this assessment concerning Pasteur's perspective on germ theory was based on more than half a century of rigorous experimentation.

Furthermore, a great deal of research conducted independently of both Béchamp and Pasteur documented how time and time again, Pasteur's so-called medical breakthroughs with respect to the development of alleged treatments involving pathologies ranging from: Silk worm disease, to: anthrax were massive failures which often killed the recipients of those treatments and, in the process, cost governments and businesses a great deal of money. Even Pasteur's much touted treatment for rabies turned out to be unreliable and questionable.

In the mid-to-late 1850s, Béchamp discovered a number of soluble ferments which he referred to as zymases. Among other properties, these entities were capable of transforming cane sugar into glucose.

During one series of experiments, he showed that when pure calcium carbonate (that is, natural forms of calcium carbonate which have been treated in ways which purify that compound) is placed in containers that have been sealed-off from contact with the air, then, cane sugar is not transformed into glucose. However if one takes calcareous materials from natural deposits on the Earth (that is, unpurified samples of calcium carbonate) and, then, adds – in a laboratory-controlled manner – this compound to cane sugar in a container that is sealed-off from contact with the air, then, moulds will begin to emerge and the transformation of cane sugar into glucose will take place.

Upon subsequent microscopic examination, the foregoing moulds were discovered to consist of granulations which, in 1866, Béchamp termed microzymas. Further investigation indicated that these microzymas appeared to constitute a form of life that could not only transform cane sugar into glucose but, they could also bring about processes of fermentation (the breaking down of molecules, such as glucose, in the absence of oxygen and, in the process, generating energy – in other words, a digestive-like dynamic capable of producing elements which yielded nutritious value).

Béchamp discovered the presence of zythozymas in yeast. He also discovered the existence of anthozymas in flowers as well as the presence of nefrozymas in urine, with each kind of organism giving rise, in some fashion, to its own modalities of zymas or fermenting elements.

By 1870 considerable research was being conducted in conjunction with the foregoing phenomena. Béchamp, along with his colleague Estor, and a number of other scientific researches all began to produce evidence indicating that such zymas were present in an array of biological organisms, and, collectively, all of this research went into shaping and developing the microzymian theory of living organisms.

In addition, Béchamp demonstrated that, under the right conditions, those microzymas were able to change their morphological and biological properties. By establishing the reality of the foregoing phenomenon, he laid the foundations which led to the formation of the principle of pleiomorphism in which certain microbiological forms of life can be induced to transform into different morphological kinds of life-forms that are capable of exhibiting properties which were not previously apparent.

Béchamp's findings were replicated by subsequent researchers such as Günther Enderlein, a German scientist who conducted biological and medical research during the early part of the twentieth century, as well as, was developed through the much more detailed work of Gaston Naessens, a French scientist who had moved to Quebec, Canada and had developed a microscope known as the Somatoscope (which has since been dismantled and permitted to deteriorate by authorities in Canada) that was capable of enabling scientists to observe organisms going about life at a near-nano scale. Naessens' work during the latter half of the twentieth-century as well as the beginning of the twenty-first century demonstrated that the organisms which he referred to as somatids have a pleiomorphic life-cycle which entails some 20, or so, morphological forms, each with different kinds of properties, and microzymas might well be a kind of somatid or one of the morphological stages through which somatids go.

In the previous chapter, the ideas of Denis Noble were discussed through which he described how genes cannot organize themselves but must be activated by something beyond those genes. For Noble this "something beyond" was a network of interacting levels of biological activity, ranging from atoms and molecules to tissues and organs

For Béchamp and Naessens the aforementioned notion of: "something beyond," assumed the form of microzymas/ somatids. For those two researchers – as well as for other investigators who were engaged in similar research -- those entities (i.e., microzymas/ somatids) were the medium through which organic matter was organized into, among other possibilities, cellular life forms.

Based on his decades of research, Béchamp came to the conclusion that there were morphologically similar entities – namely, microzymas – which were present in all of the organs, tissues, and cells of organisms but the functional character of these morphologically similar entities varied from organ to organ, tissue to tissue, and cell to cell. Based on independent research, many years later, Gaston Naessens had come to similar conclusions with respect to the dynamics of somatids.

Just to provide one example from the work of Naessens that gives expression to the foregoing perspective, one might consider Naessens experimental work involving transplant dynamics. More specifically, skin segments from rabbits with single colored hair (black or white) were used during transplant procedures in which skin tissues from, say, black-haired colored rabbits were transferred to white-haired rabbits.

Naessens discovered that when the foregoing procedures were conducted without taking into consideration the somatids from the skin cells/tissue of the rabbit whose skin sample was going to be transplanted into another rabbit with different hair color, then, the skin transplant was rejected. However, if, first, somatids were collected from the rabbit whose skin segment was going to be transplanted to another rabbit and, secondly, those somatids were transmitted to the future transplant recipient, then, the subsequent transplant procedure would be successful (i.e., the transplanted skin was healthy, not rejected, and gave rise to hair with a different color than the rest of the hair color of the transplant recipient).

Similarly, Béchamp previously had discovered decades earlier that when microzymas were dislodged or removed from their usual biological conditions, the destabilization process induced the microzymas to function differently and, as a result, give rise to biochemical fermentation processes that led to the dissolution of the tissues or cells in which such destabilization had taken place. In addition, Béchamp noted that the microzymas underwent morphological changes that manifested in the form of various kinds of bacteria … a dynamic which Naessens (with the help of his revolutionary imaging device, the Somatoscope) would work out in much more detail over a half-century later.

Béchamp also discovered that after all of the foregoing pleiomorphic morphological changes had taken place and the region which had become biologically destabilized and, as a result, finally succumbed to whatever form of pathology had occurred, the pleiomorphic life forms, themselves, would disappear and return to their original microzymic state. Further research by Béchamp indicated that the foregoing microzymas were identical – both morphologically and functionally – to the microzymas which he originally had found to be present in the natural -- unprocessed forms of -- calcium carbonate with which he had begun in work in the 1850s and which had been found in deposits that were millions of years old, and, consequently, Béchamp had established a connection between the microzymas of ancient times and the microzymas of modern times.

In addition, Béchamp also had discovered that the ovule or predecessor out of which the female egg eventually emerges contains microzymas. Consequently, he concluded that microzymas have a fundamental role of some kind to play with respect to the organizing of subsequent embryological development.

The capacity for pleiomorphic changes in morphology and function were present in microzymas. When the bacteria and other life forms to which such pleiomorphic changes gave expression disappeared because of changing, pathological changes in cells, tissues, or organs, the microzymas reappeared.

When embryological development began, microzymas were present in the eggs. Cells in general were a function of the dynamics of microzymas.

Microzymas could remain dormant for millions of years in calcium carbonate deposits. Yet, they could resume fermenting activity if given something – such as sugar cane -- to ferment.

Consequently, Béchamp had established empirically and experimentally that microzymas were responsible for organizing processes of development but, as well, that when the biological terrain became destabilized, microzymas -- via pleiomorphic transformations – also were associated with conditions of pathology, and, moreover, when those sort of pleiomorphic transformations had run their course (irrespective of whether this meant the life or death of the organism), microzymas reasserted themselves and could be viably dormant for millions of years. All of the foregoing pieces of evidence indicated to Béchamp that microzymas were a special form of life.

Béchamp also tested microzymas for their durability under a variety of conditions of temperatures and extremes of other kinds. He found them to be very robust.

The foregoing characteristic was also confirmed by Naessens many years later. Naessens found that somatids – like microzymas –

could withstand very high temperatures and, yet, still function. Naessens also discovered that somatids could viably withstand exposure to various strong acids, normally lethal levels of radiation, and were so hard that they could not be cut by a diamond knife.

Given his empirical and experimental discoveries, Béchamp took issue with the contention of Rudolf Virchow (a preeminent German physician and biologist of the 19th century) that all life arose from cells. However, although Béchamp believed that, initially, cells arose from the activities of microzymas, nonetheless, he also felt that the meme-like phrase which is often associated with the perspective of Virchow – namely, *Omnis cellula e cellula* ("All cells come from cells") – still had significance because cells could arise from cells through other kinds of processes that microzymas had helped to make possible.

As noted in the previous chapter, Denis Noble indicated that scientists have long had difficulty pinpointing the where the cause of life might be found in a cell, tissue, organ, or organism. In order to resolve that problem, he developed the notion of biological relativity which indicated that there was no privileged point of view – in the form of genes, cells, tissues, or organs -- which was capable of successfully identifying what caused life.

Therefore, Noble argued that one must consider the entire network of interacting levels of biological dynamics to which an organism gives expression in order to be able to intelligibly explore the cause of life. However, for Béchamp, the basic causal unit of life was a function of the dynamics of microzymas because cells live and die, and, as well, networks of cells live and die, due to the presence of microzymas which, depending on conditions, organize the health or pathology of such networks of cells.

Béchamp was of the opinion that while pleiomorphic remnants of microzyma activity (in the form of bacteria or microbes of one kind or another) were present in the air, nonetheless, none of these remnants were pathogenic. Therefore, Béchamp believed that diseases such as plague, anthrax, typhoid fever, tuberculosis, and so on could not be communicated by coming into contact with those sorts of air-borne remnants.

For Béchamp, disease arose when a person's or organism's biological terrain was destabilized in some way and that process of destabilization induced microzymas in the individual or organism to undergo pleiomorphic changes that gave rise to the pathological conditions that constituted disease. According to Béchamp, the pleiomorphic remnants of microzyma activity which were present in the air could not induce a person's normal modes of microzyma functioning to become destabilized and, thereby, lead to a pathological or diseased condition.

Following several decades of experimental work and empirical investigations, Béchamp had formulated most of the foregoing conceptual position by mid-1870. More specifically, in early May of that year, he published "*Les Microzymas, la Pathologie et la Therapeutique*" (*Microzymas, Pathology and Therapeutics*).

During the preface to *The Blood and its Third Element*, Béchamp comments that his research into the dynamics of blood is rooted in experimental work (some of which has been outlined in the previous pages of this chapter) which dates back to 1854. Such exploratory investigations began with the study of fermentation and ferments, as well as carried over into issues concerning spontaneous generation (which Béchamp rejected), and, then, that research expanded into a variety of topics concerning biological organization, physiological phenomena, and various kinds of pathology.

As noted earlier, the foregoing research generated the foundations for what Béchamp referred to as the microzymian theory of biological organization. In turn, the evidence on which that theory was based, led Béchamp to discover some very essential elements concerning the nature of blood, including the dynamics of blood coagulation.

Before providing some of the details of his perspective concerning the nature of blood, Béchamp indicated that no one – including physicians, chemists, and physiologists – seemed to know why blood coagulated. In order to create a context for his theory concerning the dynamics of coagulation, Béchamp takes readers of *The Blood and Its Third Element* through a brief history of some of the developments which have taken place during the 18th and 19th centuries concerning the research of different people who were attempting to explain why blood coagulated.

For example, Haller, an 18th century investigator, referred to certain kinds of fibers – which also had been noted by Aristotle – that formed a membranous network that had been observed to be present in coagulating blood. However, Haller did not believe that such fibers were an inherent feature of the blood because he was of the opinion that there was nothing solid in blood except globules – blood cells – that were suspended in a liquid which, initially, was referred to as lymph and, later on, was termed "plasma" (Béchamp, in opposition to the beliefs of many researchers during his life, did not consider the plasma to be a liquid that consisted of a set of components which formed a perfect solution).

The fibrous material observed in the blood came to be known as fibrin. It was deemed to be unrelated to, and, therefore, was differentiated from the globules which were present in the blood plasma, but a great deal of speculation arose concerning the origins of the fibrin complex.

Initially, a variety of interested observers believed that fibrin might be present as an extremely fine solute in the blood plasma. The foregoing possibility was developed to include the idea that when blood stopped flowing, the fibrin materials would come out of solution and gather together in a fibrous complex.

The foregoing theoretical perspective went through a number of different iterations. In one way or another, however, no one had a satisfactory explanation concerning the original source of the fibrin material.

Eventually, researchers began to equate coagulation with the condition of death. In other words, under normal circumstances, blood was considered to be a living force, but when, for whatever reason, coagulation takes place, then, that event was interpreted to be an indication that the plasma underwent some sort of destabilization process and, as a result, lost it capacity for life.

Various kinds of "occult-like" forces were proposed by various individuals in an attempt to "explain" the cause of the alleged destabilization process that, supposedly, led to coagulation. However, no one was ever able to offer a plausible account concerning how such forces worked.

As a result, referring to such mysterious forces as the cause of the destabilization dynamic which led to coagulation had only the appearance of constituting a causal explanation. In reality, those accounts were entirely devoid of anything of a substantive nature that was capable of being able to demonstrably and reliably account for the process of coagulation.

Béchamp, along with his research colleague, Alfred Estor had begun to investigate the issue of coagulation. Unfortunately, Béchamp had to continue those investigations on his own when, among other things, his friend and research associate died at a fairly young age in 1886.

Certain investigators (e.g., Frantz Glénard) indicated that no one had any understanding of the coagulation process and whether, or not, it is chemical and whether, or not, it involved crystallization. However, Béchamp had maintained as early as 1869 that microzymas were responsible for the formation of fibrous networks in coagulating blood, and, therefore, microzymas – not fibrin -- were the proximate cause of coagulation.

Nevertheless, dotting all the evidential "i's" and crossing all the experimental "t's" proved to be a challenging undertaking. Several more decades of rigorous research by Béchamp would have to be completed before the matter could be settled completely.

Eventually, Béchamp showed that the phenomenon of coagulation only constitutes the initial stage of a complex process in which blood is transformed in a number of ways. According to Béchamp, when the microzymas which are present in blood are subjected to certain kinds of destabilizing conditions, then, those microzymas begin to bring about the fermenting of certain aspects of the blood, and, among other things, this is accompanied by the formation of fibrous networks that play a role in the coagulation of blood.

In order to establish the foregoing understanding, Béchamp had to set up his experiments very carefully. He wanted to ensure that the presence of microzymas in blood was a function of the blood itself – the third element of blood beyond plasma and red cell globules.

By using a chemical procedure involving dilute hydrochloric acid – a process which had been developed by earlier researchers -- Béchamp was able to isolate microzymas that were connected with the fibrin that had been taken from blood. The foregoing process led to the identification of two products, one which was dissolvable and the other which was not dissolvable.

The latter, insoluble product consisted of microzymas. When examined under a microscope, this product could be observed to be made up of granulated forms that are very tiny (a diameter that is .0005 millimeters or .5 microns in size) and spherical in shape, but notwithstanding their small size, they revealed themselves to be both durable and quite dynamic.

According to Béchamp, the presence of microzymas could be observed in different kinds of tissues and cells. Nevertheless, not all microzymas appeared to be the same size, and some microzymas – for example, those found in blood – appeared to be more transparent than other kinds of microzymas, and the transparency could be due to the extent to which the refracting index of the microzymas is near to, or the same as, refracting index of the liquid which surrounds it.

Due, in general, to the small size of microzymas as well as their relative degree of transparency, Béchamp believed that many histologists might not have been able to detect the presence of microzymas very easily. In addition, Béchamp noted that another obstacle that might have prevented microzymas from being readily detected by researchers is that microzymian granulations were often surrounded by a complex of albuminoid materials (globular proteins), and, as a result, these sorts of molecular complexes had to be treated with a number of substances (e.g., alcoholised ether and distilled water) before one would be able to see the presence of microzymas.

Notwithstanding their small, individual size, Béchamp believed that the collective number of microzymas in the blood was quite high. For instance, one estimate he made indicated that each liter of blood contained over 400 billion microzymas.

Béchamp conducted the foregoing fibrin experiments in conjunction with blood that had been drawn from different animals. In all cases, the microzymas which were isolated and observed exhibited the same behavioral characteristics, and one of those behavioral features had to do with the zymas or fermenting materials which were released by, or emerged in relation to, the presence of microzymas.

While an array of individuals in the 21st century appear to believe that Béchamp's microzymas and Naessens' somatids are one and the same entity, nonetheless, some of the experiments which Béchamp performed in conjunction with the fibrin taken from the blood of different animals involved subjecting both the microzymas, as well as the zymas or fermenting materials that were associated with those microzymas, to a temperature of 100° Centigrade. When Béchamp heated the microzymas and the fermenting material to the foregoing temperature, both the microzymas and the fermenting material (i.e., the zymas) were destroyed.

However, when Naessens exposed somatids to a variety of extreme conditions – including temperatures that were 200° Centigrade and above -- the somatids remained intact and functional. The temperature-differential between the results or outcomes of the experiments conducted by Béchamp and the experiments performed by Naessens are considerable, and, consequently, while microzymas have proven to give expression to a remarkable form of life, there is reason to believe (given the aforementioned temperature experiments) that however microzymas might be related to somatids, the former are not necessarily precisely the same as the latter but might play some role with respect to the 16-stage pleiomorphic somatid cycle which Naessens had established on the basis of his own research.

Béchamp maintained that microzymas were not only associated with the presence of fibrin in blood. Based on experiments which he conducted over a period of time, he also indicated that microzymas were present in the membrane-bound red globules or hemoglobin molecules that are found within the plasma of blood.

Three anatomical elements were recognized by Béchamp as being present in the blood. These were: the white globules, the red globules, as well as the microzymian molecular granulations, and all three of these elements were surrounded by a fourth component – namely, the liquid plasma.

As far as Béchamp was concerned, the only facet of the foregoing set of components which could be said to be living is the microzymas. He held the foregoing opinion because, on the one hand, the fermenting dynamics of the blood could be shown to be a function of the presence of microzymas, while, on the other hand, Béchamp maintained that the microzymas were alive because they appeared to serve as the points of origin for the emergence of various pleiomorphic life forms.

Béchamp believed that the properties of red globules (hemoglobin), white globules (leukocytes), and the plasma are organized by the activities of the microzymas in the blood. This quality of being the source of biological organizing activity which underwrote the continuing integrity of the organism was a key to why Béchamp attributed life to the microzymas rather than to the components of the blood – or to the components of any other kind of organ, tissue or cell -- which were being shaped through the dynamics that were being organized by microzymas.

For Béchamp, blood constitutes a flowing form of tissue. Just as microzymas contribute to organizing the dynamics which take place in other kinds of tissues (though zymas, fermenting processes, and the pleiomorphic transformation of various life forms), so too, microzymas play a similar role in the tissue termed "blood."

According to Béchamp, what coagulates is not the blood, per se. In other words, the red and white globules in the blood are not coagulating.

Rather, the activities of the microzymas give rise to fibrous materials which form a meshwork in which various components present in the blood – such as albuminoids – become caught up in that meshwork. Moreover, as indicated previously, the foregoing process of coagulation is just the first stage of a series of changes that occur in the blood due to the activities of microzymas, and one of these subsequent changes has to do with the dissolution of various red globules which leads to the diffusion of hemoglobin in affected portions of the blood serum.

In addition, given the existence of certain conditions, bacteria could arise in the areas which have become destabilized. This was true even if – and contrary to the perspective of Pasteur -- such areas were completely sealed off from the "germs" of the atmosphere because the appearance of such bacteria was part of the pleiomorphic transformations brought about by microzymas which occurred in conjunction with the destabilization of the blood tissue.

Béchamp conducted experiments in which he showed that when, say, beer yeast cells were destroyed, the microzymas contained in those cells would be released. Under the appropriate conditions (involving considerations such as temperature, humidity, acidity, and so on) these microzymas transformed into anaerobic forms of bacteria (a process that could be traced via the microscope) and, then, subsequently, those bacteria transformed back into microzymas (a process that also could be traced via the microscope).

What occurred in conjunction with beer yeast cells was, for Béchamp, typical of a general phenomenon involving all plant and animal life. When cells or tissues are destabilized and, as a result, break down, they release their indigenous microzymas, and, furthermore, given the right conditions, some of these microzymas transform, first, into various forms of bacteria, and, then, subsequently, return, once again, to being microzymas.

According to Béchamp, microzymas are the agents of change within organisms. Everything else in an organism – whether in the forms of cells, tissues, or organs (and, as indicated previously, Béchamp considers blood to be a form of tissue) – constitute alterable forms of organic material, and every alterable form of organic material is attended to by species of microzymas which are specific to that kind of organic form, so the microzymas that are present in the blood are unique to that tissue, but, as Béchamp discovered during his experimental research, the microzymas which are present in the blood of other organisms are also unique to those animals and, therefore, are different from the microzymas which are present in the blood of human beings.

Béchamp points out that, morphologically, the microzymas from different animals might have the same set of external characteristics. Functionally, however, the microzymas are different, and all species of microzymas secrete their species-specific forms of zymas or fermenting materials.

Furthermore, Béchamp maintained that bacterial forms of life did not pre-date or exist independently of microzymas. For example, he contended that whatever evidence for bacteria is found (such as in geological strata from long ago eras) constitutes, ultimately, pleiomorphically transformed editions of previously existing species of microzymas, and part of the evidence which he cites in support of the foregoing contention has to do with the still viable microzymas that he discovered in chalk deposits that had been laid down millions of years ago.

Moreover, just as bacteria did not arise either prior to, or independently of, microzymas in a geological context, so too, Béchamp held that in matters of disease, the same sort of temporal relationship existed. Therefore, bacteria do not precede the emergence of a disease, but, instead, disease is the result of whatever toxic conditions are present which, among other things, are conducive to the pleiomorphic emergence of bacterial forms of life -- some of which are pathogenic in nature – as a result of the destabilizing factors which undermine the usual modalities of functioning among microzymas.

In short, we might become ill when various microzymas within us are prevented from functioning normally. Under such circumstances, the biological terrain of an organism becomes vulnerable to a variety of pathological possibilities including – under the 'right' set of biological conditions -- the emergence of pleiomorphic transformations of a pathogenic nature that are made possible by the dysfunctional dynamics of certain microzymas.

Whether, or not, an individual gets sick under the foregoing circumstances will depend on a complex set of factors involving, among other things, the degree of health which is, or is not, present in the biological terrain where microzymas have been destabilized. Béchamp refers to the foregoing complex of factors as the "individual coefficient" and determines whether, or not, either (or both) of two individuals who are exposed to the same set of destabilizing conditions will become ill," and this notion of "individual coefficient" resonates with Morton White's previously discussed approach to the complexities surrounding the issue of causality.

As noted earlier, Béchamp asserted that not only do microzymas vary in functional properties across different species of organisms, but, as well, they vary in functional properties across different systems of cells, tissues, and organs within any given, single organism. However, he also argued that the functional characteristics of microzymas also exhibit changes during different stages of embryological development – a position which resonates with the discoveries made many decades later concerning the manner in which various cells, tissues, and organs arise with new kinds of functions as the process of cellular differentiation unfolds over time.

Modern embryology would trace such functional changes to transitions which occur in conjunction with the way stem cells organize what kinds of cells will emerge at different stages of development. Béchamp didn't know about stem cells at the time he conducted his research, but if he had been informed about them by, say, an informed time-traveler, then, after listening to what that time-traveler had to say, Béchamp would likely have claimed that since cells with different functions arise as a result of transitions taking place in various microzymas, then, for Béchamp, the emergence of stem cells themselves would be considered to be a function of the prior activity of certain kinds of microzymas.

Béchamp was a first-rate researcher, scientist, and experimentalist. As a result, he restricted his work to what could be observed empirically.

Consequently, one will find very few, if any, speculations in his writing concerning how microzymas might have come into existence Moreover, although Béchamp could describe, in considerable detail, the morphological and/or functional differences which were present in the microzymas that were present in various kinds of cells, tissues, or organs within a given organism or an array of species, he couldn't explain how those microzymas had acquired such differences in functional and/or morphological character.

Béchamp knew that different kinds of microzymas were present at various stages of embryological developmental. Nonetheless, he couldn't explain what induced those sorts of differences in embryological dynamics become manifest at one time rather than another.

Béchamp understood that the microzymas which were present in different species, cells, tissues, or organs had their own unique set of zymas or fermenting materials which were secreted by or associated with, those microzymas. However, he couldn't explain how microzymas "knew" which zymas to secrete or help to bring into existence in conjunction with any given set of conditions.

Many decades later, another researcher of French ancestry – namely, Gaston Naessens – extended the work of Béchamp by both empirically and experimentally demonstrating that there was a 16-stage pleiomorphic cycle that was associated with the activity of "somatids" (tiny bodies) in the blood. Naessens also was in agreement with Béchamp with respect to the idea that every kind of species, cell, tissue, or organ was populated by tiny bodies which were unique to, and fundamental for the functioning of, those species, cells, tissues, or organs (and, among other things, this realization formed the basis of his transplant experiments which were touched upon earlier in this chapter).

Naessens considered somatids to be the link between the non-living and the living. In addition, he felt that somatids were, in some sense, a precursor to the emergence of DNA.

Yet, like Béchamp before him, there were any number of questions which Naessens could not answer in conjunction with the phenomenon of somatids. For example, Naessens could not explain how somatids came into existence, nor could he explain how different somatids acquired or possessed different functional capabilities, nor could he explain how somatids were able to give rise to 16 different kinds of microorganisms in the blood, but despite what he did not know, he knew – on the basis of observation and experimentation, just as Béchamp had done – that somatids were remarkable entities which remained functional notwithstanding exposure to: High temperatures (200° Centigrade and more); normally destructive and lethal doses of radiation, as well as various acids.

As Béchamp had maintained in relation to microzymas, Naessens believed that somatids were necessary for life. Furthermore, just as Béchamp had acquired considerable concrete, hard-won, first-hand knowledge concerning many facets of the dynamics associated with microzymas, Naessens also had done the same with respect to the study of somatids, and as was the case with Béchamp and microzymas, Naessens was both intrigued by, as well as mystified by, the phenomena associated with somatids.

Microzymas and somatids might, or might not, give expression to the same sort of phenomenon. However, as noted previously, some of the experiments which Naessens did seem to indicate that the microzymas with which Béchamp dealt were not able to viably withstand temperatures that were just half of the temperature (100° Centigrade) to which Naessens had exposed somatids (200° and higher) without adversely affecting the functionality of the latter entities.

Notwithstanding the foregoing considerations, if microzymas are, in some way different from somatids per se, maybe microzymas are pleiomorphic forms which have been made possible by somatids. If this were the case, then, somatids might be responsible for directing the activities of microzymas.

Irrespective of whatever the relationship – if any – between microzymas and somatids might be, there is a great deal of empirical and experimental evidence concerning such phenomena. Many people are ignorant concerning the existence of that research and, yet, all of the foregoing data tend to suggest that something is more deeply hidden than many modern medical doctors and biologists suspect.

<u>Chapter 9:</u> Bionsic Man

After running through a variety of majors as an undergraduate – including pre-theological, physical sciences, and philosophy – I, finally, settled on psychology. At the time, my university had an interdisciplinary program known as "Social Relations" which cut across a number of academic disciplines involving: Anthropology, Sociology, and Psychology.

With one, or two, exceptions, all of my major course work was directed toward the psychological end of the foregoing three-some. While a few of those courses delved into various aspects of psychoanalytical theories, the work of Wilhelm Reich was touched upon only in passing, if at all.

There might have been the odd reference to something called "orgone energy" in the lectures, readings, or class discussions. However, to whatever extent this occurred, my focus was being directed toward, and drawn in, other directions, and, as a result, Reich's work became part of my considerable cloud of unknowing.

My next exposure – limited though it might have been – occurred after I went to Canada as a way of protesting the Vietnam War. During my search for gainful employment, I was introduced to a professor of sociology who taught at the Glendale Campus of York University located in a suburb of Toronto.

He was looking for someone to serve as a co-director of a youth haven which he was opening up in Toronto. Prior to being hired, and on a number of occasions following that event, the two of us talked about a variety of topics.

One of these topics of discussion had to do with his interest in the work of Wilhelm Reich. Apparently, at some point in the early 1950s, my employer had spent time at Reich's compound in Rangeley Lake, Maine which was some 29 miles, or so, from the town – Rumford, Maine – where I was living and attending grammar school at the time that my future employer was interacting with Reich.

Due to a disagreement about the purpose of the aforementioned youth haven which I had been hired to help run, my association with the sociology professor lasted only about six, or so, months. After we parted company, he went on to write a book concerning Reich's work which was well-regarded by Myron Sharaf, one of Reich's biographers, and someone who had spent considerable time both studying with Reich as well as studying an individual who was quite extraordinarily gifted in many ways but who also was a very flawed person.

Some fifty years later, when research for the present book was being conducted, one of the people whose ideas seemed like they might be relevant to my purposes was Wilhelm Reich. This led to a reading of not only Sharaf's biography: *Fury on Earth*, but led, as well, to a close encounter of the third kind with the work by Ted Mann to which I previously alluded (entitled: *Vital Energy & Health: Fr. Wilhelm Reich's Revolutionary Discoveries and Supporting Evidence*) which had been written by my former employer in the early 1970s and which explored some of Reich's ideas, together with various related issues of health and energy.

During the foregoing research, I came across the description of an experience which Reich had encountered at a certain point in his journey. The foregoing experience struck a chord with me because it reflected something of a very specific nature which had transpired in my own life decades before I knew anything about Reich's ideas or his research.

Upon completing the foregoing part of my investigations – and notwithstanding a few delays -- my wife and I took a trip to Orgonon situated in Rangeley Lake, Maine. This facility is now known as The Wilhelm Reich Museum.

While at the museum, I spent a very brief amount of time in one of the orgone accumulator chambers which had been built under Reich's supervision. These chambers have a structural form that is somewhat like a narrow telephone booth which contains a built-in seat.

An essential component used in the construction of the foregoing chambers is celotex. This is an insulating fiberboard that is made out of sugar waste materials from which all liquid had been removed.

The layers of celotex-fiberboard are alternated with layers of steel wool and glass wool. According to Reich, the degree to which orgone energy could be 'captured' by these accumulators depended on the number of layers which went into the construction of such chambers, and also depended on the manner in which those layers were arranged.

In addition, Reich had maintained that metal tended to reflect the form of energy that he was trying to study, whereas organic materials (such as the fiberboard insulation) supposedly absorbed that energy. Consequently, metal layers were placed nearer to the interior of the chambers, while organic materials were placed nearer to the exterior of the chambers, and, as a result, the interior metal layers were intended to reflect energy toward the outer organic layers that were supposed to absorb the energy being reflected toward the latter layers of materials.

One of the objective indices used by Reich to measure accumulator dynamics had to do with possible heat differentials between the environments within and outside of the accumulator. He found that there was a consistently higher temperature (of about, on average, .5 degrees Centigrade) within the accumulator relative to its exterior, but the temperature differentials tended to be slightly greater when measured outdoors rather than indoors and the differentials also were greater when the weather was clear and dry, but when the weather was rainy, the temperature differential often disappeared altogether.

Reich also had accumulator-like chambers built from either wood or cardboard that were to serve as experimental controls in the temperature trials. He found that temperatures tended toward equilibrium within and outside of the control structures.

The individuals who, at various points in time, were engaged in testing the possible value of the accumulators fell into two groups. One set of individuals were working for, or supporters of, Reich, while the other group tended to consist of individuals who were skeptical of Reich's ideas about: Bions, anomalous forms of energy, and accumulators.

The test results of the two groups tended to differ with one another. However, one has difficulty knowing whether, or not, various kinds of bias might have been involved in shaping the test results of either one side or the other -- or both – of the foregoing two groups of investigators.

The accumulators were considered to be capable of drawing and storing a form of energy which Reich first discovered in conjunction with his research concerning bions. However, although metal was used in the construction of the accumulators and Reich knew that orgone energy was interacting with the metal because both various objective indices as well as subjective phenomena were more intense within the chamber than outsider of it, nonetheless, by his own admission, he never understood the nature of the actual dynamics which took place between the metal aspects of the accumulators and the energy which interacted with those metallic facets of the accumulator.

That energy was later referred to as "orgone energy" (inspired by Reich's preoccupation with the dynamics inherent in an orgasm), but Reich believed this energy also permeated the universe.

While at the aforementioned Reich Museum, I purchased Reich's book: *The Bion Experiments: On the Origin of Life*. This work will be briefly discussed toward the latter part of this chapter.

"Bions" is the term which Reich chose to refer to the entities which he had explored between: 1936-1937 while he had been living in Oslo, Norway. The aforementioned entities resonate in certain ways with the microzymas of Béchamp and the somatids of Naessens which were introduced in the previous chapter of the current work.

What sets the foregoing research apart from other aspects of Reich's explorations (such as his ideas concerning psychoanalysis, political ideology, and sexuality) is that it is rooted in actual scientific methodology and experimentation. After immersing himself in various aspects of science as a medical student and being quite accomplished in this respect, Reich had drifted away from the rigorous requirements of scientific discipline and had become entangled in the heavily theory-laden facets of psychoanalytical thought, philosophical discussions, and political issues which dominated much of his life for the next 20 years.

The foregoing experimental work provided Reich with an opportunity to return to a scientific way of thinking about things. Due to his investigation into the nature of the bion – and notwithstanding the fame achieved by Lee Majors as the fictional Steve Austin -- Reich might be referred to as a real-life edition of a 'Bionic Man' … although in a very different sense than when that term was used in conjunction with the aforementioned Steve Austin character.

Unfortunately, many scientists in Norway were unhappy with the conclusions to which Reich had come concerning the origins of life in conjunction with his research. As a result, he left Norway and, eventually – after setting up shop in a few other locations such as New York in the 1940s – he found his way to Rangeley Lake, Maine where a laboratory was designed by James Bell, a New York City architect, and its construction was completed in 1948.

Less than a decade later, Reich died while incarcerated in a federal prison. Since a great many of the events which transpired over that final, nearly ten-year-period have to do with the issue of orgone energy, and since orgone energy might, or might not, have something to do with the issue of bions, then, before discussing Reich's investigations into the nature of bions, reviewing some of the events which occurred during the aforementioned ten-year period of time might prove to be instructive as well as provide a larger, contextual framework within which to place, and against which to consider, his earlier research into bions.

In 1942, a patient of Reich's who was also married to someone who worked with Reich, came across an abandoned farm in the Rangeley Lake region of Maine. Shortly thereafter, Reich brought nearly 300 acres of land on which the farm was located.

A year later, Reich built a small cabin on the foregoing property. He used the isolated cabin as a space where he could write without interruption.

In 1945, a laboratory was also built on the same 280 acre spread. The laboratory was constructed in order to carry out experiments exploring, as well as to conduct classes concerning, not only the bions to which Reich had devoted much study in the later 1930s, but, as well, the newly discovered energy phenomenon that Reich had begun to study in 1940 and which he termed "orgone" due to his belief that such energy was present during the process of orgasm, a dynamic which played a central role in his approach to psychoanalysis.

However, the notion of "orgone" energy came to be associated with much more than the issue of sexual activity. For example, Reich maintained that orgone energy had healing properties (more on this a little later) which could pervade a person's body when an individual spent time in a specially designed, narrow, old-time pay telephone-like box known as an orgone accumulator which was made from, among other things, a number of layers of organic materials and included a built-in seat.

One of the effects which people reported when using the orgone accumulator was a form of tingling heat. In addition, sometimes, if a person had been spending too much time (for the individual) in an accumulator, the individual would tend to resist, or avoid, going back into the accumulator until such time as the person's body became, once again, more receptive to the experience of being in the box because, apparently (that is, as the theory goes), when further exposure to orgone energy became problematic in some way, then, time away from the accumulator had to take place in order to enable the orgone energy which had accumulated in a person's body to dissipate.

A number of medical doctors became involved in the orgone research. The first physician was James Willie who owned and ran a private psychiatric facility in Oklahoma.

Initially, Willie sought out Reich because the former individual had been seeking relief from depression and after reading a book by Reich felt that Reich might be able to help. At some point he tried out the accumulator box, but, when initially asked what he thought about the process, he indicated that he thought it was a scam.

After Reich heard Willie's initial impression, Reich was amused, but he encouraged Willie to continue using the accumulator. Subsequently, Willie's assessment of the orgone box changed considerably and, as a result, he never returned to Oklahoma.

Another medical doctor, Elsworth Baker, had heard about Reich's energy work while Baker had been serving as secretary for the New Jersey Medical Society. Baker also was chief of staff of Female Services at the Marlboro State Hospital in New Jersey.

Baker became actively involved with the scientific research taking place at the Rangeley Lake laboratory. After a time, he spent a lot of time engaged in various kinds of microscopy at that facility in conjunction with the exploration of orgonomy (the phenomena of life energy).

Eventually, Baker resigned from his position at the Marlboro hospital in New Jersey. However, by the time he resigned, his private practice involving the successful use of orgonomy in the treatment of patients had grown considerably.

Another medical doctor who began to study orgonomy intensively was Chester Raphael. He was interested in applying orgonomy to a variety of physical ailments, including cancer.

There were a number of other medical doctors who became interested in orgonomy. The problem was that neither Reich, nor most of those doctors, was in a financial position to be able to fund whatever research into orgonomy which might be undertaken and neither governments nor the medical establishment was prepared to financially back such studies … in fact, a number of doctors got fired from their jobs when those individuals tried to integrate orgonomy principles with their standard treatments of patients.

There were a few biologists from both Canada and the United States who would self-fund their summer trips to Rangeley Lake in order to study and develop orgonomy. However, for the most part, when Reich passed away in 1958, there were few people who, financially or professionally, were in a position to be able to carry on with that research, and, as a result, orgonomy largely disappeared from view until the 1970s when, for a variety of reasons, individuals such as my aforementioned former employer began to carry out their own research in relation to not only orgone energy but, generally speaking, a more expansive approach to the study of biological energy in general.

While running various experiments in 1947, Reich had been exploring, among other things, the potential for some sort of interaction between vacuum tubes and orgone energy. More specifically, he discovered that if one were to leave a vacuum tube in an orgone accumulator for a couple of months, then one, subsequently, could observe a bluish field in those tubes if they either were subjected to another accumulator or were exposed to a small electrical charge, and he demonstrated the foregoing phenomenon during the First International Orgonomic Conference held in late August of 1948.

On the basis of the foregoing experiments, as well as by taking other experimental work into consideration – such as his work with bions and accumulators, Reich concluded that orgone energy was cosmic in nature. He believed that it suffused all of being.

In May 1947, an article by Mildred Brady appeared in *The New Republic*. The title of the piece was: "The Strange Case of Wilhelm Reich, and it depicted Reich as being a self-aggrandizing con man who was claiming that the orgone accumulator was an orgiastic device which could cure all manner of pathological disorders, including cancer.

The central themes and biases of the foregoing article found their way into a number of other publications, ranging from *The New York Post* to the *Bulletin of the Menninger Clinic*. In July of 1947, the FDA received a letter from the Medical Advisory Division of the Federal Trade Commission suggesting that the FDA might want to take a closer look at Reich's claims and his Orgone accumulator.

R.M. Wharton was serving as the head of the Eastern Division of the FDA, and, as a result of unknown factors or influences, he became obsessed with the issue. Among other things, he authorized Charles Wood, who was an FDA inspector for the state of Maine, to initiate an investigation into the work, products, claims, and activities of Wilhelm Reich at the Rangeley Lake facility.

The primary focus of Wood's investigation was whether, or not, the accumulator could be classified as a medical device as defined by the FDA. Following a very cordial initial meeting between Reich and Wood, Reich invited Wood to visit work place where the accumulators were assembled.

The person responsible for constructing the accumulators was Clista Templeton who had taken over this work from her father after he had passed away in 1944. Templeton and Wood got on well together and, in fact, later married.

At some point, she supplied Wood with a list of the names and addresses of approximately 250 people who were using the accumulators. After Wood filed a report concerning his investigation into Reich, Wood's boss, R.M. Wharton, claimed the report demonstrated that Reich had been, and was continuing to be, engaged in a process of defrauding the public through a program that had salacious overtones.

Interestingly enough, in a May 18, 1948 memo, Wharton expressed knowledge of the fact as far as the accumulator users were concerned who had been contacted by the FDA (based on the list which has been supplied it by the aforementioned Clista Templeton) and who, subsequently, were interviewed by the FDA, **none** of those users indicated any kind of dissatisfaction with their accumulators. They all reported having had positive experiences in relation to their use of the accumulators.

In 1948, with Reich's blessing, the American Association for Medical Orgonomy was established. Eventually, there were 21 physicians – including several medical doctors from Norway and Israel – who became members of the AAMO -- and one of the requirements that was listed as being necessary for membership eligibility was having a medical degree.

For a time, and largely because it lacked any evidence that Reich had been committing fraud or was entangling people in some sort of sexual exploitation scam, the FDA suspended its investigations. Reich misinterpreted this pause as an indication that his troubles with the FDA were over, but despite the absence of evidence indicating that users of the accumulators had been defrauded in any way, the FDA would begin, later on, to pursue the matter once more.

Ultimately, due in no small part to both Reich's self-destructive self-indulgent, arrogant, egoistic, dogmatic, and childish behavior which resulted in his inability to control himself and act like a mature, rational adult during the court proceedings, as well as due to the obsessive pettiness of the FDA, together with the questionable fairness of a series of federal court proceedings which took place in Maine, Reich was eventually sent to a federal prison. However, he was sent to prison as a result of having exhibited contempt for the court rather than having been found guilty of fraud in conjunction with the accumulators.

Before the foregoing scenario played itself out, Reich had become interested in exploring the issue of whether, or not, orgone energy could be used to counter the destructive effects of various kinds of radiation. Previously, Reich had discovered that burns which had been caused by over-exposure to X-rays could be healed via treatment with orgone energy, and, now, he wanted to explore the possibility that orgone energy might be used to counter the radiation from nuclear energy and nuclear weapons that was present in the atmosphere.

He coined the term Oranur to refer to this project. The term linked together the notions of orgone energy and nuclear radiation.

Reich planned to run a series of experiments with mice to determine what effect, if any, orgone energy might have on radiation. However, before conducting trials involving living organisms, Reich was interested in determining what effect orgone energy might have on materials which emitted radiation.

The radiation sources he selected were two, one milligram samples of radium – the very substance that had caused burns on the arm of Pierre Currie, along with various other symptoms, and, later on, the substance which was considered to be responsible for inducing leukemia in both Marie Curie as well as her daughter who had carried on her mother's work following the passing away of the two-time Noble-prize winner. Before beginning the primary part of the initial experiment which did not involve mice, Reich used a Geiger-Müller device to measure the amount of background radiation which existed in the absence of the radium samples so that he would have a baseline reference measurement against which to compare subsequent readings when radium was present.

Next, Reich separated the two radium samples. The first sample was left in its lead casing, not exposed to any orgone accumulators, and placed in a garage that was located outside the laboratory, while the other radium sample was put in a small orgone accumulator container, and this container was placed within an accumulator which was much larger and said to be 20-times more powerful than the small accumulator, and, then, the container within a container combination was placed in a room located near to the previously mentioned garage.

The foregoing room was, itself, built from the same kinds of materials which went into the construction of the portable accumulators. Prior to that initial Oranur experiment, the room had served as a 'dark-room-like' structure in which one could observe various visual phenomena associated with orgone dynamics.

The second sample was left in the: "Accumulator-within an accumulator-within an accumulator" arrangement for a period of five hours. At that point, Reich entered the room and tried to measure any radiation which might be present.

When he did this, he found that the radiation was being emitted at a rate that was too fast for the counter to measure. In addition, Reich considered the atmosphere in the room to be very oppressive and charged in some sense, and this experience was quite different from what Reich had hypothesized might be the case – that is, he was of the opinion that the orgone energy would have been able to counter whatever radiation was present.

Reich took the small accumulator which contained the radium sample and transported it to a small shed-like structure which was located half a football field away from the "dark-room-room" structure where the sample had been placed originally. His hope had been that by removing the radium sample from the initial room where it had been placed that this might provide a chance for any radiation that was present to dissipate to some degree.

When Reich used the Geiger-Müller device to measure whatever radiation might still be present in the foregoing "dark-room-like" structure, he discovered that while the radiation level was higher than the baseline background rate which had been measured prior to the placement of the radium sample in the room, nonetheless, it was not sufficiently high to be causing any of the many symptoms which people were reporting who had gone into the room after the removal of the radium sample. Almost all of Reich's co-workers, as well as Reich himself, had been experiencing a variety of symptoms after spending any amount of time in the 'dark-room-like' structure.

Included among the symptoms were: Nausea; alternating sensations of hot and cold waves; a taste of salt in the mouth; loss of appetite; a sense of oppressiveness; a feeling of intense pressure in both the area of the cheekbone as well as the forehead; headaches, as well as a debilitating sense of malaise or weakness. The foregoing symptoms did not necessarily cease when a person left the aforementioned room, but, instead, often lingered for days and often increased in their severity.

Moreover, radiation did not appear to be the cause of their symptoms because when various co-workers or Reich went into the structure to which the experimental radium sample had been transported following the five-hour period it had spent in the "dark-room-like" structure, no one reported any of the foregoing symptoms. Symptoms emerged only in conjunction with the 'dark-room-like' structure.

Something had transpired in the "dark-room-like" structure during the five-hour period in which the radium sample rested in a small accumulator that had been placed in a larger, more powerful accumulator, that, in turn, was placed inside a room that had been constructed from accumulator materials. Relative to the baseline background radiation measurement which originally had been made prior to the start of the experiment, the readings in the "dark-room-like" structure were still higher than "normal" even after the removal of the radium sample, but, as noted previously, these higher readings were not considered to be sufficiently high to cause the intense symptoms which had arisen almost immediately upon entry into the "dark-room-like" structure.

Of course, one possibility which might account for what took place during the foregoing experiment revolves about the idea that some sort of collective hysteria or mass-symptom formation, phenomenon took place. Some people might consider it to have been an indication that some sort of nocebo dynamic having occurred.

However, the nocebo effect is a function of the existence of <u>expectations</u> that a certain kind of negative outcome will be forthcoming – as has been described in conjunction with the so-called Voodoo-phenomenon. However, Reich and his co-workers tended to believe that the outcome of their experiments would be positive in nature and not negative.

While one can hypothesize that the reported symptoms were the result of some sort of nocebo effect or mass-hysteria, this is not, in and of itself, enough. If one is going to demand of Reich that he must be able to prove any of his claims concerning orgone energy, then, it becomes incumbent on those who are disinclined to accept what Reich says concerning such issues to put forth demonstrable proof concerning their own claims concerning the matter.

Carl Sagan once indicated that extraordinary claims are in need of extraordinary evidence. This maxim refers both to claims in support of something as well as claims in opposition to something.

Although not necessarily worthy of being referred to as extraordinary, Reich had been engaged in actual scientific research involving various aspects of biophysics. In addition to his own work on bions (to be discussed later), there had been a considerable amount of research conducted by a variety of medical doctors and scientists which had led to findings that lent support to – rather than rejection of -- Reich's earlier findings. In addition, there had been the satisfied experiences of more than 250 people with respect to the constructive impact which accumulators had been having on their lives.

Finally, despite being relatively negative in nature, the outcome of the initial Oranur experiment was both dramatic and inexplicable. Reich might not have understood the nature of the 'lightning' which he was trying to catch in a bottle, but for twelve years since his explorations into the nature of bions had taken place in the late 1930s, Reich had stumbled into some phenomena that were anomalous in nature and not easily explained.

Reich followed up his initial foray into the possible nature of the way in which orgone energy interacted with nuclear radiation with further experiments. For an hour a day, on six consecutive days, Reich placed a radium sample in an accumulator which was described as being 20-times more powerful than the small accumulator in which the radium sample had initially been placed.

When Reich and co-workers looked through a window into the interior of the structure where the foregoing radium sample had placed for an hour a day, they reported seeing a bluish-purplish-like haze diffused throughout the interior of the structure. Furthermore, both Reich and a fellow investigator reported experiencing nausea and a lightheadedness in conjunction with their visits to the latter structure.

Reich began to refer to manifestations of orgone energy that had interacted with nuclear radiation of some kind in several ways. One version was termed DOR – that is, deadly orgone energy -- while the other edition of such orgone energy was called “Oranur.”

However, while no one had died from exposure to the accumulators that had housed the radium, nevertheless, almost everyone had had adverse reactions whenever they came into contact with such radiation-exposed accumulators. Consequently, one can’t be quite sure whether Reich was making a distinction between two different kinds of orgone energy or merely referring to the same phenomenon with two different terms.

Reich believed that the DOR/Oranur effect seemed to attack people either in whatever way those individuals were most susceptible to being affected by DOR/Oranur or in accordance with how such individuals had responded to the presence of stress in the past. However, his suppositions in this regard were never rigorously tested.

Initially, he had been working on the assumption that orgone energy would be able to counteract the presence of radiation. Nonetheless, following the foregoing set of experiences, Reich began to believe that radiation was acting on orgone energy and adversely affecting the latter in some fashion.

Over a period of time, he entertained a number of theoretical possibilities that he felt might account for what had happened. By and large, however, his thoughts on the matter were mostly speculative and not backed up by hard evidence of any kind.

The reality was that most, if not all, of the individuals who had been exposed to Oranur became quite ill for a period of time and that these pathological conditions did not appear to be caused by having been exposed to nuclear forms of radiation per se. To confuse matters even more, many of the people who, apparently, had been adversely affected by the initial Oranur experiment, subsequently went through periods of a heightened sense of well-being, but that condition would pass and return to a previous level of debilitation before returning, once again, to a state of a heightened sense of well-being, only to be followed by a period of illness of some kind.

Reich had always considered orgone energy to be an unequivocal good that needed to freely flow through human beings in order for emotional, physical, and cognitive health to be fully realized. The Oranur experiments and experiences had induced Reich to begin to critically reflect on his previous ideas concerning the nature and potential of orgone energy.

In many respects, orgone energy was, for Reich, a more sophisticated, if not a scientifically more viable, version of the notion of libidinal energy which played such an essential role in psychoanalytic thought. Reich had gone from: Being a leading candidate to replace Freud as the heir apparent for the psychoanalytic movement that was gaining momentum in Europe and America, to: Being expelled from the International Psychoanalytical Association because of the differences which had arisen between Freud and Reich over the issue of libidinal energy.

Freud held that libidinal energy was instinctual and needed to be reigned in through various kinds of defense mechanisms (e.g., sublimation, repression, reaction formation, and so on) which had a cost – namely, neurosis of one kind or another – but which, nonetheless, were crucial to the survival of civilization, and when properly engaged through psychoanalytical techniques, individuals could be assisted to learn how to constructively adapt themselves to the discontents associated with civilized life . Reich, on the other hand, came to believe that while disengaging libidinal energy from defenses and/or various forms of character armor too quickly or in the wrong way could prove to be problematic, if not destructive, in nature, nevertheless, Reich believed that genuine psychological and physical health were only possible through the relative free flow of libidinal energy.

The results which arose in conjunction with the Oranur experiments tended to constitute something of a monkey wrench with respect to understanding the place of orgone energy/libidinal energy in the lives of human beings. For all of his talents and brilliance, in many respects Reich was in the middle of something – i.e., life -- that he didn't necessarily understand.

For example, on the one hand, he preached freedom (politically, emotionally, and sexually). Yet, in many ways he was a control freak who seemed to feel that only he should have such freedoms and, consequently, he often went into rages when things didn't turn out the way in which he wanted or didn't go in the he felt they should go or when people didn't act in the way he desired.

As Myron Sharaf noted in his biography, Reich didn't appear to have a problem with emotionally and sexually betraying people who were close to him (including Sharaf). However, Reich didn't seem to be able to handle the thought – even when it could be shown to be not true – that someone might have engaged in behavior which Reich considered to constitute a form of betrayal toward him.

Orgone energy was another aspect of life which, as a result of the Oranur experiments and experiences, Reich had begun to question the extent to which he correctly understood a phenomenon that, over a period of fifteen years, or so, had come to play such an important role in his exploratory journey. Reich had broken with Freud over the issue of libidinal energy as well as over Reich's insistence that human beings should be helped (politically, educationally, and socially) to learn how to constructively deal with such energy through something other than defense mechanisms or having to submit to the discontents of civilization, and, now, Reich had come face-to-face with hard evidence that orgone energy might have a dark side to it – a side that he didn't necessarily understand.

Reich came to the conclusion that it was not chemical, nuclear, and electromagnetic pollution, per se, which was the problem, but, rather, for him, the fundamental issue was the adverse impact that those different forms of physical dynamics had on the healthy flow of orgone energy in both the environment as well as in living organisms. The foregoing perspective might constitute a distinction without a difference because something is a pollutant precisely because of the adverse impact that those sorts of commercial dynamics have on the environment and living organisms.

Orgonon – where the Oranur experiments had been conducted -- was, for the most part, evacuated in March of 1952. Researchers began to work out of their living quarters but, occasionally, met with Reich for very brief meetings at the Rangeley Lake Observatory.

During this period of time, Reich became fairly mobile. Among other things, this induced him to begin to reflect on what he perceived to be changes in the environment around him.

For example, he started to speak about what he termed "DOR-clouds". The idea seemed to refer to a form of atmospheric bleakness in a given set of environmental circumstances which he claimed was observable in a wide variety of conditions, even on clear, sunny days.

When present, Reich believed that such DOR-clouds appeared to oppress whatever dynamics were taking place in the vicinity of those clouds. Among other things, Reich felt the presence of those clouds diminished the energy with which many life-forms operated.

One of the things which Reich had discovered during the Oranur experiments was that both DOR energies as well as 'normal' or 'natural' forms of orgone energy seemed to be drawn to water. As a result, Reich developed a set of pipes which could be connected, via cables, to water located in underground wells, and he believed that his Rube Goldberg-like device could be used to dispel or "bust" the aforementioned DOR-clouds and, in the process, be able to improve surrounding conditions.

Whether, or not, Reich correctly understood how his device worked and irrespective of whether, or not, he correctly understood what might have been transpiring in the environment as far as the issue of 'DOR-clouds' is concerned, and before the eyes and minds of readers begin to glaze over as a result of the foregoing considerations, let's take a brief look at some of the actual tests to which the foregoing device was put. For example, the *Bangor Daily News* reported on July 24, 1953 how two blueberry growers had been concerned about a drought that had been plaguing their barrens.

At some point, the two blueberry growers had heard about Reich's weather modification experimentations. As a result, they sought his assistance.

The foregoing article indicates that Reich set up his 'contraption' on the morning of July 6th 1953. By the evening of the same day, rain began to fall and continued throughout the night and into the next morning. The *Bangor Daily News* article indicated that a reliable witness indicated that Reich and his assistants were also able to change the direction of the wind by adjusting their weather modification device in certain ways.

Reich indicated that his device could be used to either induce clouds to form and gather together, or it could be used to cause clouds to dissipate. Over the next several years, Reich used his device in conjunction with several droughts which were taking place in New York as well as in other parts of the North East, and, on each occasion, a successful outcome was reported to have occurred.

Just as Reich believed that the character armor which people developed during their lives interfered with the free flow of orgone energy or libidinal energy within a human being, so too, he also began to see the DOR-clouds in the atmosphere as a form of artificial armor which had been imposed on the environment through the dynamics of pollution. As a result, he considered his weather manipulation device to constitute a form of 'therapy' which was directed at removing the DOR-cloud armor which had formed as a result of pollution and, in the process, help to redirect the flow of orgone energy in the atmosphere in a more constructive manner.

Was the foregoing, alleged weather-modification events instances of remarkable coincidences or was something else taking place? In a way, Reich was conducting his weather interventions in a manner that resonates with what many medical doctors do who experience success when using off-label drugs to treat certain pathological conditions in a clinical setting, and, yet, no one (least of all the doctors) seems to understand why those drugs have the effect they do because the drugs were designed to function in entirely different biological circumstances.

Having provided a very broad overview of some of Reich's later ideas and experiments concerning orgone energy, let's turn to the research which he conducted on bions in Norway in 1937-1938. The future has been used – for purposes of explication -- as something of a prologue to the past.

Early on in his book, *The Bion Experiments*, Reich notes that while he accepted Freud's equating of life impulses with sexual impulses, Reich rejected Freud's notion of the death instinct and, instead, sought to further develop his own theory concerning the role of the orgasm both with respect to life and sexuality.

According to Reich, there was a basic dynamic in all life processes with which the orgasm complied and to which it gave expression. More specifically, the foregoing fundamental life process consisted of: (1) The building up of tension through mechanical events which, in turn, led to (2) an increase in electrical potential followed by (3) the discharge of the foregoing potential and, then, (4) a period of mechanical relaxation.

On the basis of the foregoing considerations, Reich believed that the orgasm was emblematic of the basic dynamics of life. To further develop his perspective, he set about trying to demonstrate how the aforementioned four-step dynamic could be found in the most basic of life processes, such as the activities of protozoa and amoeba.

He re-characterized aspects of his four-step dynamic as being, on the one hand, a function of contractile dynamics (which had to do with avoidance, withdrawal, and electrical discharge), as well as, on the other hand, expansive dynamics (the process of reaching out or an expression of well-being and a manifestation of electrical charge). However, he acknowledged that the processes of expansion and contraction were, themselves, a function of an array of more complex dynamics.

Reich noted that although, superficially, the nerves could be seen as the generators of impulses of one kind or another, nonetheless, when nerves were studied more carefully, he believed that one could see how they were merely the pathways which served more basic forms of organizational functioning – that is, the pathways which constituted the nervous system were giving expression to a complicated network of organized activities that was being shaped by the dynamics of the entire body. Thus, Reich was of the opinion that metaphysical musings involving notions such as entelechy in which potential became actualized through mysterious -- possibly non-physical –- processes could be replaced by a purely materialistic account involving nothing but biological processes.

He maintained that the basic difference between inorganic and organic processes was a function of the kind of organization which was present. His exploration of bions was directed toward shedding light on, and bringing methodological rigor to, the foregoing considerations.

Reich began his biological research by developing infusions of hay and water which created a context in which various kinds of organisms began to become visible. Initially, he was curious about how those organisms came into being, but, then, he remembered the "germ" theory which indicates that life is present everywhere and just needs the right set of conditions to become manifest.

He did not indicate whether the "germ" theory to which he was alluding was an expression of Pasteur's approach to the issue or a reflection of Béchamp's way of engaging that issue. The direction which research takes depends a great deal on which fork in the biological path one pursues.

Interestingly, when one takes a look at the bibliography which is as the end of *The Bion Experiments*, one finds quite a few mentions of Pasteur but no mentions, at all, of Béchamp, and, yet, Reich's position concerning bions is actually more in line with the work of Béchamp than Pasteur.

After spending some time with different microscopes observing the life-cycles of various organisms (photographs of both equipment and various organisms had been included in his book), Reich began to notice certain kinds of vesicles which could be found within amoeba and which also were associated with plants that had disintegrated. He began to wonder if, perhaps, amoeba were nothing more than a set of such vesicles which were enclosed within a membrane.

He also noted that when a particular species of grass is placed in water and begins to decompose, a specific kind of protist (usually, but not always, a eukaryotic, single cell microorganism which does not fall into any of the usual categories of classification) arises which goes through a number of stages. As the foregoing blades of grass begin to decompose, Reich observed the formation of spherically-shaped cells that contained various vesicles which, morphologically, were indistinguishable from other vesicles which had formed at various locations along the edges of the grass. He went on to indicate how such entities took on a variety of what he considered to be transitional forms.

Reich doesn't describe any of the foregoing stages with a great deal of detail. However, one wonders whether he is talking about the phenomenon of pleiomorphism which was developed by, among others, Béchamp.

After conducting a variety of further infusion experiments, Reich discovered the presence of certain kinds of unstructured crystals, alongside various kinds of vesicles. In addition, he also observed the presence of structured crystal entities which contained vesicles that were indistinguishable from some of the vesicles which were freely floating about in the infusion amalgam.

Reich referred to the vesicles which appeared to be forming along the edges of some of the crystal structures as "plasmoids." When he applied a current of 1-2 mAmps to the infusion, the plasmoids moved toward the cathode end of the circuitry and, thus, Reich noted that they were positively charged entities.

There were other entities which Reich observed in the infusions which he referred to as "pseudo-amoebas." This designation was given because there were certain aspects of their behavior which appeared to be different from the way in which amoebas normally moved.

When Reich added small portions of gelatin to his infusion, he discovered that a number of vesicles began to cluster around the gelatin. The complex moved about the infusion in a cohesive manner which could not be reconciled with Brownian movement.

In order to try to make sure that various kinds of germs weren't somehow finding their way into his infusions, Reich began to subject his infusions to a process of boiling for fifteen to thirty minutes while they were enclosed in glass containers. When he did this, he was surprised to discover that there seemed to be a richer variety of life following the boiling protocol than existed prior to undertaking such a protocol.

In addition, whereas the liquid present in his infusions that were not subjected to boiling tended to remain clear, the boiled liquid became opaque like a colloid. When a current of between .5 and 1 mAmp was run through the boiled liquid, the vesicles in the liquid were identified as being positively charged.

Reich conducted many experiments involving boiled and non-boiled preparations. In every case, he found that there was much more life to be found following the boiling of such preparations than was the case in such preparations that had not been boiled.

After studying boiled preparations for some time, Reich began to consider many of the vesicles in those preparations as incomplete forms of life which were exhibiting various forms of preliminary stages of life. He referred to these entities as “bions.”

On the basis of his observations, Reich felt that the cells he was observing were a function of the vesicles and other structures that were present in those cells. As a result, he came to the conclusion that the cells were not the basic unit of life but, instead, life was a function of what those interior vesicles brought to cell cellular structures.

Without wishing to prematurely conflate the aspects of Reich’s research which have been outlined in the foregoing discussion with what was explored in the previous chapter, nonetheless, one should note that what is being said here is fully consistent with Béchamp’s research involving microzymas. What Reich refers to as bions might, or might not, be microzymas, or, alternatively, bions might be giving expression to some of the pleiomorphic changes involving morphology and function which Béchamp had observed take place in conjunction with microzymas and which many decades later were confirmed and further developed by Naessens in conjunction with the somatid-cycle of pleiomorphic transformations.

Just as both Béchamp and Naessens had discovered that microzymas and/or somatids could be induced to change their morphological and functional character by altering the character of the surrounding environment, Reich also observed similar sorts of phenomena. When he added or subtracted different conditions, elements, or factors in conjunction with his infusions, he found that morphological and functional changes took place in the vesicles which inhabited those infusions.

At a certain juncture during the foregoing sorts of research, Reich began to entertain the possibility that, maybe, life might have emerged out of that which is lifeless through the manner in which changes in a given environment could induce bions to develop into more complex forms of life. However, Reich readily admitted that nothing was known about the specific nature of what he considered to be the underlying principle of self-organizing dynamics which might link non-life with life.

Reich goes on to describe experiments in which he took certain mixtures, boiled them until all liquid was removed, mixed this residue with sterile, colloidal preparations, and was able to generate cultures which were capable of giving rise to entities capable of reproducing themselves for at least five generations. Throughout these sorts of experiments, Reich determined that a necessary condition for the establishing of a viable culture had to be the presence of a negative charge, whereas experimental mediums which were characterized by neutral charges did not lead to the emergence of viable cultures.

As indicated previously, Reich gave the term “bions” to the aspects of these cultures which could be induced to give rise to various kinds of life forms. He maintained that bions are preliminary stages of life which constitute a sort of transitional bridge between the realm of inorganic dynamics and full-fledged life forms.

There might be any number of things which could be said with respect to the foregoing research that would run counter to, or raise questions about, the conclusions to which Reich eventually came. Notwithstanding such considerations, one might also keep in mind that both Béchamp and Naessens had subjected, respectively, microzymas and somatids to high temperatures – as Reich had done – and found that the microzymas and/somatids remained functionally viable, just as Reich had done with respect to that which he termed “bions.”

One might also note that the work of Béchamp, Reich, and Naessens shared at least one other commonality. None of the foregoing three individuals knew what was going on inside of, respectively, microzymas, bions, or somatids, nor did they have any understanding concerning what role that internal dynamic played in the phenomena which subsequently were observed under a variety of different conditions.

Reich’s foregoing research led to the discovery of several kinds of bions. For example, there was a larger type of entity which he termed: “PA-bions,” while another, smaller kind of bion was referred to as a T-bacilli.

PA-bions had the capacity to immobilize as well as affect the functioning of T-bacilli in various ways. In addition, the PA-bions had a blue color, and this blue-hue was characteristic of emanations which were visible (e.g., in the dark-room-like shed mentioned in conjunction with the Oranur experiment) in conjunction with various orgone energy related phenomena.

A third edition of bions was discovered by accident. Someone had taken the wrong container from a sterilizer.

Instead of earth, the container had ocean sand. After several days had passed, a growth appeared on the heated ocean sand, and this growth could be cultured.

Like the PA-bions, these bions were also blue, and upon microscopic examination, they were observed to have between six and ten vesicles within them. In addition, they seemed to have a much stronger effect upon bacteria, as well as T-bacilli, than the PA-bions had.

Reich referred to the accidentally discovered bions as SAPA-bions (PA-bions derived from heated ocean SAnd). While examining them through the microscope, Reich developed a severe case of painful conjunctivitis, but if he viewed other kinds of bions through the microscope, his eye was not adversely affected by those bions.

He conducted a number of experiments with the SAPA-bions. Those experiments seemed to indicate that there was some sort of energy being emitted from the SAPA-bions.

The SAPA-bions were stored in a dark basement. If someone went into the room and waited for their eyes to adjust, they would see a grey-blue haze rather than the sort of blackness that one might expect to see.

Additionally, Reich reported that one could see lines of light and blue dots in the basement where the SAPA-bion samples were stored. Moreover, the walls of the basement, together with various objects that were present in the basement, seemed to give off a purplish hue.

The emanations appeared to indicate that the SAPA-bions were radiating energy. Eventually, this energy was referred to as orgone energy, and based on his personal experiences, as well as experiments which, as noted previously, he had conducted with vacuum tubes, together with his ventures into weather modification and some successful treatment trials conducted with mice, Reich believed that orgone energy pervaded all of space, and, as such, was available to be stored in specially constructed accumulators which could have a palliative effect on individuals suffering from an array of emotional and physical problems (including cancer).

Although Reich was able to describe different manifested aspects of this energy -– such as: (1) its color and visible properties; (2) the heat which people felt when exposed to it; (3) the constructive impact it appeared to have on the health of individuals when they spent time in the accumulators which, supposedly, attracted and stored orgone energy, as well as (4) its potential for destructive effects, as was discovered in the Oranur experiments –- nonetheless, Reich was never able to get much further than a description of the effects of orgone energy, and, as a result, he never discovered what orgone energy was or the full nature of its internal dynamic, any more than Béchamp had insight into the internal dynamics of microzymas or Naessens understood how somatids did what they did and, therefore, among other things, made the 16-stage pleiomorphic somatid cycle possible.

<u>Chapter 10</u>: Ling's Nano-Protoplasm

Before exploring, to a limited degree, Dr. Gilbert Ling's theory that "nano-protoplasm" -- and not the cell -- is the basic unit of life, perhaps some nuance, of sorts, should be offered as a prolegomenon to the aforementioned topic of nano-protoplasm. Research of any kind is rarely a straightforward project but often is influenced by a variety of considerations – not all of which have to do with the generation and evaluation of evidence or, alternatively while not having anything to do with actual research or data, does affect the way in which such research or day is assessed and evaluated.

There are a numerous aspects of Dr. Ling's perspective that I admire. At the same time, there are facets of that perspective which seem problematic – one of these problematic aspects being that notwithstanding my willingness to acknowledge the heuristic value of the nano-protoplasm idea, nevertheless, the phenomena to which the nano-protoplasm notion alludes does not seem to constitute the basic unit of life, and when discussion of that notion is undertaken later in this chapter, an attempt will be made to distinguish between what appears to be of value and what might be problematic in conjunction with the claim that nano-protoplasm is the basic unit of life.

Having acknowledged that I have some differences with certain aspects of Dr. Ling's perspective, nonetheless, I also believe that there has been a concerted effort to suppress, if not distort, various dimensions of his work. The following commentary is not a definitive treatment of those issues, but it is intended to alert the reader to some of the complexities which tend to permeate and surround research due to motivations which have little, or nothing, to do with sincere research … which is always seeking the truth as best one is able to do.

On November 17, 2003, Dr. Gilbert Ling, a physiologist, wrote an extraordinary covering letter that was accompanied by various documents which were cited in the letter. The foregoing set of materials came with a signature-required feature which ensured that the individual to whom the material had been mailed actually had received the communication.

The package was sent to Roderick McKinnon, recipient of a newly-awarded 2003 Nobel Prize in Chemistry. Following a five-year period in which no return response was received to the November 17th, 2003 overture, Gilbert Ling sent another signature-required letter to Dr. McKinnon on February 22, 2008 concerning the same topic, and, when no response was forthcoming to the second letter, a third letter was written and sent on April 2, 2008 to the same individual that dealt with the same issue, and this copy was sent via two carriers (U.S. Postal Service and Federal express), both of which required a signature when it arrived at their destination.

None of the aforementioned letters was ever acknowledged or answered by their recipient. Given the nature of those letters, perhaps the absence of any acknowledgment or answer is, in some ways, not surprising.

In effect, the letters accused – and put forth evidence in support of the accusation – that Dr. McKinnon's Nobel Prize winning work had committed at least two fundamental mistakes. The first problem was that according to Dr. Ling, Dr. McKinnon's work was, in part, rooted in a theory concerning membrane pumps that had been disproven approximately four decades prior to the time when Dr. McKinnon's prize-winning work had been published, and the second problem – perhaps even more serious – is that key elements of Dr. McKinnon's prize-winning perspective reflected research which had been conducted and published by Dr. Ling many years before Dr. McKinnon had published his own "research," and, yet, Dr. McKinnon had failed to cite Dr. Ling as being the source of those ideas.

During the initial, November 17th, 2003 letter, Dr. Ling briefly went through some other research concerning issues involving the idea of membrane pumps that previously had been awarded Nobel Prizes but which, according to Dr. Ling, were unworthy of that honor, This issue of membrane pumps is significant because Dr. McKinnon prize-winning work presupposes the truth of theories concerning such membrane pumps and which Dr. Ling indicates were shown to be false some 40 years ago.

For instance, Dr. Ling made reference to the 1978 Noble Prize in Chemistry which was awarded to Peter Mitchell for the latter's development of the Chemiosmotic Hypothesis. Dr. Ling was nonplused that for the first time a Nobel Prize had been awarded to a mere hypothesis which had not even been proven to be true.

In passing, Dr, Ling refers to his own 1981 review of Peter Mitchell's work which deconstructed the Chemiosmotic Hypothesis and put forth all of the evidence which ran contrary to Mitchell's perspective. As well, Dr. Ling indicates how he finds it very difficult to believe that both Mitchell and the Nobel Prize referees apparently were unaware of the existing experimental research which had demonstrated why the Chemiosmotic Hypothesis was resting on empirically-challenged grounds.

The work of another Nobel Prize winning researcher – namely, Jens Skou and his notion of a hypothetical sodium pump (1997) – is referenced by Dr. Ling as constituting something of a puzzle because between 1955 and 1970 four different laboratories all came to the same conclusion. More specifically, each of those laboratories presented experimental evidence indicating how the 'exchange diffusion hypothesis of Hans Ussing' -- on which Skou's position (and, therefore, Dr. McKinnon's perspective) depended -- was not viable.

Dr. Ling goes on to refer to 70 of his own experiments concerning the sodium pump hypothesis which, among other things, demonstrated that in order for the sodium pump idea to work it would require a source of energy which was 1500% to 3,000 % more than what is available under actual biological conditions. He further indicates that his findings have been replicated by two other researchers.

The foregoing research which runs contrary to the sodium pump idea is important. Not only does it demonstrate that the sodium pump notion -- which is presumed to be true by many scientists today -- is untenable, but, as well, it indicates that all of the other kinds of membrane pumps which have been postulated by various researchers over the years to account for communication taking place between the exterior and interior of a cell are also undermined by the same energy problem – in other words, such membrane pumps require way more energy to operate than is biologically available for them to use.

14 years after Dr. Ling had published material which showed that the sodium pump theory was untenable an article by Gina Kolata was published in a 1976 edition of the journal, *Science*. The article

referenced the alleged work of several researchers – both of whom had been former students of Dr. Ling and had worked in his laboratory – that entailed findings which purportedly offered substantial evidence in support of the idea of membrane pumps.

When Dr. Ling asked for citations concerning the research material alluded to in the article, the author of the article as well as the two researchers mentioned in the journal piece, were unable to do so. Dr. Ling tracked down the "source" for the foregoing claims within the doctoral dissertation of one of the two researchers mentioned in the *Science* article and discovered that the so-called crucial experiment which was being alluded to by the two foregoing researchers never actually was conducted and, furthermore, that same doctoral dissertation actually had distorted, in a substantial way, the experimental findings of Dr. Ling concerning the issue of sodium pumps.

Next, Dr. Ling mentions a 42-page review of research concerning the sodium pump hypothesis which was written by Glynn and Karlish that surfaced in volume 37 (1975) of the *Annual Review of Physiology*. The alleged review article referenced 245 articles that had something favorable to say about the sodium pump hypothesis but that alleged "review" article did not cite even one single article which critiqued the sodium-pump hypothesis despite the existence of considerable research conducted by H.R. Catchpole of the University of Illinois, Gilbert Ling, and others indicating that the sodium pump idea was not tenable.

In 2002 Glynn wrote another review concerning research on the issue of the sodium pump hypothesis. Once again, only research in support of that hypothesis was included in the updated review while all research that was critical of the hypothesis was excluded from the article.

One could speculate that Gilbert Ling might have been somewhat unhinged when he wrote his various letters to Dr. Roderick McKinnon, perhaps, unjustly upset that someone other than Dr. Ling had won the Nobel Prize. However, there is other evidence – independent of the Ling-McKinnon issue – which can be brought to bear on the foregoing considerations that, at the very least, should give one a certain amount of pause before arriving at any final conclusion concerning the foregoing considerations.

For instance, Kary Mullis -- the 1993 winner of the Nobel Prize in Chemistry which recognized his research which led to the invention of the PCR (Polymerase Chain Reaction) protocol -- was asked to write an article on HIV and AIDS while he was working at the National Institute of Health. He wanted to start the paper out with the statement that HIV causes AIDS, but he wanted a citation which proved that this statement had been shown to be empirically true.

He went in search of such a citation. He found nothing.

As a result, he began to ask scientists and medical doctors that he knew or encountered for such a reference. None of the people he asked was able to answer his question, and the people he was asking were among the foremost experts in a variety of fields of research which were related to his query.

Mullis indicates that when attending a party he ran into Luc Montagnier -- who later won a Nobel Prize in 2008 for the alleged discovery of the HIV virus -- and asked him for a source indicating that HIV caused AIDS. Montagnier could not provide such a citation and became upset with the situation and, as a result, he abruptly walked away from Mullis.

Later on in life, Montagnier began to backtrack on previous claims concerning the alleged relationship between HIV and AIDS. First, he began to argue that there was some sort of secondary factor which had to be present in order for HIV to be able to cause AIDS, and, then, not too long before his death, he began to distance himself altogether from the idea that HIV causes AIDS.

Yet, billions of dollars are being made today by medical doctors, scientists, pharmaceutical companies, and advertising firms who all continue to claim that HIV causes AIDS. They do this despite the fact that none of them can cite experimental research which shows that HIV causes AIDS.

Although Kary Mullis passed away just prior to the onset of the set of events known as COVID-19, he had always maintained that the PCR protocol could not be used as a diagnostic test for the existence of a virus and further indicated that the whole notion of quantitative PCR was oxymoronic. Unfortunately, just as his research concerning the lack of any experimental data indicating that HIV caused AIDS fell on unreceptive minds and ears, so too did his statements concerning the nature and purposes of the PCR protocol and, if he had been alive during the COVID era, he would have delineated the massive abuses of that protocol which were perpetrated by many, if not most, governments, medical doctors, hospitals, and universities during COVID (and since).

Christine Massey, a science researcher from Ontario, Canada, sent out FOI-requests to hundreds of universities, hospitals, medical research institutes, government agencies, private laboratories, and so on, all over the world. In effect – although this might not have been her motivation – she was doing something similar to what Mullis had sought to do with respect to claims that HIV caused AIDS, and in the case of Christine Massey, this involved seeking specific citations indicating that SARS-CoV-2 had been properly isolated or that there was evidence indicating that such a virus actually existed.

She received back several hundred responses to her inquiries. Not one of the governments, universities, hospitals, private labs, or research institutes could provide her with evidence that SARS-CoV-2 had ever been isolated or that it even existed.

If no one can prove that such a virus exists, then, no one is in a position to make claims about the genetic sequencing of such a non-existent entity. And, yet, notwithstanding a complete absence of evidence concerning the existence of the SARS-CoV-2, there were all manner of papers appearing in so-called scientific and medical journals which put forth alleged genetic sequences for a non-existent virus.

In 1954, John Enders received a Nobel Prize in Physiology and Medicine. The award was for work which Thomas Weller, John Enders, and Frederick Robbins conducted in 1941 when, supposedly, the trio developed a procedure for culturing the polio virus.

Up until the aforementioned 1941 research, many people had doubts about whether, or not, viruses could be cultured. The term "virus" was a catch-all which had been given to entities that seemed to have toxic properties and which due to their allegedly tiny size could not be filtered from solutions/samples.

Traditionally, bacterial, parasitic, or fungal infection often could be ruled out in certain clinical conditions because those microorganisms could be filtered and, therefore, identified if present. As a result, many clinicians and researchers assumed that the cause of whatever pathological condition might be manifesting itself under conditions in which bacterial, parasitic, or fungal infections could be ruled out might be due to a virus which, allegedly, had made its presence felt by the symptoms that they supposedly caused and which were being observed by clinicians and researchers.

However, because viruses were believed to need a living cell in order to replicate themselves and because not all viruses were necessarily considered to have a pathogenic effect in relation to all living organisms, there was some question about whether a set of techniques could be discovered that would enable viruses to be cultured so that they could be grown, studied, and, as a result, possible counter-measures (such as vaccines) might be established. The aforementioned research work of Enders, Robbins, and Weller concerning the alleged polio virus -- which culminated in 1941—was considered by many to have solved the culturing problem.

However, their "solution" entailed a problem. More specifically, there are two outcomes in conjunction with such research which need to be critically engaged to determine whether, or not, research has actually shown what is being claimed. The aforementioned two outcomes concern the results associated with both the experimental as well as the control group.

In the experimental group, a sample is taken from an individual who has been diagnosed with a particular malady – say polio -- which is believed to be caused by a particular entity. If one assumes that such a diagnosis is correct and that an unseen entity (presumably, a virus of some kind) is the illness-causing pathogen, then, in order to establish a culture: (1) the foregoing sample from an ill individual is mixed together with a living cell of some kind (e.g., a Vero kidney cell); (2) a few ingredients are added to ensure that whatever is infecting that cell is not a bacterial organism of some kind (for example, today, this would involve the use of certain kinds of antibiotics to kill off any bacteria which might be present); (3) the foregoing mixture is placed in a set of nutrient-deprived conditions, and (4) one waits to see what happens.

Different researchers might add a step, or two, to the foregoing sequence of steps. Nonetheless, the indicated four steps constitute the primary features of the viral culturing process.

The people who purportedly have cultured a sample in the foregoing manner are waiting to see whether, or not, a cytopathic event occurs. That is, they are waiting to see whether, or not, the living cell that is present in the aforementioned culture will die.

If such a cytopathic event occurs, then, this is attributed to the presence of a toxic virus. Presumably – or, so, the thinking goes -- the structure of the cell has been compromised in some fashion – such as through a process of lysis in which the membrane of the cell is punctured in some way (for example, by replicating viruses that, supposedly, have released proteins capable of creating holes in the membrane) which causes the contents of the cell to escape, and, as a result, the cell dies, and, viruses – along with the rest of the interior contents of the cell – are said to have been released into the dish in which different components have been brought together to culture a putative "virus."

What would happen, however, if one were to set up a culture in the foregoing way with one exception? More specifically, what if one were to take the initial sample from a person who was healthy (rather than ill), and, then proceeded with all of the same steps which were followed in the experimental group – including waiting to see whether, or not, a cytopathic event occurred? That is, what if one waited to see whether, or not, the culture containing a sample from a healthy person led to a cytopathic event as had been observed to occur in the experimental group?

If the control group -- which is the same as the experimental group with the exception that the sample be studied is from a healthy person and not an ill person – also leads to a cytopathic event, then, one can no longer automatically assume that the cytopathic event which was observed in conjunction with the experimental group is necessarily due to the presence of a toxic virus. In fact, if both the experimental group and the control group end in a cytopathic event, then, one might point to one, or more, properties of the sequence of steps in the culturing process as being the cause of the death of the living cell which was in the attempted culture.

For example, maybe the antibiotic which is used is toxic in some way to the living cell which is being used. Or, maybe the condition of being in nutrient-deprived conditions is what leads to the death of the cell in the culture.

Whatever the reason might be, if both the experimental and control group end with a cytopathic event, then, one cannot conclude that the death of the cell has been caused by a virus in each case. This is because the sample from the healthy individual is presumed to be free of viruses.

This condition of being virus-free is what makes the control group of experimental value. If only the experimental group cells die, and, the control group cells continue to live, then, there would appear to be something in the experimental sample which is different from the control sample, and this “something different” is presumed to be a virus.

On the other hand, if the cells in both the experimental and control groups die, then, whatever is causing the death is not due to differences between the two samples. Instead, the cytopathic event which occurred in both the experimental and control groups is likely to have had something to do with one, or another, aspect of the culturing methodology being used.

At a certain point, Enders followed through with a control group in his aforementioned experimental research. He discovered that the live cells in both the experimental group and the control group died, and, therefore, the cause of death could not be attributed to alleged differences between the samples used in the experimental and control groups.

Unfortunately, many subsequent scientists and medical doctors focused only on what happened to the living cell in the experimental group. They entirely ignored the fact that precisely the same cytopathic event was observed in conjunction with the living cell present in the control group as had been observed in the experimental group, and, consequently, there was no proof that what had caused the cytopathic event in the live cell in both groups was due to a virus.

The foregoing sort of practice in which researchers pay attention only to what might advance some ideological, financial, political, social, and/or career goal resonates with something which was stated nearly half a century later. More specifically, Marcia Angell was the first woman to serve as editor-in-chief of *The New England Journal of Medicine* and has taught at the Harvard Medical School.

At one point, she commented on her tenure as editor at the journal and said: "It is simply no longer possible to believe much of the clinical research that is published, or to rely on the judgment of trusted physicians or authoritative medical guidelines. I take no pleasure in this conclusion, which I reached slowly and reluctantly over my two decades as an editor of *The New England Journal of Medicine*." Conceivably, the previously mentioned research concerning the alleged polio virus, or the previously cited *Science* article, as well as the review articles concerning the sodium pump hypothesis that were discussed by Dr. Ling in his letter to Dr. Roderick McKinnon might serve to illustrate the kind of problem to which Dr. Angell was alluding in her previous quote.

So, while the foregoing considerations involving the experiences of Dr. Kary Mullis, Christine Massey, Dr. John Enders, or Dr. Marcia Angell do not prove the truth of the allegations which Dr. Ling has been making concerning the research of various individuals – including Dr. Roderick McKinnon -- nonetheless, the aforementioned experiences of Dr. Mullis, Christine Massey, Dr. John Enders, and Dr. Marcia Angell offer much food for thought concerning the possible value of the perspective which is being outlined in Dr. Ling's various letters to Dr. Roderick McKinnon.

Let me add a set of experiences from my own life that lend a degree of support to, at least, the plausibility of what is being said by Dr. Ling. Just as Dr. Ling has accused a Nobel laureate of having committed plagiarism, the set of experiences which is to be described below also involves a case of plagiarism, and while the person involved is not a Nobel laureate, nevertheless, he was a full professor in a position of power at a world-class university.

At one point in my life while attending the University of Toronto as a doctoral student, I was the chairman of a student group that held a weekly discussion session and, as well, from time to time, the student group would hold public functions involving, among other things, a series of lectures. During my tenure as chairman, a faculty member who had participated in a number of our programs approached me and indicated that he had reason to believe that a member of one of the academic departments in the university had committed plagiarism in a book of readings that the latter professor had edited and which also contained several articles that had been contributed by the editor of the book.

The professor who had approached me concerning the foregoing issue provided me with a couple of leads should I decide to pursue the matter. I followed up on the leads given and began doing research in the central library of the university.

I came across several works from which the editor of the book to which I alluded earlier had taken, without attribution, a fair number of passages and had passed them off as his own work in the two articles which he had included in the book which he had edited. After discussing the matter with other members of the student group of which I was chairman, we decided to engage in a campaign to expose the plagiarism – after all, if students could be denied course credits, suspended, or expelled from university for engaging in the practice of plagiarism, then, how much more important would it be to protect the integrity of the academic process by attempting to ensure that professors were not involved in similar sorts of behavior.

We put together a small newsletter that took quotations from a number of books that we believed had been illicitly used by the University of Toronto professor and placed those quotations (along with their source) side-by-side with relevant passages from the articles which had been written by the professor who taught at the University of Toronto and who had included the latter articles in the book of readings which recently had been released. The newsletter was printed up and distributed throughout the university, and this included providing a copy of the newsletter to the president of the University together with a covering letter which addressed a variety of issues concerning the matter of academic integrity.

In addition, copies of our newsletter were distributed to a number of television and radio stations as well as to various newspapers, including the newspaper of record for Canada. After receiving the package we had delivered to it, a reporter from the latter paper contacted us and wanted to do an exclusive concerning the exposé, but we indicated that our newsletter already had been released to a variety of media outlets.

The president of the university failed to respond to our letter to him. Moreover, although there had been a lot of initial interest in our newsletter which had been expressed by various aspects of the media, no one from the papers, radio, or television followed up on any of that initial interest.

Given the absence of such responses, we decided to send: Our newsletter, a covering letter, and a questionnaire to various North American university student newspapers as well as to professors who taught in the area of concern. The questionnaire asked a number of questions about whether, or not, the individual receiving the questionnaire thought that the evidence provided in the newsletter demonstrated that plagiarism had been committed.

We received nothing back from any of the university student newspapers to whom we had sent our package of documents. We did receive a fair number of filled-out questionnaires from various university professors who taught at different institutions in either Canada or the United States.

The latter responses were overwhelmingly of the opinion that the evidence provided indicated that plagiarism had been committed by the professor in question. One professor from a university in New York even indicated that he previously had come across additional evidence indicating that the professor toward whom allegations were being directed had committed plagiarism on at least one other occasion.

There were a few professors who responded to our questionnaire by objecting to what our student group had done. In essence, these professors believed that students had no right to make such accusations against professors.

To make a much-longer story mercifully shorter, the bottom line is no action was ever taken against the University of Toronto professor who – according to peers in his own academic field – had committed plagiarism. Instead, the professor was appointed as head of a university honors committee that was in charge of overseeing alleged cases of plagiarism as well as other possible violations of the student honor code.

Furthermore, there were some repercussions for me as chairman of the student group which had brought the issue of plagiarism to light. For instance, the Ministry of Education for the Province of Ontario contacted the director of my graduate school and raised questions about whether my being allowed to continue on as a graduate student was necessarily a good idea (I was informed of this by a professor in my department).

In addition, I needed nearly 17 years to have the opportunity to be able to have the opportunity to defend my dissertation. During that period of time I: "(a) was put on what was termed "lapsed candidacy status" in which, among other things, I was denied the right to use any of the facilities or resources of the University of Toronto; (b) I wrote a second dissertation; (c) I fired my initial dissertation committee, cobbled together a new thesis committee, and went directly to my oral defense.

Among the individuals who had been assigned to the oral defense proceedings were: A quantum physicist, a biophysicist, two philosophy of science experts, a linguist, and a professor of adult education who said during the oral defense proceedings that he had never seen a dissertation like mine and hoped never to do so again – but he, like all the other examiners, voted in favor of accepting my dissertation.

Just prior to going to my oral defense, my old thesis advisor (who had told me a number of years earlier that the Ministry of Education had tried to have me thrown out of graduate school), found out that I was about to take my oral defense and told me that a number of people had tried to do what I was trying to do, and they all had failed to get their doctorates. When I returned from having defended my dissertation successfully, I met with the same individual again, and, to say the least, he was nonplused to learn that all the efforts which had been made to throw academic obstacles in the way of my receiving a doctorate (and my former dissertation advisor had a major role in such efforts) had come to nothing.

The major reason for why the University of Toronto, the Ontario Ministry of Education, and the media acted as they did with respect to the foregoing case of plagiarism had nothing to do with issues of evidence or academic integrity. It constituted nothing more than giving expression to religious bigotry.

The student group which launched the plagiarism case was: The Sufi Study Circle of the University of Toronto and the chairman of that group – i.e., me – was a Muslim. I later learned that the reason why a number of members of the media had backed away from the plagiarism issue was because they had been contacted by officials from the University of Toronto who put forth a narrative that what was going on was not a matter of plagiarism but was merely an attempt by a group of disaffected, trouble-making Muslim students to cause trouble for the University of Toronto by trying to leverage the media to pursue a case that was nothing but misinformation and disinformation.

When people have vested ideological, political, religious, educational, financial, and/or economic interests to protect, they often have little trouble with ignoring matters of fact, evidence, proof, moral principles, or fairness. Dr. Ling fought against a similar alignment of antagonistic government officials, academic institutions, so-called expertise, and the media when he sought to defend decades of experimental research which indicated that there were serious problems with theories concerning: (1) The alleged existence of phospholipid membranes in biological organisms; (2) whether, or not, the idea of membrane pumps – such as the alleged sodium pump – made energetic sense, and (3) whether, or not, the primary role of ATP was as a source of energy or, instead, might have more to do with the way in which ATP constructively affected the electrical properties of a given biological environment during the dynamics of metabolism.

Throughout the course of his decades of experimental work, scientific research, writing, and educational activities, Dr. Ling put forth evidence indicating that a number of the sacred cows of modern biology (see the previous paragraph) did not seem to be tenable. As a result, a variety of institutions, agencies, media outlets, and individuals sought to suppress, censor, ignore, and distort his work in order to try to save the appearances of their own ideological perspectives and professional reputations or careers.

Having provided the foregoing set of back-stories, attention, now, will be directed toward engaging in some critical reflection concerning

Dr. Ling's notion of nano-protoplasm. As intimated previously, while I think there are many worthwhile elements associated with the idea of nano-protoplasm as a fundamental component of cellular, tissue, organelle, and organ activities, nonetheless, I do not share Dr. Ling's perspective that it constitutes the basic unit of life, and, hopefully, the essential reason for such a difference of opinion can be clearly indicated.

In the early 1960s, Gilbert Ling developed a perspective which provided what he considered to be a unifying account of cellular life. He termed his framework: The association-induction hypothesis.

According to Dr. Ling, the foregoing hypothesis was intended to resolve a variety of problems which were entailed by early attempts to identify protoplasm as being the physical basis of life. One of these problems had to do with the way in which traditional attempts to explain cellular dynamics failed to make a distinction between macroscopic and microscopic protoplasm because Dr. Ling maintained that cellular life could only be properly understood if it was engaged on a microscopic level.

Dr. Ling referred to microscopic protoplasm as nano-protoplasm. He contended that the properties of macroscopic protoplasm are a function of -- and, therefore, give expression to – the dynamics of nano-protoplasm.

In addition to the foregoing issues, Dr. Ling indicated that two other problems which emerged in conjunction with the cell theory that had been outlined by Theodor Schwann (a zoologist) and Mathias Schleiden (a botanist) had to do with the idea of a membrane. More specifically, on the one hand, Schwann had described the cell as a region or area filled with clear water which was enclosed by a membrane, and, on the other hand, this membrane had the capacity – through, at that time, unknown ways -- to control what happens near to the exterior of a cell as well as within such a cell.

Thus, in developing the notion of a cell, Schwann had introduced the concept of a fixed membrane of some kind which enclosed a volume of clear water. Over time, this property of enclosure developed into various kinds of theories concerning the nature of the membrane.

The membrane concept also eventually gave rise to the idea of pumps. Various hypotheses concerning the nature of membrane pumps began to appear which sought to explain how those proposed pumps worked and, in the process, allegedly controlled significant aspects of the dynamics concerning what entered and what left a cell.

The foregoing properties of: Enclosure, a clear volume of water, and pumps that controlled the way in which the interior of cells interacted with aspects of the environment which were exterior to the cell became associated with the idea of a cell. However, Schwann might have been somewhat lackluster when examining the world which was being engaged through that instrument.

For example, four years prior to Schwann's announcement of the cell theory, Felix Dujardin, a zoologist from France, reported a gelatinous, water-insoluble substance that could be observed emerging from a protozoan organism when that life form was crushed. A water-soluble, gelatinous material appears to be a very different kind of description from Schwann's later pronouncement that cells consisted of clear water – a description which was based, supposedly, on Schwann's having spent considerable time observing all manner of cellular life through a microscope.

Dujardin referred to the aforementioned gelatinous, water-insoluble material as a "sarcode" or 'living jelly'. A little over five years later, Jan Purkinje a microanatomist from Czechoslovakia identified the interior portion of a cell – whether plant or animal – as 'protoplasm.'

Another 26 years passed before Max Schultze, a German botanist, introduced a protoplasmic model of cellular life. He discarded Schwann's notion of a membrane, while giving protoplasm a central role, and, as well, added a nucleus.

Gilbert Ling notes that once the foregoing perspective had been established, scientists began to encounter all manner of problems trying to account for how such protoplasm made life possible. The problems were so extensive that the nature of life seemed to become ever more elusive as scientists parsed protoplasm into smaller and smaller units that like some sort of 'Humpty Dumpty puzzle' couldn't be put back together again as a functional whole.

Noting, in passing, that the term "protoplasm" began to disappear from many standard textbooks, Dr. Ling also indicated that that those same textbooks were treating the ideas of "membranes" and "membrane pumps" as if they were unquestionable truths. Yet, as Dr. Ling goes on to indicate, those ideas had been experimentally demonstrated to be untenable for more than four decades.

According to Dr. Ling, real progress toward developing a heuristically valuable research context for exploring the nature of life didn't begin until two things had been accomplished. First, the molecular structure of all 20 of the α-amino acids which are present in living organisms had to be identified, and this took more than a hundred years to accomplish, while, secondly, Ludwig Boltzmann had to invent statistical mechanics so that there could be a quantitative way to link what was happening on a microscopic scale (in terms of either nanometers -- 10^{-7} centimeters, or Angstroms -- 10^{-8} centimeters) with the dynamics taking place on a macroscopic scale.

The foregoing developments enabled Dr. Ling to begin exploring the properties of protoplasm. Eventually, he came up with an early edition (which first surfaced in 1952) concerning the previously mentioned notion of the association-induction hypothesis, and this early version of the latter perspective appeared in the guise of what Dr. Ling referred to as the 'fixed charge hypothesis.

In 1965, the principle of the polarized-oriented multilayer theory of water was later added to his earlier fixed charged hypothesis. Together, the foregoing two ideas formed the framework for the association-induction hypothesis (which will be outlined in what follows).

For Dr. Ling, there was a hierarchical structure to life. For example, organs were a function of the tissues that comprised them, and tissues, in turn, were a function of the cells to which those tissues gave expression.

Moreover, cells consisted of macroscopic protoplasm. Macroscopic protoplasm, in turn, was a function of microscopic protoplasm.

The foregoing microscopic protoplasm was another way of referring to the aforementioned biologically fixed charge system that formed one part of his association-induction hypothesis. He renamed this aspect of his hypothesis: "nano-protoplasm."

He considered nano-protoplasm to be the most basic unit of life. As such, he maintained that it was a living machine of an elementary nature.

In order to unravel the properties of nano-protoplasm, Dr. Ling selected a mature mammalian red blood cell to illustrate his perspective. Red blood cells have no nucleus, and, therefore, this helped to simplify his task of explication.

Dr. Ling indicates that by weight, 65% of the red blood cell is water. 97% of the remaining weight of that cell consists of just one protein – namely, hemoglobin.

In addition, there is a certain amount of potassium ions (K^+) which are present in a red blood cell. Furthermore, there are even lesser amounts of various kinds of metabolites from the energy production cycle that are present in a red blood cell, and these metabolites include both ATP (adenosine triphosphate) as well as 2,3 DPG (that is 2,3 disphosphoglycerate).

At this point, a question tends to bubble to the surface of consciousness. As indicated in earlier chapters, Béchamp, Reich, and Naessens all explored the nature of blood and blood cells.

Béchamp observed what he called microzymas to be in the blood. Reich spoke about the bions which he had observed in the blood. Naessens referred to the somatids that he found in the blood.

The foregoing entities were not just in the plasma in which blood cells reside, but, they were, as well, within the red blood cells which inhabit that plasma. Consequently, one wonders why Dr. Ling makes no mention of these inhabitants of, among things, red blood cells.

Moreover, Béchamp, Reich, and Naessens all thought that microzymas, bions, or somatids were fundamental to the process of life. In fact, they each considered those entities to be so basic to life that – each in their own manner – stipulated that those entities (whatever they were) were more fundamental than cells and, in fact, cells, themselves, were a function of those entities.

Whatever microzymas, bions, and somatids are (whether different names for the same thing or different from, but related to, one another in some fashion), they were not hypothetical concepts. They each had been seen through, and studied with, microscopes.

The microscope that Naessens had invented (known as the Somatoscope and which employed advanced techniques of optics) could resolve objects down to the level of 150 angstroms (15 nanometers). Moreover, unlike the electron microscope, what Naessens was observing via his microscope was life actually being lived on the microscopic level rather than objects which had been killed by the processes (involving extreme temperatures and radiation as well as various kinds of chemical agents) that are necessary to fix images via electron microscopes.

Given the foregoing considerations, one may have to place an asterisk or caveat next to the claims of Dr. Ling that his notion of nano-protoplasm constitutes the smallest unit of life. Nevertheless, notwithstanding the foregoing possibility, there is much to learn from the way in which Dr. Ling proceeds with his investigation into the red blood cell.

Dr. Ling asks his readers to imagine taking a red blood cell and cutting it up so finely that all that remained was a small volume of material containing, among other things, just one hemoglobin molecule. Also present in the foregoing tiny volume of material would be seven thousand water molecules, nearly two dozen potassium ions, and one molecule of either ATP or 2,3-DPG.

In a red blood cell, the foregoing set of components, when connected with one another, give expression to what Dr. Ling is referring to when he speaks of the notion of “nano-protoplasm”. When other kinds of cells are broken down in the way in which the reader has been asked to envision with respect to red blood cells, then, the tiny volumes of a similar set of components would consist of: (a) One, or more, proteins which play a physiologically significant role in a given type of cell (and, therefore, are not just structural in nature); (b) some relatively large amount of water molecules (numbering in the thousands); (c) a relatively small quantity of ions of some kind (say, 20, or so), and (d) either one molecule of, or a very limited number of ATP or 2, 3-DPG molecules, and when this set of molecules is connected together, then they are referred to as a nano-protoplasm unit for the specific cell being considered.

After running through an additional number of calculations, Dr. Ling indicates that the diameter for a red blood cell NPU (nano-protoplasm unit) would be about 8.6 nanometers. According to Dr. Ling, this small size confirms that nano-protoplasm warrants being referred to as the smallest unit of life.

However – and let's leave aside what role microzymas, bions, and/or somatids might play with respect to the nature of life – until one can settle on what life is, one really doesn't know if one can refer to nano-protoplasm as the smallest unit of life, let alone necessarily be able to justify claims that such units constitute some form of life at all. Certainly, NPUs might well be an instructive way through which to gain some insight into, and understanding of, what is transpiring on a microscopic level in living organisms, but nothing in the foregoing considerations necessarily indicate that life is a function of what NPUs do, even if one were willing to acknowledge that NPUs have important roles to play in life processes on the cellular level.

Upon considering the amino acid groups which make up a physiologically active protein such as hemoglobin, Dr. Ling is most interested in two particular categories of several tri-functional amino acid residues – namely, either, on the one hand, aspartic acid and glutamic acid, or, on the other hand, lysine and arginine (sometimes histidine). According to Dr. Ling, aspartic acid and glutamic acid residues tend to be present in fairly high numbers among the many amino acids which make up many physiologically active proteins such as hemoglobin, and when they are present, they constitute a fixed negative charge (i.e., fixed anion) through the presence of β-, and γ-carboxyl groups within these two amino acids. Furthermore, the amino acids lysine and arginine (sometimes histidine) also often occur in relatively high numbers within physiologically active proteins like hemoglobin and, when present, can confer a fixed positive charge (i.e., fixed cation) through ε-amino and guanidyl groups which are present in latter kinds of amino acids.

The fixed charge – whether negative or positive – which is conferred by the aforementioned pairs of molecular groups indicates why Dr. Ling initially referred to his hypothesis as the "fixed charge system." As, hopefully, will soon be made clear, these places of fixed charge play significant roles within any given nano-protoplasm unit since approximately 11% of the amino acid residues in hemoglobin consist of fixed anions while roughly 10% of hemoglobin's amino acids come equipped with fixed cations.

If one integrates the information from the last several paragraphs with what already has been said in relation to the nature of the nano-protoplasm unit, one arrives at a more nuanced understanding of Dr. Ling's perspective. What is central to the physiological dynamics of the NPU has to do with the way in which positive and negative charges are distributed throughout the NPU, either as a result of the β-, and γ-carboxyl groups (negative charge) that are present in the aspartic acid and glutamic acid residues which constitute 11 % of the amino acids in hemoglobin and are distributed at different points in the sequence of amino acids that constitute hemoglobin, or as a result of the ε-amino and guanidyl groups (positive charge) that are present in the lysine and arginine (sometimes histidine) amino acids which make up about 10% of the amino acid sequence present in hemoglobin and also are distributed at different points along that sequence.

In addition to the foregoing positive and negative groups in some of the amino acids which compose hemoglobin, there also are the NHCO groups that are present in the backbone of all amino acids and which play important roles in transmitting various kinds of energetic and other sorts of influences within a given NPU as the former NHCO groups interact with the surrounding water molecules, as well as with ions (e.g., potassium or sodium) which also form part of the nano-protoplasm unit. The charge characteristic of any given NPU is critical to what such a nano-protoplasm unit will or will not do with respect to which other NPUs will be engaged by the former unit and what the nature of that engagement will be in relation to biological functionality.

Metabolism can be seen as a sequence of nano-protoplasm units that posses the right sorts of charge characteristics which come together at the right time, in the right place, for the right duration, in the right sequence, and in the right amounts. Given the foregoing considerations, one catches a glimpse of why Dr. Ling considers nano-protoplasm units to be so crucial to cellular, tissue, and organ dynamics which are biologically functional only to the extent that those nano-protoplasm units interact with one another in accordance with a set of precise protocols.

Dr. Ling refers to two modes of transmission which take place within a given protein chain or between two, or more, different proteins. These are termed "Direct F-effect" and "Indirect F-Effect" which are made possible by the degree to which polypeptide chains form resonance relationships that underlie the property of high polarizability which is present in such polypeptide chains.

The "direct F-effect" consists of some physiological agent that couples together the dynamics involving one part of the polypeptide chain of a protein with some other target group which is either part of the same polypeptide chain or part of some other, separate protein chain. The "indirect F-effect" involves a sequence of the foregoing sort of "direct F-effect" dynamics.

Sets of: 'direct F–effects' and 'indirect F-effects,' are regularly conveying physiologically significant influences through the same, as well as different, nano-protoplasm units. According to Dr. Ling, the biological distances across which such effects can be transmitted could be indefinitely large.

Dr. Ling contends that there are adsorption dynamics which take place in, and between, nano-protoplasm units that involve a process of connectivity in which ATP and 2, 3-DPG play fundamental roles. The essential nature of such adsorption dynamics is due to the way that the presence or absence of ATP or 2, 3-DPG tend to control much of what will, or will not, take place in, or between, NPUs.

Furthermore, such adsorption processes involve dynamics in which one pair of negatively- or positively-charged adsorbents create physiological conditions within a given NPU or interacting NPUs that tend to favor a similar sort of pairing in neighboring adsorption sites. He refers to this sort of dynamic as an example of "auto-cooperative interaction".

The notion of auto-cooperative interaction is just another way of referring to the sorts of resonance processes, or polarizing dynamics, or 'direct F-effect' and 'indirect F-effect" transmission influences which Dr. Ling indicates take place within or among nano-protoplasm units. These sorts of interactions, dynamics, ionic effects, resonances, adsorptions, and polarizations are how NPUs communicate or transmit various kinds of physiological influences within themselves as well as in relation to one another.

In subsequent updates of his association-induction (AI) hypothesis, Dr. Ling has replaced the 'indirect F-effect' transmission phenomena with what he refers to as the "AI cascade mechanism". This is the process through which energy and various forms of molecular communication are transmitted to other NPUs (or transmitted to separated sections within a given NPU), and what is transmitted is a function of how all of the different aspects of a nano-protoplasm unit interact with one another in terms of: Resonances, adsorptions, polarizations, and polypeptide conformations that exist among components of a given nano-protoplasm unit which consists of: one, or more, physiologically active proteins (in the case of red blood cells this would be hemoglobin); ions; water molecules, and ATP or 2, 3-DPG molecules.

Connected to the foregoing considerations is a physiological parameter which Dr. Ling refers to as a "c-value". C-values have to do with the electron density which surrounds some given molecule or molecular group, and which can be characterized as being either high or low.

The c-value is important because it indicates whether, or not, certain kinds of adsorption dynamics -- involving, say, β-, and γ-carboxyl groups in aspartic acid or glutamic acid amino acids in a given protein – are likely to take place or can be induced to take place. In turn, adsorption dynamics are significant because they affect the way in which nano-protoplasm units operate internally, within themselves, as well as the way in which they operate in conjunction with other NPUs as a function of their respective charge properties and conditions.

There are other kinds of physiological parameters mentioned by Dr. Ling which affect the charge properties of a given nano-protoplasm unit or set of such units. Some of these are referred to as: "c'-values" and "c-value analogues".

Without getting into the weeds of an over-abundance of physiological details, the essential principle which appears to tie all of the foregoing sorts of parameters together is the manner in which they collectively impact issues of resonance and polarity which, in turn, affects the kind of conformation that a given sequence of polypeptides will assume (for example, which molecules or groups are oriented in the same direction as, or perpendicular to, a given polypeptide axis). The conformation of such polypeptide sequences will determine what sorts of charge conditions will be present in a given set of circumstances involving one, or more, NPUs, and, therefore, such conditions will shape what kinds of dynamics will take place due, among other things, to the manner in which water molecules will be oriented or polarized by the foregoing sorts of conformational properties.

The way in which the conformation of polypeptide or protein chains can orient or polarize water molecules -- which, in turn, will affect or help shape how a given nano-protoplasm unit will function -- is what Dr. Ling added in 1965 to his initial fixed charge hypothesis of 1952. This addition is referred to as the "polarized-oriented multilayer theory of cellular water" (POM), and together with the previously described fixed charge hypothesis, constitute the basic principles which are inherent in the association-induction hypothesis of Dr. Ling.

According to Dr. Ling, cardinal adsorbents (such as ATP, hormones, and certain ions) are entities which can have significant physiological effects at very low concentrations. Among other things, they impact the dynamics of the AI cascade mechanism mentioned previously in this chapter.

Cardinal adsorbents can assume three different kinds of roles. For example, what binds to, or is adsorbed to, a given adsorbent, might involve no effective change in charge properties, and when this occurs, the condition is referred to as an "electron-indifferent cardinal absorbent."

There are two further possibilities concerning such binding or adsorbing dynamics. In one case, electrons are withdrawn by the cardinal adsorbent, and this is termed an "electron withdrawing cardinal adsorbent" or EWC.

In the other case, electrons are donated. This is known as an "electron donating cardinal adsorbent" or EDC.

Dr. Ling indicates that many NPUs have the capacity to break down ATP to yield: ADP, plus a molecule of inorganic phosphate (PO_4). Oftentimes, according to Dr. Ling, the cardinal adsorbent site occupied by ATP can serve (but might not) as an ATPase or enzyme and in the process, when ATP is removed, the status of a NPU can change from a resting to an active state, and, therefore, in such cases constitutes a switch of sorts.

While elucidating the role which ATP plays in his AI hypothesis, Dr. Ling inserts some information that runs contrary to the way in which many people understand the functional nature that ATP supposedly plays in an organism. More specifically, he indicates that ATP does not contain the high-energy-phosphate bonds that usually are attributed to it in textbooks and high school or university classrooms.

According to Dr. Ling, the presence of ATP in NPUs serves functions that have nothing to do with the alleged capacity of the phosphate bonds in ATP to be a source of energy for metabolic processes. Instead, for Dr. Ling, ATP constitutes a charge-modulating tool which helps structure or shape how NPU dynamics operate, both internally as well as in conjunction with other NPUs.

The withdrawing and donating of electrons, as well as the process of remaining charge neutral, are all ways in which a cardinal adsorbent -- such as ATP -- can affect the dynamics of a NPU. Resonance, polarity, ionic properties, polypeptide conformation, activity, the orientation or polarity of water molecules, and the cascading dynamic which radiates out to one or more neighboring NPUs are all affected by what happens to electrons at adsorbent sites.

In effect, resonance, ionic, binding, and polarizing interactions within, and among, different aspects of NPUs involving: (a) The CO groups of the polypeptide backbone associated with amino acids; (b) β-, and γ-carboxyl groups in aspartic acid and glutamic acid amino acids, or ε-amino and guanidyl groups in lysine and arginine (sometimes, histidine) amino acids; (c) withdrawal and donation of electrons associated with adsorption sites in amino acids; (d) conformational changes in polypeptide orientation relative to the backbone axis, (e) together with the modulating effects generated by different functional groups on various side chains of the polypeptides that make up the physiologically significant protein (e.g., hemoglobin) in a given NPU all help to induce across-the-board changes in electron density in which everything interacts as if part of single functional unit and constitutes a dynamic which, in turn, could lead to a cascade of changes among other NPUs. Dr. Ling indicates, however, that all of the foregoing considerations – despite their relative complexity -- only give expression to a simplified version of NPU dynamics.

When the foregoing exchange process is set in motion by something which binds to a specific cardinal adsorbent, the process is referred to by Dr. Ling as a "controlled auto-cooperative transition. When such an exchange process is initiated by an increase in the relative abundance of a given adsorbent in the vicinity of a given NPU, then, this is called a "spontaneous auto-cooperative transition."

The aforementioned spontaneous form of transition is described by Dr. Ling as being able to start at any site because the process is allegedly random. On the other hand, the controlled form of transition always starts with a particular adsorbent site and, therefore, the ensuing path of communication propagation is said to be determined.

Whether one is considering spontaneous forms of transition or controlled forms of transition, Dr. Ling uses the idea of falling dominos as a way of trying to convey something of the nature of the dynamics which take place in nano-protoplasm units. However, he points out that the example of dominos is limited because unlike biological dynamics which can be reversible, dominos only fall in one direction.

Notwithstanding whatever limitations might exist in the dominos example, there is an obvious aspect of the falling dominos metaphor which Dr. Ling might be missing. More specifically, in order for dominos to be able to do whatever interesting dynamics they do, someone or something has to set those dominos up in a way that will enable them to fall in one way rather than another when engaged.

Dr. Ling seems to believe that the association and induction aspects of his hypothesis concerning the dynamics of nano-protoplasm units are an automatic, natural function of the components which are present in any given NPU. In one sense, this aspect of automatic, natural functioning might be quite appropriate for describing what occurs in conjunction with a nano-protoplasm unit that exists in an assembled state (which he calls a resting state) as well as what occurs in conjunction with a nano-protoplasm unit in which the components of that unit are freed, to a degree, from one another (which he refers to an active state) and perform in accordance with whatever degrees of freedom and constraint are present in the interactions, dynamics, effects, resonances, adsorptions, and polarizations that are entailed by the potential of any given nano-protoplasm unit or interacting set of such units.

Nonetheless, what appears to remain unexplained by Dr. Ling is the nature of that which “knows” how to bring together a sequence of nano-protoplasm units. After all, such nano-protoplasm units must have the right kind of charge characteristics at the right time, in the right place, in the right sequence, in the right amounts, and for the right duration in order to give rise to a needed biological function within a cell, or within a tissue, or within an organ, or within an organism.

In a sense, given Dr. Ling’s account of a nano-protoplasm unit, such an entity is complex form of electrical circuitry. The nature of this circuitry can be changed by altering one, or more, of the components which give expression to the circuitry’s having the functional properties that it does, and so that which needs to be explained is what has oversight over the way, or extent, or time, or amount, or sequence in which the various components of a given NPU will be put together so that the circuitry of such a unit will have operational functionality in a given set of biological conditions.

To a certain extent, and as is probably true of any physiologist, Dr. Ling was engaged in a sort of process of reverse engineering. In other words, he took what can be observed experimentally and seeks to make sense of it on both a macrocosmic and microcosmic level so that the two levels can be coherently synchronized with one another.

Let’s assume, for the sake of argument, that his account of NPUs correctly reflects what actually goes on in a biological organism (and right, or not, he has given us all much to think about). Knowing how something works in terms of how its different facets interact with one another (and, I believe this is what Dr. Ling has attempted to do) doesn’t necessarily tell one anything about how that something came to be able to work in the way it does.

Of course, there is a way out of the foregoing "origin" problem, but it is only a temporary "fix," and it is only temporary because, ultimately, it leads to a sort of infinite regress. In other words, Dr. Ling could say that the previous NPU will establish biological conditions (via, say, the impact of the previously discussed AI cascading mechanism) which are conducive to, or which will induce, the following NPU to associate with the previous NPU in just the way which is needed – that is, in a biologically functional manner.

However, the foregoing sort of response requires one to ask about what shaped the previous NPU to have the properties it does so that it will be able to induce the following NPU to have certain properties and characteristics. At some point, one will be forced to acknowledge that NPUs don't generate themselves but need to be generated by some sort of organizing dynamic and, as a result, NPUs are not necessarily self-generating but appear to need to be constructed through an epigenetic process which creates a localized space of physiological conditions out of which a given NPU emerges that will have a specific kind of circuitry potential rather than some other kind of circuitry potential because if that circuitry potential (that is, its array of possible degrees of freedom and constraints) is not right, then, pathogenicity, rather than functionality, is likely to ensue.

Just as something must organize a set of dominos with different properties to be able to fall in different ways, at different rates, with different effects, in different sequences, in different directions, then, so too, the same is true for nano-protoplasm units. Something must organize any given NPU to possess a specific kind of physiologically active protein (or proteins) with the right kind of charge properties as a function of β-, and γ-carboxyl groups (negative charge) or ε-amino and guanidyl groups (positive charge), and a certain set of water molecules, and a specific set of specific ions as well as the presence or absence of adsorption factors such as ATP or 2, 3-DPG which serve as controlling factors in NPUs.

One cannot keep putting off what organizes the way in which any given NPU or a sequence of different NPUs becomes part of a particular metabolic pathway. Once NPUs are set up, things might have a certain inevitable, automatic dynamic to them, but, first, something must organize the individual NPUs to ensure that they have certain properties and, as well, something must organize which NPUs are to be induced to associate or interact with one another in certain sequences, at certain times, in certain places, in certain amounts, for a certain duration.

Whatever the foregoing “something” is that is responsible for organizing individual NPUs, or is responsible for organizing sets of interacting NPUs in functional pathways, then, seemingly, this “something” resonates much more closely to the idea of life than do the NPUs which Dr. Ling refers to as the basic unit of life. NPUs seem more like tools that are used by the “something” to which reference is being given here and which might be responsible for assembling NPUs and inducing their interaction or association in biologically functional ways.

To be sure, Dr. Ling’s association-induction hypothesis is far more detailed and nuanced than what has been presented over the last 14, or so pages. Nonetheless, the foregoing discussion has attempted to capture the general character of many of the most fundamental aspects of his perspective.

Each reader of this book will have to decide for oneself to what extent the aforementioned attempt has succeeded in realizing its objective of conveying important aspects concerning the association-induction hypothesis of Dr. Ling. However, irrespective of the extent to which things have been properly characterized, there is considerable food for thought which is present in this chapter concerning the possibility that something more deeply hidden might exist beyond the horizons of Dr. Ling’s perspective.

<u>Chapter 11</u>: Energizing Biophysics

The human body is electrically wired. This is proven every time someone experiences the process of defibrillation in order to help re-set an abnormal rhythm of the heart.

The human body is electrically wired. This is proven every time someone undergoes an electrocardiogram or an electroencephalogram.

The human body is electrically wired. This is proven every time someone encounters an imbalance in electrolytes which generate electricity through the dynamics of ions such as: Calcium (Ca^{2+}), chloride (Cl^{-}), sodium (Na^{+}), magnesium (Mg^{2+}), Potassium (Ka^{+}), and hydrogen phosphate (HPO_4^{2-}) which are often present in various organic acids, salts, and bases that are dissolved in polar solvents within the body such as water.

The human body is electrically wired. This is not only proven every time one detects and/or measures the generation of an electrical charge in the human body as a result of the presence of some sort of mechanical stress in relation to crystalline or crystalline-like structures that are present in bones, DNA, and certain kinds of proteins, but as well, it is proven every time bodies are exposed to electrical fields which, given the right circumstances, can translate electrical energy into various kinds of mechanical forces and stresses within the body. The foregoing reversible process is known as the piezoelectric effect.

The human body is energetically wired. For thousands of years, Chinese, Buddhist, and Taoist researchers, among others, have demonstrated that the way in which energy flows through the body can spell the difference between health and pathology (there will be more on this in next chapter).

The human body is energetically wired. This has been proven through the work of Gilbert Ling, Gerald Pollack, and others who have established that a form of water is regularly formed in living organisms which some have termed “structured water” (Gerald Pollack) and others have referred to as the “polarized-oriented multilayer theory of cellular water” (Gilbert Ling).

Such watery structures are continuously forming and dissipating as a result of the way in which, under different conditions, polarizing dynamics induce separation of charges (protons and electrons) within water. Moreover, depending on the nature of the separation of charge being generated and the conditions in which such a separation of charge is being generated, various kinds of energetically charged biological terrain are created which, on the one hand, can facilitate and help establish the sort of internal electrical ecologies which are capable of leading to all manner of constructive biological functions, or, on the other hand, if toxic influences destabilize the foregoing sorts of healthy formation of structured water, then, pathologies of one kind or another often ensue.

In the present chapter, the work of Mae-Wan Ho (as put forth in her book: *The Rainbow and the Worm: The Physics of Organisms*) will be explored. In the introduction to the foregoing book, the water-related research of Gerald Pollack and Gilbert Ling is mentioned.

At various junctures of her book, she speaks in laudatory tones concerning the research of the aforementioned individuals: Gerald Pollack and Gilbert Ling. Yet, she appears to fail to mention that Dr. Ling's investigation of water is only part of a much more complex framework of explication involving the idea of nano-protoplasm units (which were, to a certain degree, discussed in the previous chapter of the present book).

To be sure, the complex dynamics of water play an important part in the notion of NPUs. Nonetheless, from the perspective of Dr. Ling, if someone is to properly understand the role which water plays in those dynamics, then, one must look at how all of the different facets of a nano-protoplasm unit (including water) come together and operate as a complex electrical phenomenon which can influence what takes place in any given NPU.

As a result, while Mae-Wan Ho mentions the water aspect of Dr. Ling's research, she doesn't seem to make any reference to his experimental work which tends to illustrate the untenable nature of membrane pump theories, or membrane potential theories (rather than, say, surface potential theories), nor does she mention Dr. Ling's contention that ATP does not possess the sorts of high-energy yielding phosphate bonds which various textbooks, articles, and lectures contend is one of the primary go-to sources for energy in an organism.

If one does a search for the term “ATP” in Mae-Wan Ho’s book, she often uses the commonly accepted idea that the primary role of ATP in the human body is to serve as a medium of energy transfer to other entities within an organism. However, in a reference note concerning a discussion of ATP in an early part of her book, she does cite a 1995 publication of hers which indicates that the contention that there is an energy transfer from ATP to other entities (e.g., proteins) within an organism has been challenged by quite a few researchers, so, one is not entirely clear about which side of the fence she sits with respect to the role of ATP in the human body.

Dr. Ling is among those researchers who challenge the notion that ATP is involved in energy transfers within an organism. For him, ATP has a very different role in the body where, as indicated in the previous chapter, Dr. Ling believes that ATP often serves as a cardinal adsorbent in nano-protoplasm units, and, according to him, such cardinal adsorbents have a major influence on, if not control over, the way in which electrical charges are donated, removed, and distributed within a given nano-protoplasm unit.

Returning to her book, Mae-Wan Ho distinguishes between two kinds of questions which are asked in science. She considers one of those kinds of questions to be small and directed toward what Thomas Kuhn might refer to as “normal” science – that is, the sorts of questions that tend to arise on a daily basis and which are not likely to cast doubt on the scientific framework through which daily scientific problems are engaged.

The big questions, on the other hand, have to do with probing essential and fundamental dimensions of reality. For Mae-Wan Ho, one of those questions appears in the title of a book by Schrödinger (namely, *What Is Life*?) which she reflects on in several ways -- one of which (the primary topic of her book) pursues questions that try to resolve the nature of a certain aspect of reality (that is, the nature of life as a biological phenomenon), but, as well, she also mentions that the foregoing question concerning life also spills over into issues involving the meaning or significance of that biological phenomena for the organisms which experience it.

Gilbert Ling once mused that Schrödinger never actually answered the question which was raised in the title of the aforementioned book. Mae-Wan Ho's work: *The Rainbow and the Worm: The Physics of Organisms* does attempt to answer the biological aspect of Schrödinger's question concerning life, and irrespective of whether, or not, she has succeeded in her quest, her book has considerable heuristic value in the sense that it induces one to critically reflect on an array of important issues.

At the heart of Mae-Wan Ho's perspective is the notion of "coherence." Her aforementioned book is an attempt to describe, if not explain (??), life as being a non-linear, far-from equilibrium, co-operative form of coherence which serves to demark the nature of the boundary which differentiates the non-living from the living.

As such, Ho's notion of coherence is not a function of the sort of physics and chemistry which can be reduced to Newtonian-influenced forms of mechanics. On the other hand, Ho's idea of coherence is also not intended to be a function of some mysterious form of non-mechanical élan vital or unspecified vital force such as that which had been proposed by Henri Bergson in the early part of the twentieth century.

Instead, the foregoing notion of 'coherence' is intended to give expression to a sort of tertium quid, or third possibility. In other words, Mae-Wan Ho's previously cited book is an attempt to elucidate the principles which form a physical and chemical framework for the notion of coherence which might be capable of explicating the biophysical nature of life – or advancing the cause of such a project, and the purpose of this chapter is to critically reflect on the foregoing perspective which is being developed through her research.

While Mae-Wan Ho acknowledges that all she might be able to accomplish in her book is to provide a certain amount of scaffolding that enables future researchers to continue to construct a more permanent form of edifice that is capable of serving as an answer for the question of: "What Is Life," nonetheless, she does offer a provisional definition for life which is rooted in the idea of being an "organizing whole." What is entailed by either the word "organizing" or "whole" remains to be seen, but, in the early going, she indicates that life is a verb and not a noun – that is, life is a dynamic of some kind rather than an object to which one can point

Furthermore, she also indicates that the idea of "wholeness" refers to the thermodynamically open form of interaction which "life" has with whatever sort of environment in which it is ensconced. The nature of such interaction involves a set of processes through which a life form withdraws certain resources or elements from the surrounding environment and transforms those elements into a stable form of existence which is capable of resisting, within various degrees of freedom, whatever forms of encroachment or constraint that the surrounding environment seeks to impose on such a life form.

Just as Gilbert Ling spoke about the idea of cascading dynamics in conjunction with nano-protoplasm units, so too, Mae-Wan Ho indicates that cascading dynamics are a common feature of various kinds of molecular communication and signal transduction. For instance, she describes the capacity of some species of organism to be able to detect the presence of a single photon, and, then, proceeds to outline the molecular cascade which transpires following such a detection event.

For instance, rhodopsin is a pigment which is located in certain membrane stacks within the rod-cells of the retina. When a photon hits rhodopsin, a particular kind of protein – transducin – is brought into existence in multiple copies, and, in turn, <u>each</u> of the latter molecules helps to induce a molecule of the enzyme phosphodiesterase to be expressed which, then, proceeds to busy itself with breaking down an array of cyclic guanosine monophosphate (cGMP) molecules into a non-cyclic form of GMP.

The reason given by Mae-Wan Ho for the foregoing molecular cascade is to shutter alleged sodium channels leading into a cell's interior and, thereby, prevent sodium ions from entering a given cell, and, in the process, inducing an increase in the polarization of the cell membrane which, in turn, leads to a nerve impulse. However, without trying to serve as a referee concerning who might be right or wrong with respect to the foregoing issue of: Membranes, membrane channels, sodium pumps, and electrical potential, one might note in passing that Gilbert Ling indicates that there is substantial experimental evidence indicating that membranes made of phospholipids, or the idea of membrane channels, sodium pumps, and electrical potential might not occur in the manner in which Mae-Wan Ho claims to be the case.

Setting aside the foregoing sorts of issue, there is an additional problem which is acknowledged by Mae-Wan Ho. More specifically, evidence exists to indicate that 10^{-2} seconds is required to activate just one molecule of the aforementioned phosphodiesterase molecule via its predecessor proteins – namely rhodopsin and transducin -- and, yet, evidence also exists which indicates that the cascade which goes from: A single photon, to the activation of one molecule of rhodopsin, to the expression of some 500 molecules of transducin, to the activation of phosphodiesterase, to the splitting of cGMP, to perceptual activity takes place in just 10^{-1} seconds, and, to date, no one has figured out how perception is able to take place within a time-frame which is an order of magnitude different than what has been experimentally shown to be required to activate just one molecule of phosphodiesterase.

From the realm of perceptual dynamics, Mae-Wan Ho launches into a discussion of muscle contraction. She starts by indicating that nearly 50% of the human body consists of muscle fibers of one kind or another.

Between 5-10% of the muscle in a mature body exists in the form of smooth muscle configurations. Another 40% comes in the form of skeletal muscle – that is, muscles which are attached to bones.

Skeletal muscles are bundles which are several centimeters in length and consist of the fusion of between 20 to 50 smaller fibers -- termed myofibrils -- which have a diameter that is approximately one millionth of a meter (micrometer).

The length of any given myofibril is regularly demarcated by structures known as sarcomeres which are about 2.5 micrometers in size, and such sarcomeres give expression to the striated character of skeletal and heart muscles. These repeating units are built with two kinds of proteins: Six, thin, actin filaments which corral a single, thick myosin filament, and the six actin proteins are attached at their positive polar ends to an end-plate known as a Z-disc.

Myosin filaments have three sections. These involve what are referred to as head, neck and tail regions.

There are 624 head groups on each myosin filament. When a larger, muscle fiber contracts, all of the sarcomeres which are present in the myofibrils are involved.

The actin and myosin proteins are organized into regular arrays. These arrays are crystalline-like in nature.

Contraction takes place when the six actin filaments and the myosin filaments are induced into action through: (a) The occurrence of an action potential which is communicated to the foregoing, crystalline-like array of actin and proteins, and (b) the delivery of the energy which is needed for the two sets of filaments to motor their way past one another. In the process, cross-bridges are constantly broken and formed between, on the one hand, the binding sites of actin and, on the other hand, the multiplicity of myosin head regions.

The foregoing description reminds one of the way in which Gilbert Ling approaches the notion of nano-protoplasm units during various kinds of physiological dynamics. In other words, one can envision NPUs consisting of two physiological significant proteins – namely, in the present case, actin and myosin rather than the hemoglobin example used by Ling – which are connected to a set of ions, water molecules, and a molecule of ATP serving as a cardinal absorbent which controls the manner in which charges are donated, withdrawn, and distributed (the forming and breaking of cross-bridges) both within a given NPU as well in conjunction with neighbor NPUs.

However, one of the differences between Mae-Wan Ho's perspective and that of Gilbert Ling with respect to the foregoing dynamic revolves about the function of ATP. As noted previously, Mae-Wan Ho contends that ATP is what she appears to believe will provide the energy for all of the foregoing dynamics, whereas Gilbert Ling proposes that ATP does not contain the high-yield energy phosphate bonds which could serve as a source of energy, and, therefore, Dr. Ling would seek his energy source from elsewhere, such as from the charge dynamics which are taking place within, and among, NPUs and which, are to a considerable degree, heavily influenced or controlled by the way in which ATP serves as a cardinal absorbent within NPUs that regulate the withdrawing, donating , and distributing of charges which, subsequently, can lead to cascading physiological effects in the form of contraction.

Mae-Wan Ho indicates that the breaking of cross-bridges between the Z-discs of actin filaments and the 624 head groups of each myosin filament takes place at a rate of 50 cycles per second. The foregoing cycles are taking place simultaneously and in concert across billions of cells.

Furthermore, she indicates that the aforementioned coordinated set of dynamics encompasses nine orders of scale. This extends from the distance between actin and myosin heads (which involves events on the nanometer scale –10^{-9}) to the scale of a meter which represents a rough measure of arm-length.

The foregoing overview of muscles raises a variety of questions. These questions all have to do with issues surrounding the organizing all of the different facets of muscle movement?

Something has induced a certain kind of action potential or set of action potentials involving neurons or nerves. Something controls the way in which that action potential finds its way to the crystalline-like array of actin and myosin proteins. Something has led to the structure of the myofibrils within the previously mentioned array to consist of units of six actin filaments surrounding a single filament of myosin. Something has organized the presence of 624 head groups (rather than, say: 625, or 623, or some other number of head groups) for each myosin filament. Something has arranged for there to be a positive and negative set of poles for the actin and myosin filaments. Something has provided the energy needed exactly as it is needed. Something has enabled actin and myosin filaments to move about one another in a functional manner. Something has arranged for the actin and myosin filaments to bind and dissociate from one another at the rate of 50 cycles per second. Something has arranged for all of the filaments to contract in a certain way. Something has enabled all of the foregoing scales of dynamics to take place in a coordinated fashion.

Early in Mae-Wan Ho's book, she indicates that life is about the coherence of organized wholes. When Mae-Wan Ho describes some of what takes place on each level of scale in conjunction with muscle dynamics, she is able to illustrate or demonstrate the character of the coherence of organized wholes which transpires, but the underlying "how" of that coherence or organized wholeness seems to be missing. In a sense there are two kinds of "how" which impinge on the foregoing considerations.

One sort of "how" refers to the description of what is taking place during the process of muscle activity, and, if we leave aside the issue of how ATP actually functions in the body or where the energy comes from that makes muscle dynamics possible, then, Mae-Wan Ho has done a good job of providing a descriptive sketch of this first kind of "how". Nonetheless, the second kind of "how" requires one to provide an account of what is responsible for all of the forms of organization which make the coordinated dynamics possible which are being described by addressing the first kind of "how".

The identification of the 'something' or more than one 'something' to organize, coordinate, and regulate how the foregoing sorts of muscle dynamics are able to take place (and not just that they do take place) is unknown. The previous example of cascading molecules described by Mae-Wan Ho which went: [photon→ rhodopsin→ 500 molecules of transducin→ phosphodiesterase→ cGMP→ non-cGMP] times [10^{-1} seconds] = "perceptual event" is another set of "how" questions in which Mae-Wan Ho addresses the "descriptive how" but not the "explanatory how" which is responsible for organizing a set of events that make perceptual phenomenology possible in such a short instant of time and which is responsible for organizing a molecular cascade so that the right molecules will appear at the right time with: The right properties, in the right sequence, in the right place, and in the right amounts so that one kind of phenomenal experience rather than another kind of phenomenal experience will take place.

Is phenomenology even a function of physics and chemistry as opposed to being a display medium to which physical and chemical events can contribute modulating aspects with respect to the character of what appears in such a medium, but those physical and chemical events do not necessarily generate the medium? Without such a phenomenological medium does the foregoing molecular cascade have any experiential value?

Next, Mae-Wan Ho explores various aspects of thermodynamics. The question she wishes to address is whether, or not, life violates the 2nd law of thermodynamics.

She begins by indicating that the 2nd law of thermodynamics refers to the manner in which potentially useful or free energy is continually being transformed into a form of energy known as heat. She further indicates that heat is considered to give expression to random molecular motion, or, a condition of entropy.

First, perhaps one might ask whether one is necessarily forced to accept the idea that any transformation of free energy which yields a certain amount of heat gives expression to random molecular motion. Just because one can no longer follow what happens to the molecular motion which is associated with heat does not make that motion random – rather, the current status of such molecules is simply unknown, and, this is not necessarily the same thing as being random.

When molecules associated with heat leave the transformation of useful energy into work, they have determinate properties. Those properties are not random in nature, but are a function of the degrees of freedom and constraints which give expression to the nature of those molecules in a given set of conditions which are being shaped by the process of being separated from – allegedly – the capacity to do work.

Do such molecules become involved in some form of ecological dynamics? Do such molecules become involved in weather or climate events of one kind or another? Do such molecules become involved in geophysical dynamics? Do such molecules get drawn into gravitational dynamics? Do such molecules get drawn into some form of plasma dynamics? Do such molecules become engaged with events in the ionosphere? Do such molecules become involved with the solar wind? Do such molecules contribute to the ambient temperature of the universe?

If those molecules do become involved in any of the foregoing sorts of dynamics, then, while their dynamics might be unknown, they are far from being random. Instead, they will have become caught up in events which operate in accordance with determinate principles of physics and chemistry … but events which are no longer being tracked through measurements.

If those molecules do become involved in any of the previously indicated possibilities, can one describe their state as being disordered? Or, conceivably, have those molecules become recycled or repurposed within various other kinds of system dynamics that no longer are part of the system from which they recently departed?

While it might be true that as far as their system of origin is concerned, those molecules no longer are part of the free energy potential of such a system – and, in that sense, the departing molecules can no longer be considered to constitute a useful form of energy which is capable of doing work in that initial system – nevertheless, the molecules which are being dissipated in the form of heat still could engage, and/or be engaged by, other kinds of physical and chemical systems in which those molecules would become a working part of the new system. In other words, those molecules would have a determinate role to play (however small) which helps shape those other systems, and, therefore, their dynamics are neither random nor disordered.

Given that the 2nd law of thermodynamics arose out of a cultural and economic context in which people were concerned about how much "useful work" could be derived from a given energy potential – useful work being defined as that which was capable of generating capital at a profit – one should not be surprised that the notion of useful work tends to be viewed through conceptual lenses and filters that constitute an insular and self-absorbed way of looking at the nature and meaning of energy. From the foregoing perspective, useful energy is so-called free energy which can be controlled for self-serving purposes, and whatever cannot serve such a function is judged to be random, useless, and disordered.

Furthermore, although, historically and culturally, the notion of entropy tends to be associated with random, disordered dynamics, this way of characterizing entropy seems rather distorted and misleading. Entropy is about the limits of a given system and, as such, it gives expression to the degrees of freedom and constraints that govern such a system.

Entropy is not about disorder but, instead, entropy is about the nature or character of the order of the universe. In a sense, entropy is a form of ontological inertia which, when present, places constraints of a determinate order on whatever it taking place.

If the efficiency associated with a given sort of energy dynamic indicates that only so much of that energy can be converted into constructive enterprises, then, whatever that rate of efficiency turns out to be, it is telling one something determinate and useful concerning the nature of reality. Among other things, one is being told that the limitations associated with energy usage are not random or disordered in nature but have determinate consequences.

Entropy demarcates determinate boundaries at which organisms – including human beings -- lose control of their potential to transform energy in a way that enables those organisms to modify various aspects of reality. Entropy demarcates boundaries at which human beings – and all other organisms – come face-to-face with determinate, unavoidable, ordered aspects of the way in which certain dimensions of reality appear to be constructed.

There is nothing disordered or random about the nature of entropy. It is an inherent dimension of reality whose determinate properties concerning problematic transitions in the degrees of freedom and constraints which are present in any set of circumstances constantly must be taken into account as one seeks to navigate one's way through those circumstances.

The first law of thermodynamics is often referred to as the principle which indicates that energy is neither created nor destroyed. This sort of characterization leads to several questions.

What do we mean by energy? How do we know that it is neither created nor destroyed?

For example, when some people refer to the notion of zero-point energy they often have in mind the idea that virtual particles of all kinds (including antiparticles) are being manifested in the depths of space (both locally and distantly) as, on a continuous basis, they wink into, then wink out of, physical existence. Are those particles being created and destroyed, or are they part of the quantum perturbations that are being generated by the random dynamics of an underlying quantum field?

Quantum fields are a theoretical construct. They are a mathematical form of probabilistic description concerning the possible behaviors of certain kinds of events and phenomena.

Since Bohr, many physicists have dispensed with the idea that one can, or should try to, penetrate the epistemological veil that constitutes the probabilistic cloud of unknowing to which the wave function gives expression. To do so, could cause one to run the risk of having to consider the possibility that there might be hidden variables which determine why quantum probabilities have the properties they do in any given set of circumstances.

Currently, no physicist can account for why different wave functions have the probabilistic characteristics that they do. Scientists just do the calculations, and, occasionally, they write books of speculation concerning issues that no one actually understands.

However, if no one can penetrate the cloud of unknowing which surrounds wave function probabilities, then, how can anyone say what is transpiring on the level of a quantum field even if such a field could be proven to exist? Once again, one can ask whether, or not, so-called virtual particles are merely the perturbations of such a field – quantum spray that is jettisoned from a quantum field and, then, soon returns to, or is reabsorbed by, the quantum ocean from which it was emitted initially?

If so, then, one could say that virtual particles comply with the first law of thermodynamics. In other words, virtual particles can be understood as temporary transformations or translations of the potential of an underlying field of some kind into active manifestations that exhibit certain kinds of properties that are being briefly expressed as apparently separate particles before being drawn back into, and re-absorbed by, the underlying field.

Such perturbations are often described as being random in nature. However, one can't possibly know if this is the case.

Moreover, one can never prove that such virtual particles and anti-particles are in compliance with the first law of thermodynamics. While possible accounts can be advanced that purport to explain how virtual particles might be compliant with the first law of thermodynamics, that account is just that – a possibility – and, at the present time, there is no known way to prove that such a possible account is necessarily true.

Many people suppose that quantum dynamics represents the bedrock of reality. However, that is all it is – a supposition.

Approximately 120 years ago, the idea of the atom was nothing more than a theoretical entity which Ludwig Boltzmann was using to develop his theory of statistical mechanics which sought to link the micro and macro scales of dynamics. Max Planck is reported to have once related an anecdote about a leading scientist and professor who, in the late 1800's-early 1900s, had informed an ambitious student that pretty much everything had been discovered in the realm of physics, and nothing much was left to discover except, perhaps, the number of decimal places that were to be worked out with respect to some measurement for a given kind of dynamic.

Are the people correct who maintain that quantum physics constitutes the fundamental nature of reality? Or, are such individuals like the professor alluded to by Planck who was claiming – on the eve of a multiplicity of revolutionary breakthroughs in physics – that there was nothing left to discover except the number of decimal places that are to be calculated in any given experimental measurement?

If some version of the Big Bang is true, then, what really was taking place in the singularity out of which our universe allegedly emerged? Was energy of various kinds being created and destroyed (for example, what happened to all of the antimatter?), or was the singularity an amazing story of symmetries which were broken and, as a result, existing energies or fields were induced to move in the direction of the universe, with all its diverse scales of dynamics, that can be observed today?

The laws of thermodynamics are working assumptions. They have been shown to have heuristic value when applied to certain kinds of closed systems.

Is the universe a closed or an open system? If the latter possibility turns out to be true, then, what kind of an open system is it since there are different kinds of openness?

For example, on the one hand, some forms of open system might be fully compliant with the laws of thermodynamics. On the other hand, some forms of open systems might not operate in accordance with, say, the first law of thermodynamics in which energy can be neither created nor destroyed.

Nikolai Lobachevsky, Carl Friedrich Gauss, János Bolayai, and Bernhard Riemann all showed some of what was possible in geometry if one did not accept Euclid's fifth postulate concerning the issue of parallel lines. Perhaps, if one were to disengage from the assumption to which the first law of thermodynamics gives expression, then, the parameters of ontological possibility might broaden in constructive, interesting, and heuristically valuable ways.

Whether, or not, the first law of thermodynamics holds could depend on the kind of energy one is considering. For example, while electromagnetic forms of energy might operate in accordance with the constraints of the first law of thermodynamics, nevertheless, there might be other forms of energy which do not abide by the strictures of that "law."

Something which Daniel J. Boorstin once said could have relevance here. More specifically, he is reported to have said: "The greatest obstacle to discovery is not ignorance. It is the illusion of knowledge."

When the universe tells us, in its own inimitable manner, that reality has this or that property, then, this is one thing. However, when we are the ones who are trying to tell reality what properties it does or doesn't have, then, this is quite another thing, and the history of science is replete with cases in which human beings have sought to force-fit its musings upon reality with all manner of problematic consequences.

In her aforementioned book, and as has been noted previously, one of the questions which Mae-Wan Ho would like to address is: "Do Organisms Contravene the Second Law?" Putting aside all the questions which have been raised already in this chapter with respect to issues related to the 2^{nd} law of thermodynamics (such as: Randomness, disorder, and entropy), one can also ask whether organisms are to be considered open or closed systems.

Mae-Wan Ho indicates that organisms operate within what might be termed "semi-open" systems. In other words, while there are all manner of transactions which can take place between an organism and the environment in which it resides, she believes those transactions operate in accordance with the laws of thermodynamics, and, therefore, sooner or later, either the organism or the environment or both, will run out of the sorts of free energy which enable the organism and/or ecological environment to remain viable, functional systems.

Earlier in this chapter, the summary of a perceptual event was discussed. In that account, Mae-Wan Ho indicated that: [photon→ rhodopsin→ 500 molecules of transducin→ phosphodiesterase→ cGMP→ non-cGMP] times [10^{-1} seconds] = “perceptual event.” At the end of that account, she indicated that no one knew how the foregoing set of events is possible in such a short time-frame (namely, 10^{-1} seconds) given that experimental data indicate that 10^{-2} seconds is required (an order of magnitude in difference) to activate just <u>one</u> molecule of a phosphodiesterase molecule via its predecessor proteins – namely rhodopsin and transducin.

If we don’t know how the foregoing sort of dynamic is possible, then, how do we know whether, or not, the 2nd law of thermodynamics is being contravened in some way? What is regulating the foregoing dynamic, and what is the nature of the relationship between such regulation and energy?

Is the flow of energy involved in the foregoing dynamics being regulated by something other than energy, and, if so, what is the nature of this sort of regulation which directs energy usage but might not be a function of any kind of energy dynamics itself? Alternatively, if those regulatory dynamics give expression to a form of energy, what is the nature of the energy to which it is giving expression and can one necessarily suppose that such energy – should it exist -- will be something with which we are familiar, can measure, and necessarily operates in accordance with the 2nd law of thermodynamics?

As previously discussed, Mae-Wan Ho, goes on to provide an account concerning some of the complexities of muscle dynamics. During that account, she provided a description of how those dynamics are manifested in terms of what happens, when, but she provided no account concerning the nature of the regulatory oversight that explains how the dynamics she describes are being organized as they unfold.

The foregoing allusion to the absence of any sort of viable account which explains the source and nature of the deep regulation of biological dynamics is directed toward muscle dynamics. However, the following sorts of question could be raised in relation to almost any kind of biological dynamic, for almost any kind of organism.

Epigenetics, as currently understood, does not fill the explanatory void being alluded to in the foregoing comments. Hopefully, the nature of such an allegation concerning epigenetics, as well as previous claims about the issue of biological regulation in general, will be become clearer during subsequent chapters of the present book, but, first, a few questions are in order.

For example, is the sort of organizational activity involved in muscle dynamics (i.e., that which regulates the" When, where, how, and sequence of this kind of biological dynamic) a form of energy, and, if so, is that kind of energy subject to the 2nd law of thermodynamics? Alternatively, if the aforementioned organizational activity uses energy to activate the potential of such an organizational capacity, then, what is the nature of the dynamic which enables that kind of potential to direct the flow of such energy?

The question – namely, "Do Organisms Contravene the Second Law" -- which Mae-Wan Ho is asking is also somewhat ambiguous as it stands. Is she talking about organisms that are displaying various kinds of on-going biological functioning, or is she referring to various kinds of evolutionary organisms whose origins need to be explained, or are both possibilities entailed by her use of the term:"organisms" which appears in her question about whether, or not, such entities contravene the 2nd law of thermodynamics?

With respect to issues of on-going biological functioning, Mae-Wan Ho seems most interested in providing limited, surface accounts about the "how" of such dynamics – accounts which tend to avoid questions that probe the nature and origin of the regulatory dynamics which make possible the 'how-dynamics' that she explores in her book. As far as issues of evolutionary origin are concerned, no one has any idea of how a coding system came into being which has the capacity to transduce one kind of molecule (ribonucleic acid or deoxyribonucleic acid) into a different kind of molecule (i.e., amino acids), or how prokaryotic, anaerobic, aerobic, chemotrophic, photosynthetic, eukaryotic, and a plethora of multi-cellular organisms came into being via the mysteries of embryological forms of cellular differentiation.

To say that the foregoing dynamics are a function of an indefinitely and extremely large series of fortuitous, random events is no scientific explanation at all. Such accounts are devoid of scientific explanatory power because they are unfalsifiable and, as such, they cannot be proven to be true or false.

Without substantial proof, one cannot tenably maintain that randomness must necessarily be an inherent characteristic concerning the nature of ontology. The notion of randomness might be just a metaphysical lens which filters experience according to the mathematical and hypothetical properties that arbitrarily have been used to construct that kind of a lens.

As a result, evolutionary story-lines might be little more than plot-developments for a technical narrative which sounds scientific but is essentially empty of any trace of a rigorous methodology, while being quite full of an array of assumptions – none of which is necessarily tenable. These story-lines might merely be conceptual systems in which theoretical speculation often tends to replace critical reflection as a way of evaluating empirical data.

Consequently, one has no way of knowing whether, or not, organisms in the evolutionary sense have contravened the 2nd law of thermodynamics. Asking whether, or not, organisms contravene the 2nd law of thermodynamics in conjunction with the issue of origins, cannot be answered currently with any degree of objective authoritativeness (as opposed to being answered in an authoritarian way through philosophy, theology, mythology, or science).

Arguing that one just can't see how life might have come into being independently of the laws of thermodynamics is tantamount to saying that ignorance should be treated as if it were knowledge. Of course, acknowledging this point doesn't, then, mean that one should accept any alternative explanatory possibility which comes along, but, rather, one is faced with the challenge of learning how to be open to possibility in a rigorously critically reflective manner.

Toward the end of her initial foray into the nature of the relationship between organisms and the 2nd law of thermodynamics, Mae-Wan Ho introduces the topic of Maxwell's demon. More specifically, during an attempt by Maxwell to demonstrate that the 2nd law of thermodynamics is statistical in nature -- and Mae-Wan Ho stipulates that Maxwell was not trying to show, as some have supposed, that the 2nd law was problematic in some fundamental sense -- Maxwell advanced a 1867 thought experiment which featured an intelligent entity that had the capacity to open and close a partition that is situated between two compartments containing a gas in a state of equilibrium.

According to the thought-experiment, the foregoing entity was able to differentiate between fast moving and slow moving molecules of the gas in the two compartments (no one seems to have asked what the arbitrary demarcation line might have been for differentiating fast- and slow-moving gas molecules). Once the speed of such molecules was determined, then, fast moving molecules would be induced to move toward one of the two containers while slow moving molecules were induced to move into the other container. (Again, nothing seems to have been said about how Maxwell's entity would have been able to induce molecules that were going at different speeds to enter into different compartments).

After fast moving and slow molecules had been separated in the foregoing manner (which remains an unknown), a temperature differential would have been established between the two compartments, with more energetic molecules in one compartment while slower molecules occupied the other compartment. As a result, work could be extracted from such an energetically differentiated system.

However, the foregoing thought-experiment comes with a caveat of sorts. More specifically, unless the previously postulated entity could actually detect differences of speed in the fluctuating molecules, then, appropriate distinctions in speed could not be made, and, consequently, although the two compartments might exchange gas molecules from time to time, nonetheless, the nature of that exchange would be statistical in nature and, as a result, it merely would reflect the condition of equilibrium in the two compartments that had existed at the beginning of the thought experiment – that is, a statistical mixture of fast-moving and slow-moving gas molecules that, together, give expression to a condition of equilibrium.

A little further on during Mae-Wan Ho's discussion of Maxwell's thought experiment concerning the 2nd law of thermodynamics, she contends that the 'problem' entailed by Maxwell's hypothetical example was supposedly definitively resolved by Léon Brillouin and Leo Szilard when they indicated that in order for Maxwell's entity to be able to separate fast-moving and slow-moving gas molecules, the intelligent entity would need to gather data or information on the molecules in the two compartments in order to be able to differentiate between the two populations of gas molecules which are to be partitioned in separate compartments. Supposedly, this process of acquiring such information would require a greater expenditure of energy than any amount of free energy that could be saved through the activities of Maxwell's entity and which, supposedly, could be used to generate work (although the nature of that work remains unspecified as do any details concerning whether, or not, machinery of some kind might have to be used to realize the potential of such free energy … machinery that would require the mining of materials which would need to be refined and, then, subjected to some sort of manufacturing process which would have to be transported to the entity's place of inquiry and, presumably, provided with some form of energy to make that machinery run).

As described by Mae-Wan Ho, the foregoing overview of Maxwell's thought experiment appears to entail some potential difficulties. First of all, if, as she contends, Maxwell was not trying to challenge the 2nd law of thermodynamics but, instead, he was trying to illustrate the inherent statistical nature of the 2nd law, then, why does she go on to suggest that the 'problem' with Maxwell's hypothetical entity was "resolved," subsequently, by two physicists when the latter individuals pointed out that acquiring information would require an expenditure of energy which was greater than anything which might be gained by the efforts of Maxwell's intelligent entity during the thought experiment. Just what problem was being resolved if Maxwell's intention was just to provide an illustration of the inherently statistical character of the 2nd law of thermodynamics?

Secondly, how do we know that the amount of energy expended by Maxwell's entity in order to acquire information about the relative speeds of the gas molecules in the two compartments would be greater, as Szilard and Brillouin claimed, than anything which might be gained by that entity during Maxwell's thought experiment? What is the nature of Maxwell's entity or demon?

Is it a biological organism? Does it use energy in the same way that biological organisms do? How does its perceptual system work? Is its intelligence a function of electromagnetic impulses, or is that intelligence a function of some other kind of dynamic? Is intelligence a form of energy? Or, does intelligence direct energy, and, if so, then, how does intelligence engage such energy in order to direct its use and flow? What, if any, energy does the entity expend in acquiring information, and what is the nature of that energy? Does the awareness or consciousness of the entity require energy, and, if so, what kind of energy is such awareness dependent on? Does the entity have a way of inducing molecules with different speeds to enter different compartments, and does this method of separation require energy which is the same as, or different from, the kind of energy that is used to acquire information about gas molecules that are moving at different speeds relative to one another? If the energy used by Maxwell's entity while acquiring information about the gas molecules is different from the energy which is acquired by creating a temperature differential capable of doing work, then, what does any of this have to do with the 2nd law of thermodynamics? Does Maxwell's entity exist in a closed or open system, and if the system is open, what is the nature of its openness?

The real problem inherent in the Maxwell thought experiment is that Maxwell, Mae-Wan Ho, Szilard, and Brillouin are all engaging the issue through an arbitrary set of presumptions concerning the way reality works. They all seem to be assuming that Maxwell's entity operates in accordance with a set of laws and principles which they believe governs all aspects of reality, and, as a result, no allowances are being made for the possibility that one, or more, dimensions of reality exist which might not necessarily operate in ways that they understand.

Maxwell, Mae-Wan Ho, Szilard, and Brillouin all conceived of Maxwell's entity in the image of their own ideas about the nature of reality. In this sense, they, to a certain extent, assumed their conclusions.

One doesn't have to postulate the existence of entities or demons in order to realize that none of the foregoing individuals knows: How the universe or life came into being, or what the nature of consciousness is, or what makes intelligence possible, or what the source of creativity or talent is, or how languages arose, or what the significance and dynamics of dreams are? The issue isn't a matter of whether, or not, Maxwell's entity or demon complies with the 2nd law of thermodynamics, but, rather, the issue is whether the origins of the universe or life, or the nature of intelligence, consciousness, creativity, talent, language, and dreams comply with the laws of thermodynamics.

Maxwell, Mae-Wan Ho, Szilard, and Brillouin were focused on a hypothetical creature as a way of reflecting on the nature of the 2nd law of thermodynamics. They should have turned their attention to the realities of their own being and asked whether, or not, the foregoing list of existential properties can be shown to necessarily operate in accordance with the laws of thermodynamics.

Maxwell postulated a thought experiment and, then, communicated it. What enabled him to do the foregoing actions?

Mae-Wan Ho, Szilard, and Brillouin critically reflected on that thought experiment? What enabled them to do that?

To what extent is free will involved in any of the foregoing considerations? If free will exists, to what kind of energy does it give expression, or, is free will something that directs energies to flow in one direction rather than another?

Does free will require energy? If not, then, what makes it possible and how does it induce energy systems to become active?

Presumably, if free will is truly free, then, to some degree, it serves as its own origin. If this is the case, then, does free will violate the first and/or second laws of thermodynamics?

Mae-Wan Ho seeks to broaden her readers' horizons of conceptual possibility by introducing the notion of non-equilibrium thermodynamics in which biological dynamics are continuously operating across a variety of size scales through cyclical and non-cyclical processes. She indicates that the cells which are involved in the foregoing dynamics consist of numerous compartments or microdomains that are energetically wired individually or in various combinations with one another, and her position at this point resonates with the discussion of Gilbert Ling's association-induction hypothesis involving the nano-protoplasm units which he considers to be the functional basis of cellular activity.

She indicates that the foregoing complex, heterogeneous set of interacting dynamics gives expression to what she calls a "deep space-time structure" which, on the one hand, cuts across temporal scales ranging from: The 10^{-14} seconds in relation to the amount of time that is needed for resonant energy to be transferred between molecules, to: the 10^{7}seconds that comprise rhythms which play out over the course of a year, and, on the other hand, also cuts across spatial scales of size which run from: The 10^{-10} meters that characterize intermolecular dynamics, to: The meters-long length of certain nerve connections. Temporally and spatially, a multitude of scales are being manifested both during on-going dynamics as well as during long-term processes which unfold in their own unique manner at the right time and place.

Irrespective of whether one is considering temporal scales or spatial scales, the same question envelops those sorts of considerations – namely, what is responsible for regulating such heterogeneous complexity. This is the same question which arose in conjunction with Mae-Wan Ho's discussions concerning both the molecular cascade which takes place in relation to the biological dynamics associated with perceptual experience as well as the dynamics entailed by muscle biology.

The 'deep time-space structure' of living organisms does not cause itself. Something is organizing and regulating it, but as Mae-Wan Ho acknowledges in her book, currently, a science does not exist which is capable of accounting, in any unified fashion, for the breathtaking intricacies that are present in the generation and regulation of the 'deep time-space structure' that characterizes life.

Mae-Wan Ho spends some time trying to develop a more expansive approach to the idea of the 2nd law of thermodynamics in the context of biological dynamics. Her re-characterization of the 2nd law involves explicating how stored energy and thermalized energy relate to one another, but there is only a passing reference to the way in which thermal energy can be used to generate work in biological organisms.

In this respect, she alludes to what happens in conjunction with enzymes embedded in membranes (which, according to Gilbert Ling might not be an actual biological phenomenon). Nothing is said of a more overt nature concerning, for example, the way in which some thermalized energy does work in the human body by, among other things, helping to maintain an ambient body temperature which provides a thermally-supported environment that is best suited for an array of biological dynamics.

Within limits, the body has ways of trying to ensure that thermalized energy operates within certain parameters. Moreover, although time and degree limited, elevated amounts of thermalized energy can help in the healing process.

The aspect of her re-characterization of the 2nd law of thermodynamics to which she gives emphasis has to do with the introduction of the notion of 'systems' into that definition. As a result, she describes living organisms as nested structures in which systems reside within systems in a manner that permits localized forms of equilibrium to be established while also allowing for non-equilibrium dynamics to arise when thermalized energies in one system are harnessed, through one metabolic fashion or another, to do work on behalf of some other system.

Notwithstanding the foregoing considerations, she also refers to biological processes such as photosynthesis which occur independently of thermalization dynamics. Photosynthesis begins with the non-thermal reception of energy from a photon and proceeds to a non-thermal transfer of that energy in the subsidization of biological processes.

In the context of the foregoing discussion concerning equilibrium, non-equilibrium, and non-thermal dynamics, Mae-Wan Ho also mentions Irena Cosic, an electronics engineer, who contends that many interactions in the body involving proteins and DNA are not necessarily a function of the lock-and-key models which have been proposed and are currently adopted by many molecular biologists but, instead, Cosic maintains that those interactions are a function of electromagnetic resonance dynamics in which proteins and DNA communicate with one another through the exchange of resonances or frequencies. However, nothing is said in conjunction with the foregoing framework concerning what regulates the resonant encoding of the time, place, sequence, and character of such a 'language' or how such resonance communications are to be "understood" or decoded by that which is the recipient of those transmissions.

However, Mae-Wan Ho does follow up on the foregoing perspective of Irena Cosic by indicating that there is a growing trend (and this was back in 2008) of biologists who are becoming more enamored with the idea of treating cells like solid-state electronic structures which consist of liquid crystalline components that are composed, at least in part, by structured forms of water. Once again, Gilbert Ling's notion of nano-protoplasm units -- that was discussed in the previous chapter and which involves the active participation of water in shaping the electrical properties of the nano-protoplasm units that populate cellular structures -- resonates with treating cellular dynamics as being a function of solid-state, liquid crystalline-based, resonance phenomena.

Before moving on to discuss what Mae-Wan Ho considers the quintessential quantum nature of biological dynamics to be, she mentions the idea of coherence. Early on in her book, she stipulated that she described life as being a non-linear, far-from equilibrium, co-operative form of coherence which demarks the boundary properties which differentiate the non-living from the living, and later on in her book, she returns to this topic of coherence in a more detailed fashion.

At this juncture in her book, she merely distinguishes between coherence and incoherence, indicating that coherence has to do with dynamics that are mobilized for purposes of doing work, whereas incoherence refers to dynamics that tend to either not generate biologically functional work of any kind or which produce forms of dynamics that interfere with one another in dysfunctional ways.

From the topic of coherence she transitions to the issue of quantum physics which, as indicated previously, she believes is fundamental to biological processes. For instance, she refers to the process of electron tunneling – a quantum phenomenon -- which she characterizes as the capacity of electrons to circumvent the presence of some sort of energy barrier due to the way in which the electron's wave function represents that electron as occupying neighboring states while in superposition (that is, prior to measurement or observation) and sometimes (following a process of measurement or observation) that electron will show up on the less likely side of the energy barrier rather than on the more likely side and the difference in positional materialization is described as a process of tunneling.

Now, while the phenomenon in which an electron can be found on the less likely side of an energy barrier rather than on the more likely side of that barrier does occur, one cannot show that the reason for this is because of superposition. Superposition is nothing more than a probabilistic description of possibility and says nothing about why what happens, actually takes place.

Many people, including many physicists, often treat 'superposition' as an ontological event. However, superposition is a hermeneutical technique used for the methodological purpose of organizing empirical data in a way that is able to capture the likelihood that such data will be manifested in one way rather than another.

Using the term "tunneling" provides a visual image for the foregoing sort of phenomenon. The scientific reality, however, is that no one actually knows why the electron shows up on one side of an energy barrier rather than the other.

Among other possibilities, that which is referred to as "tunneling" shows up in various forms of biological transport dynamics. For reasons which are still not understood, the phenomenon which is referred to as "tunneling" entails processes that enable electrons to circumvent the presence of various kinds of energy barriers.

Tunneling describes a relationship between an electron and a given energy barrier. It does not explain the actual dynamics of that relationship, nor does the notion of superposition explain those dynamics but, rather, as indicated earlier, superposition provides a description of what the possibilities are with respect to the foregoing sort of relationship.

Mae-Wan Ho maintains that the essential challenge which faces anyone who wishes to resolve the problem of biological organization is to determine how quantum molecular machines can operate in concert with one another. She believes that some kind of new principle is needed to meet the former challenge, and she believes that the notion of ‘coherence’ -- possibly ‘quantum coherence’ -- constitutes such a principle.

One might agree with her that some principle of coherence is necessary to account for how a set of interacting biological phenomena can come together with the right charge properties, at the right time, in the right place, in the right amounts, for the right duration, and in the right sequence. Gilbert Ling engages this challenge through the notion of nano-protoplasm units, while Mae-Wan Ho refers to her version of the basic units of life as “quantum molecular machines”, but her suggestion that the principle of coherence might be a quantum phenomenon seems problematic.

More specifically, although coherence might involve phenomena which have certain features which are describable in terms of the mathematical formalism of quantum physics, nevertheless, being present in a describable form in such phenomena is not necessarily the same thing as being responsible for whatever processes of coherence might regulate the dynamics of those quantum phenomena. For example, as was pointed out during the previous discussion of quantum tunneling, while quantum physics can be used to describe certain behavioral possibilities concerning the tunneling phenomenon, nonetheless, quantum physics has no capacity to account for what regulates or organizes the actual deep dynamics of how electrons get to where they are observed or measured to be on one side of an energy barrier rather than on the other side of that same barrier.

Up to this point in the discussion concerning some of the ideas of Mae-Wan Ho, only about one-eighth of the publication which houses those ideas has been touched upon. However, before writing had even begun on the current book – namely, *Something More Deeply Hidden* -- the chapters for the latter work had been laid out ahead of time and within that projected framework, Mae-Wan Ho’s research was envisioned as having a role to play by providing me with various opportunities to introduce certain conceptual possibilities, as well as to develop particular themes that, hopefully, would serve the overall purposes of the present book, and those objectives have been achieved.

As a result, a fork in the road emerges at this point with respect to whether, or not, discussion of Mae-Wan Ho's book: *The Rainbow and the Worm* should continue, or, alternatively, whether, or not, other perspectives should be engaged. She has written a very interesting and informative research work, and, consequently, there is no shortage of quality material with which to grapple conceptually and which could be leveraged, in one way or another, for purposes of exploring and developing different dimensions concerning the biophysics of living organisms.

So, two roads have diverged in my road of exploration, and having peered down into the undergrowth of possibilities to the point where they bend into the unknown, a decision has been made to take another path which seems just as heuristically valuable. Whether such a choice will make all the difference, I am unsure, but the path chosen might well be one that has been less traveled by. (cf. Robert Frost)

Before leaving Mae-Wan Ho's research, however, a few words ought to be directed toward shedding some light on the strange title of her book – namely, *The Rainbow and the Worm*. Mae-Wan Ho indicates that long before she wrote her book she had felt that if some sort of principle of coherence was present in life, then, some facet of that principle ought to be detectable in the way in which molecules are organized in life forms. One possible method through which to seek such evidence revolves about the polarizing microscope.

If – as she believed was, and is, the case – organisms consist of coherent solid-state, quasi-crystalline-like structures, then, a polarizing microscope might be a useful method for studying the dynamics of life forms. This is because polarizing microscopes frequently have been used to study regular, crystalline-like structures in both inert biological specimens as well as rock crystals, and, therefore, she felt that such microscopes might lend themselves quite easily to the study of similar sorts of structure in living organisms.

In 1992, she had an opportunity to test the foregoing considerations. A colleague of hers by the name of Michael Lawrence was engrossed in a project that involved using a polarizing microscope to film processes of crystallization.

At the time, Mae-Wan Ho had been researching early pattern formation in the development of Drosophila embryos. She persuaded her colleague to take a look at such embryos with his polarizing microscope.

A one-millimeter long Drosophila larva plays the role of the 'worm' in the aforementioned title of her book. Over time, Mae-Wan Ho and her colleague developed an imaging technique which enabled them to translate the activities of the developing Drosophila larva into colors that could be displayed on a television set, and the colors which were displayed consisted of all of the colors of the rainbow – thus, the title of her book: *The Rainbow and the Worm: The Physics of Organisms*.

As the 'worm' inched its way along its path of life, it displayed different colors according to what sorts of dynamics were taking place at different points in its journey through life. Eventually, the two researchers were able to decode those colors and determine the principles of correspondence between certain kinds of molecular structures that were present in different tissues of the worm at the time certain colors were manifesting themselves.

Among other things, their unconventional use of the polarizing microscope enabled them to observe the phase ordering that occurred in conjunction with various molecules in living organisms. These are phenomena which cannot be detected under normal circumstances and, prior to their research, had not been observed previously.

Since, as indicated previously, polarizing microscopes have the capacity to detect the presence of crystalline and quasi-crystalline structures in rocks and inert biological samples, it turned out that Mae-Wan Ho and Michael Lawrence discovered that such microscopes also could capture the way in which the molecules (including water) of the tissues in living organisms display ordered structures consisting of aligned liquid crystals that move with coherent dynamics. As a result, Mae-Wan Ho was able to find evidence which indicated that coherence phenomena are present in living organisms, but what makes such coherence phenomena possible alludes to something more deeply hidden.

Stated in another manner, while the flow of electricity might enable lights to be turned on, the flow of electricity did not create the electrical grid through which that electricity flows and which regulates that flow in coherent ways. Similarly, while the flow of quantum particles might be the medium through which coherence phenomena become manifest (i.e., visible), that flow does not necessarily generate the ontological grid through which those quantum entities flow and which regulates that flow in coherent ways.

Chapter 12: Mending Meridians

The present time would seem to be an appropriate temporal juncture for credentials to be listed that might be able to inform the reader, in an impressive and intriguing manner, about my profound insight into all aspects of Acupuncture and Chinese medicine. However, since I have conducted a very rigorous and thorough search of my life up to this very moment and have found all signs of such credentials missing, I am forced to either stay overnight at a Best Westin Hotel and take one of their accelerated courses into becoming expert at almost anything while having a good night's sleep or, alternatively, someone else's research will have to find its way into the following pages and inform, in an elevated fashion, the contents of those pages.

As I became inclined toward reaching a decision that favored the aforementioned alternative approach for engaging issues of possible relevance, a problem of annoying impertinence announced itself. More specifically, if a person – say, me -- didn't know anything about Acupuncture and Chinese medicine, then, how would such an individual go about choosing someone to serve as a ghost researcher for this chapter.

I immediately reached for a copy of the I Ching that was strangely missing from my bookcase. I scrambled for some other way to divine an answer to the problem before me.

At this point, a book was selected that somehow had come to my attention. One could attribute the foregoing selection process to be a function of an entirely series of random events, or one might consider the possibility that a set of determinate events had been set in motion some years ago in which the foregoing book selected me as much as I selected it as our respective destinies crossed paths.

The aforementioned situation reminds me of a Japanese Zen story which distinguishes between "jariki" – self power – and "tariki" – other power. Although casting only a faint light in my memory because of the years that have passed between that point in my life when the foregoing Zen story was first encountered and the present time, I seem to recall that two Zen masters were strolling along a beach area that ran parallel to an ocean as the two were discussing the ideas of "self power" versus "other power."

One of the two individuals decided to demonstrate the nature of self-power by picking up a relatively thin, but longish, stick which was lying on the sand in front of them. The person threw the stick into the water, and the object began to float on the ocean's surface.

After throwing the stick into the ocean and watching it float for a few seconds, the person jumped on the stick, and began to surf the waves while balancing on the thin stick. Demonstrating incredible skill while surfing about on the waves, the person finally dismounted from the stick and walked to his companion, saying words to the effect that (I believe, originally the gentleman spoke in Japanese, but when translated conveyed the following): "This is the nature of self-power," to which the companion responded (again, in translation): Yes, but how did the stick come to be on the beach for your use? That is other power."

Of course, if one wanted to embellish the latter response a little, one could add a few more considerations under the rubric of "other power." For instance, from where did the ocean come that provided the waves on which the Zen surfer rode, and what provided either of the two individuals with the: Life, consciousness, intelligence, character, aspiration, language, and talent which enabled the foregoing discussion and demonstrations to take place. Some individuals have even said that the "Self" and its "power" are but manifestations made possible by the "Other."

In any event, to the best of my recollection, somehow (either randomly – which I can't prove -- or as a result of unseen activities of "other power" – which I can't prove), I tripped over a book entitled: *The Spark in the Machine: How the Science of Acupuncture Explains the Mysteries of Western Medicine*. As a result, my fate – at least for the time being – was sealed, and what follows is my account of certain aspects of the perspective presented in the foregoing book by Dr. Daniel Keown who, as far as I know did not sleep at a Best Westin Hotel but did spend considerable quality time studying with someone – Dr. Wang Ju-Yi -- who is reported to be one of the world's foremost experts on Acupuncture and Chinese Medicine.

The reason why an overview concerning various facets of the foregoing sort of perspective is being presented here is because, in lots of different ways, the scientific perspective of people such as Dr. Ju-Yi and Dr. Keown not only seems to point, rather emphatically, in the direction of some phenomena which are more deeply hidden than certain aspects of Western medicine might suppose, but, in addition, their perspective appears to have considerable resonance with both the material that already has been put forth in the present book as well as, hopefully, will continue to resonate with material which has been planned for subsequent chapters. For whatever mistakes are about to be made in conjunction with the foregoing considerations, apologies have been drawn up and are being expressed in advance in relation to the two doctors, the 'Self' and the 'Other.'

Dr. Keown begins the main part of his book with a mystery. He recounts an incident from his childhood when one of his fingers was crushed so severely that the tip of the finger was disconnected from the remainder of that digit.

His mother had the presence of mind to pack the severed finger-tip in some ice and, then, take her son and the foregoing package to the hospital. The severed finger-tip was surgically reconnected with its former place of residence, and, eventually the finger-tip was operating like nothing had ever happened.

However, Dr. Keown points out that there is considerable clinical evidence to indicate that even if his mother did not have the presence of mind to pack the severed finger-tip in ice and take her son and the finger element to the hospital, nevertheless, given some time, the injured finger would have grown a new finger tip on its own.

The foregoing self-healing phenomenon appears to be age limited as well as limited with respect to the amount of damage from which a person can recover and still regain the portion of the finger which had been severed in some fashion. More specifically, an individual has to be six years old, or younger, and the amount of lost tissue cannot be more than what exists above the upper-most joint of a finger.

Salamanders, on the other hand, appear to be able to retain the capacity of regeneration for their entire lives and, in addition, exhibit this phenomenon in conjunction with more than the tips of the digits on their four appendages. Robert Becker, an orthopedic surgeon and intrepid researcher, studied the foregoing mystery for many years and was able to apply what he learned to advance the use of electricity to help heal certain kinds of injuries … although such research was shut down when untoward human forces brought his investigations to an end.

During his research, Becker had discovered a very miniscule, but steady current (measured in micro-amperes), which ran from a salamander's head to the tips of its appendages. Furthermore, this small, steady flow of electricity was not the sort of alternating current which is associated with nerve activity, but, instead, it ran as a form of direct current and, therefore, among other things, did not exhibit the sinusoidal waveform properties associated with alternating currents.

When surgical injury was imposed on the salamanders, Becker found that the foregoing DC flow of electricity became reversed in polarity. Once this occurred, regeneration began to take place.

In general terms, the aforementioned reversal of polarity were associated with changes in the red-blood cells of the salamanders. These latter changes preceded a re-activation of gene expression which had been discontinued since early on in the differentiation of stem cells during the process of embryological developmental unfolding of the genetic potential in the salamander.

The red-blood cells of human beings are not nucleated, and therefore, human red blood cells are devoid of DNA. However, the red blood cells of salamanders are nucleated and, therefore, there is DNA present in those cells.

Whatever changes are caused in the red-blood cells of the salamander due to the reversal of polarity that takes place in the steady micro-amperage flow of DC electricity when injury occurs, those changes are associated with a re-formulation of how the genes in the DNA of the salamander's red-blood cells are expressed. In short, following injury, gene expression reverts to an earlier stage of embryological activity when the capacity to generate tissue for newly developing aspects of the salamander's body plan played a dominant role.

There are a number of question which arise in conjunction with the foregoing overview. First, given that the red-blood cells of salamanders are nucleated and, therefore, contain DNA which can be reprogrammed with respect to which genes are expressed, how does one explain the regeneration of finger-tip tissue in human beings whose red-blood cells are not nucleated and, therefore, contain no DNA?

One possible suggestion – and it is nothing more than a suggestion – is that there might be something present in the red-blood cells of human beings which, under certain circumstances, has the capacity to set in motion a process of regeneration independently of the DNA. This "something" might have something to do with the microzymas which were discussed in the chapter on Béchamp's research concerning blood and which also has been touched upon in conjunction with some passing comments concerning the research of Naessens involving somatids and the somatid cycle of pleiomorphic dynamics.

To be sure, the foregoing suggestion leaves unanswered questions such as: Why does human access to the "something" in the red blood cells stop at around the age of six? On the other hand, the fact that the red-blood cells of human beings – unlike the red-blood cells of salamanders -- aren't nucleated and, consequently, contain no DNA, then, this leaves unanswered questions such as: If the regeneration of tissue in salamanders depends on a re-formulation of the way DNA is expressed in their red-blood cells, then, given the absence of DNA in the red-blood cells of human beings, how is any sort of regeneration possible in human beings – even if only for a short period of time and even if only possible in limited ways?

There are additional questions which arise in relation to the regeneration issue as previously outlined. For example, what is the source of the aforementioned steady, micro-amperage currents noted by Becker which do not appear to be a function of nerve activity? What directs the flow of such currents? What causes the reversal of polarity in that current when certain kinds of injuries occur? How does this reversal of current induce the DNA in a salamander's red-blood cells to initiate a form of gene expression that had been shut down? What regulates the gene expression of the DNA in the salamander's nucleated red-blood cells to re-capture a previous stage in embryological development? How does the salamander's system "know" when regeneration is complete, and how does arrival at this stage of regeneration lead to the shut-down of that process, including, presumably, a further reversal of the reversal of the micro-amperage current with which the regeneration process began?

The latter question is of interest because Becker had conducted studies through which he discovered that once the polarity of the aforementioned micro-amperage DC-like current was reversed following a forced injury to salamanders, he could re-reverse the flow of that electricity through the use of tiny electrodes. When he did this, the regeneration process came to an end.

He also discovered that when he experimented with so-called more highly developed organisms, the capacity of these life forms to invoke the process of regeneration tended to become more attenuated. In addition, the ability of such organisms to be able to generate a strong re-polarized flow of the micro-amperage DC-like current -- on which regeneration seemed to depend -- also was considerably reduced.

Apparently, Robert Becker inferred that as different organisms devoted more of their energy to brain functioning, then, their capacity for regeneration became inversely related to the former kind of enhancement. Such an inference seems a little shaky because while there might be an inverse correlation between organisms that, on the one hand, devote more energy to their brains while, on the other hand, apparently undergoing a devolution in their capacity for regeneration, one has difficulty grasping the way in which those two factors might be causally related.

Raising questions about the possible significance of the aforementioned sort of correlation might be especially pertinent given that the energy which is being devoted to the larger brain is likely to be a function of AC-like currents (as occurs with respect to neurons) rather than the DC-like micro-amperage currents that are associated with the regeneration phenomenon. On the other hand, given that human children have big-brains, one might wonder if somewhere around the age of six, there is a developmental change which leads to the foregoing DC-like micro-amperage change being attenuated while the brain continues to further develop its potential through the early twenties.

Toward the end of the opening chapter of his book on Acupuncture and Chinese medicine, Dr. Keown indicates that "regeneration is just embryology." He goes on to point out that regeneration occurs whenever a broken bone heals, or a cut disappears over time, or when tissues in different organs go through a replacement process in which older cells die off and new cells replace those spent cells.

Although the following might seem like a form of nit-picking, nonetheless, it seems worthwhile to posit the possibility that cell replacement is not necessarily a demonstration of the same kind of regeneration process as occurs in the case of the severed limbs of a salamander or the severed finger-tip of a child who is six-years old or younger.

That which regulates the cell-replacement process is not necessarily connected to that which regulates the process of regeneration in salamanders or young children. One reason for suggesting the foregoing possibility is that the dynamic or set of dynamics which leads to the differentiation process involves a constant re-programming of the way in which genetic potential is expressed, whereas the process of cell replacement involves a switch of some kind which gets turned on and off at regular intervals because with, perhaps, the possible exception of the nervous system (and opinions differ on this) each kind of tissue seems to have its own, unique cycle for replacing the cells which make up that kind of tissue.

Notwithstanding the foregoing considerations, Dr. Keown notes that physicians who are adept in Chinese medicine operate out of a perspective in which the space between cells has a significance that is comparable to what takes place within cells (and, for now, we'll put aside the possibility that, as researchers such as Gilbert Ling have intimated, cells in the traditional sense of individual units of life might not actually exist because membranes in the traditional sense of tri-laminar phospholipids might not exist or, perhaps, do not exist to the extent that we have been induced to believe might be the case). Dr. Keown continues the foregoing discussion concerning the issue of space between cells by introducing the notion of fascia which, in Chinese medicine, is considered to be a form of tissue which surrounds organs, muscles, nerves, bones, blood vessels, as well as tendons and, thereby, creates individual compartments through that process of envelopment.

Unlike other organs, fascia lacks any form of its own. Instead, fascia, which is quite thin in character (almost transparent), either takes on the form of whatever it is encasing, or, perhaps, it might impose contours on the shapes which different topological forms in the biological terrain can assume.

Dr. Keown indicates that in Western medicine, the fascia is relegated almost to a level of non-existence. For instance, in Western medicine, one might occasionally hear that as a result of unknown causes, some aspect of a person's fasciae has become inflamed and when this occurs, the condition is referred to as: "fasciitis."

There might be one, or two, other kinds of conditions which are mentioned in conjunction with fasciae. Nonetheless, beyond the foregoing sorts of references, the fasciae are relatively absent from the framework of Western medicine.

However, fasciae play such a central role in Chinese medicine that two organs – and the existence of both of these organs tends to be denied by Western medicine – are linked to the functionality of the ubiquitous fasciae tissue. These disputed organs are referred to in English as: The Triple Burner and the Pericardium.

Even within Chinese medicine and among Acupuncturists, there is considerable disagreement about the nature of the Triple Burner organ. Dr. Keown indicates that an ancient treatise on Chinese medicine – namely, The *Classic of Difficulties* – had been written in order to try to resolve certain difficulties which had been raised in conjunction with an even more ancient text known as (in English) as: *The Yellow Emperor's Classic of Internal Medicine*.

The former document (which was written 2000 years ago) had referred to fasciae as an organ without form. Based on what Dr. Keown has said to this point in his book, whether the aforementioned characterization clarified something that had been written in the latter document (which was written at a much earlier time) is uncertain.

While those who have expertise in Chinese medicine might differ with respect to what they consider the physical form of the Triple Burner to be, apparently, they all tend to agree with respect to the nature of its functionality. More specifically, the consensus view seems to be that the Triple Burner works somewhat like a compost heap.

In other words, there is a lower level of this organ which, like manure or decomposed organic materials, helps transform organic material into a nutrient-rich medium. In turn, that medium is mixed with other materials which, like soil, promote healthy growth, and, finally, the previous two levels lend support to dynamics through which the growth of cells, tissues, and organs take place … and this is comparable to the flowers or vegetables that eventually emerge amidst various kinds of composting materials.

As such, the Triple Burner appears to refer to a set of dynamics rather than a particular, physical, concrete object. Since organs in the sense understood in traditional Western medicine are associated with certain kinds of functional dynamics in which different organs specialize, then, one might treat the Triple Burner as being an organ, or organ-like, in as much as its activities give expression to a specific set of dynamics which have organ-like characteristics that are specific to the dynamics of the Triple Burner.

More specifically, the Triple Burner operates within regions of the abdomen, chest, and pelvis which are compartmentalized by fascia networks. In effect, the Triple Burner encompasses a set of interacting metabolic pathways in the aforementioned areas which serve biological functions unique to that set of fasciae-encompassed compartments.

In fact, according to Chinese medicine there are three major metabolic pathways which comprise the Triple Burner organ. Thus, the aforementioned name alludes to those three systems of metabolism.

In Chinese medicine, the fasciae are considered intimately connected with the Triple Burner. This is because, as indicated above, fasciae tissues establish compartments within which different functional aspects of specific organs take place (i.e., its composting-like dynamics).

When the fasciae and their surrounding conditions among contiguous organs are healthy, there tends to be a vacuum-like, negative pressure which is present between those organs, and this negative pressure prevents interstitial spatial pockets from arising. However, when problems arise in, or in connection with, the fasciae of contiguous organs, then, dynamics might arise which create some form of spatial separation between the contiguous organs and this can be problematic, leading to various kinds of pathology.

Fasciae consist of networks of cells which not only hold other kinds of tissue in place but, as well, any given fascia network of cells serves as a connective medium in conjunction with whatever other fasciae networks it might make contact. For example, fasciae networks provide connectivity among organs, nerves, muscles, and bones.

Fasciae networks are quite strong. One of the reasons for this strength is due to the presence of the protein collagen which tends to be liberally distributed throughout those networks.

Fasciae networks are also piezoelectric in nature. In other words, the presence of mechanical stress in fasciae networks can be transduced into electrical currents, just as being exposed to electrical fields can induce various kinds of mechanical stress in those networks.

Furthermore, there are other kinds of electricity-related properties which are present in fasciae networks. Depending on circumstances, fasciae networks can serve as either electrical conductors or resistors.

Acupuncture is a set of methods for engaging the flow of energy within the human body. The meridian system with which the practice of Acupuncture is closely associated can be found in the vicinity of tendons and muscles, as well as can be located in places of curvature near the ends of bones but doesn't seem to flow along the rest of those bones.

For the most part (and there are exceptions to this general rule), meridians do not follow the pathway of nerves. In addition, although certain kinds of interactions do occur between meridians and different fasciae-demarcated compartmentalized regions of the body, these interactions don't necessarily continue from one compartmentalized region to the next.

Moreover, meridians, like the English language, also entail various exceptions to whatever rules one might have formulated in order to try to understand their operational dynamics. Aside from whatever regularities which might have been discovered with respect to the way meridians operate, meridians also manifest themselves through a logic which is not necessarily easy to grasp.

Unfortunately, due to the failure to detect the presence of a consistent, discernible, traceable set of energetic pathways, many

Western investigators claim that the meridian system has no substantial reality. However, such a judgment might be like a person who comes in contact with a strange language or anomalous system of logic and because that individual can't figure out how the language or system of logic works, that person goes on to arrive at a, possibly, premature conclusion which contends that the language or logical system which has been encountered must be some form of gibberish – in effect, making ignorance the measure of what constitutes knowledge.

Just to consider one possibility, fasciae have piezoelectric properties. As noted earlier, this both means that mechanical stresses in the fasciae can lead to the generation of electrical currents and, as well, that when fasciae are subjected to electrical fields, this can lead to mechanical stresses which, however subtle, might move the fasciae networks in ways that induce fasciae networks to generate further currents.

In other words, there is an on-going dialectical dynamic taking place among changes in mechanical stress and electrical fields which feed into one another in response to changing conditions in different aspects of the biological terrain surround any given fascia network. The foregoing dynamics are constantly taking place and can be quite subtle in nature.

Unless one is able to actively observe the foregoing dynamics as they happen and, as a result, one is able to see how the mechanical responses of fasciae to the presence of electrical fields can alter the shape of such networks which, in turn, can generate further electrical currents, one is not in a position to appreciate the possibilities for current generation which are present within, and among, networks of fasciae. Consequently, without the right kind of direct, experiential exposure, one is unlikely to be able to follow the flow of energy through the meridian system because that flow is often subject to subtle, on-going mechanical and electrical transitions within the networks of the fasciae of living organisms to which one doesn't necessarily have any direct access due to their sporadic, intermittent, localized, subtle, and irregular characteristics.

The foregoing example is not meant to indicate that anything for which evidence cannot be established must, therefore, be accepted. At the same time, one needs to keep in mind the adage that: Absence of evidence is not necessarily evidence of absence.

Apparently, many Western researchers believe that because countless experiments and studies have been conducted which have involved all manner of rigorous methods and advanced forms of technology, and, yet, those investigations all have come up empty with respect to being able to detect the presence of a meridian system, then, this constitutes solid evidence that all talk about meridians and the flow of certain kinds of energy must necessarily be untenable. However, such research might resonate with the experiences of a drunk who is looking for lost keys beneath a light standard because that is the only place such an individual has access to light that allows the person to see anything at all and not because that is where keys must necessarily have been lost.

Or, one can approach the foregoing sorts of research problems as one might approach the issue of toxicology screens. The latter technology is only able to detect the presence of some sort of toxin if one knows for what one is looking and how to look for it, and, similarly, when it comes to meridians, Western science often makes proclamations concerning possibilities which it believes don't exist simply because it doesn't understand that for which it is looking and, as well, doesn't know how to go about looking for signs of whatever it is that it doesn't understand.

The theory of Acupuncture indicates that there are both small and larger channels, or pathways, which run through the body. These are called, respectively, the "luo" and the "Jing," and, in a sense one might liken such a system of channel-ways to a non-fixed arterial-like system in which there are capillary-like channel-ways which branch off from larger pathways that serve every part of the body just as blood reaches, and serves, every part of the body through a series of smaller and larger channels.

Since conditions in the body are changing all the time, the aforementioned small and large channels are also undergoing modulation in response to such changes. This means there are an indefinitely large number of ways in which energy can flow through the body.

The fasciae networks establish a general framework within which energy flows and metabolic pathways are generated. The large and tiny channel-ways operate within that general framework, but there are many degrees of freedom within such a framework according to on-going conditions.

The large and tiny channels are not like a fixed system of highways. Those channels are more like what happens on a ski-slope in which there are broad regions set aside for skiers with different competencies and capabilities (the fasciae), but even within these sorts of broad frameworks or channels, there are still many ways in which a skier can get to the bottom of the hill.

In Chinese medicine, and in a broader metaphysical sense, the term "Qi" refers to a life force or vital energy. According to Dr. Keown fasciae helps to explain "Qi."

Although the foregoing can be understood in several ways, perhaps what is being indicated is that the existence of such a life force or vital energy illuminates why the fasciae networks are structured the way they are. Those networks provide a medium within the human body though which Qi moves, and, therefore, fasciae networks establish a set of reference points for engaging that flow via the techniques of Acupuncture when something adversely affects the quality and/or pathways of such flows.

Since fasciae are everywhere in the body, there are many ways in which Qi might flow through such networks. This is the case irrespective of whether Qi is something that flows through all processes in the universe, including biological dynamics, or Qi is something which is induced to become manifest only when conditions are receptive to Qi's properties according to the potential of those conditions for interacting with, or being affected by, the presence of Qi.

The possible pathways through which Qi might flow within the complex set of manifolds which constitute fasciae networks have been mapped for thousands of years. The possibilities are so numerous, subtle, and complex that any conceptual map which attempts to depict those possibilities can seem almost random in nature, and, yet, the properties of the human body – such as the fasciae networks -- have the sorts of degrees of freedom and constraints which are conducive to being able to interact with the life energy or vital energy which is termed “Qi,” and, therefore, such a fortuitous congruence-like set of relationships between the body and Qi hardly seems to be random in nature even if we don’t understand the full scope and nature of the interaction between the two.

Although the term “meridians” is often used in Western descriptions to refer to the pathways through which Qi flows, Dr. Keown feels that the former term is a problematic way of characterizing the reality to which that term is supposed to be referring. He prefers the notion of channels which, among other things, is much more flexible with respect to the sorts of dynamics it can accommodate than is the more fixed aspect of meridians, and, perhaps, this sense of fixedness is part of what has misled Western investigators to look for set pathways – like the nervous system – rather than looking for a chameleon-like set of phenomenon which alters its dynamics according to conditions.

One of the primary components present in fasciae is the protein collagen which constitutes approximately one-third of the body weight of a human being. However, collagen does not only serve as one of the main ingredients of fasciae, but, as well, it also is present in cartilage, ligaments, tendons, bones and connective tissue.

In addition, it can be found in the lenses of our eyes. Furthermore, it has a role to play in the composition of arterial walls.

Dr. Keown refers to collagen as a triple helix. This is because Lego-like collagen structures known as “tropo-collagen” are brought together and, then, spontaneously self-organize to form a triple helix.

Moreover, the initial construction of a collagen triple helix is followed by a second triple-helix which combines with the first triple helix to give rise to a microfibril. Dr. Keown contends that the Lego-like units of collagen (tropo-collagen) spontaneously form the triple helix, and, in addition, once this initial triple helix is formed, a second triple helix spontaneously arises.

One might question use of the term “spontaneously” in the foregoing account. For example, what is regulating the number of tropo-collagen units that are to make up any given triple-helix formation, and how, specifically, are those units either gathered together or added together in such an allegedly “spontaneous” fashion.

In addition, what determines that the number of strands which should be generated and brought together are three, rather, than, say, two or four? What regulates the process of bringing those three strands together?

Moreover, how does the first triple helix of collagen lead – 'spontaneously' – to the generation of a second such triple helix? Furthermore, what regulates the joining together of the two triple helices into a microfibril?

Use of terms like: "Spontaneous," "self-organizing," and "self-assemble" are often code words for ignorance concerning how, exactly, something actually works. Such words often tend to sound more appealing than saying we don't actually know how what happens, happens.

Moreover, to whatever extent such dynamics are, in some sense, "spontaneous" or "self-organizing," to what extent might "Qi" be involved in such processes? In other words, perhaps such 'spontaneity' is not a function of, say, favorable thermodynamic conditions but, instead, is due to the way in which "Qi" serves as some sort of catalyst for such those dynamics.

Dr. Keown goes on to indicate that the aforementioned microfibrils are either deposited along stress lines or are formed along such lines. His description could be understood in several ways.

Irrespective of which is the case, what regulates the process of laying down such microfibrils along stress lines or regulates the construction of microfibrils along various stress lines. Furthermore, what "recognizes" that something is a stress line or that such stress lines are the place where those microfibrils should be deposited or constructed?

As mentioned earlier, the term "Qi" is translated as being a form of "life energy" or "vital energy". What is the inherent character of "Qi" and how does it do whatever it does?

Dr. Keown spends an entire chapter in his aforementioned book addressing the question: "What is Qi?" Initially, he points out that the understanding -- or lack thereof -- of that term in the West is embedded in a great cloud of cultural and linguistic insensitivity and ignorance which often tends to fail to place the term in appropriate contexts.

In Chinese languages, characters are used instead of letters. Different characters are put together to modulate one another and, in the process, those characters give expression to something that is, in a sense, more than the sum of the parts (characters), and these parts are known as radicals. The radical "Qi" (which is a transliterated, phonetic rendering of a visual character) can be found in combination with hundreds of other characters which are radicals used in various ideograms.

A common theme running through the use of the character or radical to which "Qi" refers has something to do with space or air. However, the written character for this radical consists of two parts.

The upper portion of that character alludes to possible qualities of air such as: Clouds, steam, as well as the aforementioned property of space. The lower portion of the "Qi" radical has to do with rice in a dynamic state of opening up, and, therefore, could be alluding to the dynamic of opening or a process of giving expression to something, and the depiction of rice opening is just a particularized example of those sorts of processes.

According to Dr. Keown, one could understand the Chinese character which corresponds to "Qi" as alluding to a basic equation of biological science in which air and food are brought together to generate energy. In other words, when one adds oxygen (air) to glucose (food), the reaction yields: Water, carbon dioxide, and energy.

He goes on to stipulate that despite the presence of properties -- such as: Rice, air, and energy, -- "Qi" is not making reference to substances, per se. Instead, he contends that the character is more of a conceptual abstraction that seems to resonate more with philosophy than science.

In the early 1990s, I attended a symposium at the Fetzer Institute in Michigan which brought together representatives from a number of indigenous nations in North America as well as representatives from Western science (two of whom were David Bohm and David Peat, both of whom were physicists). Being from neither the indigenous side of things nor the scientific side of things, I wasn't quite sure why I had been invited, although as a Sufi who had recently defended a dissertation which had a great deal to say about many facets of science, there was a sense in which one might consider me as someone who had a foot – or possibly a toenail – in both camps.

Notwithstanding my uncertain status, I learned a great many things during the course of that weekend. One of the items which found its way into my memory had to do with a discussion which explored how many native languages tend to be verb-oriented rather than object-oriented.

Despite being a complete outsider to native languages as well as being a complete outsider to Chinese languages, in the light of my aforementioned time at the Fetzer Institute, a thought has occurred to me about a possible connection between various native languages and Chinese languages … at least, this might be the case with respect to the issue of trying to understand the significance of the Chinese character to which "Qi" corresponds. More specifically, while I have no idea whether the following suggestion applies to the rest of Chinese languages, perhaps, like many native languages, "Qi" is character which is more oriented toward a dynamic of some kind rather than referring to things.

For instance, the Chinese character to which "Qi" corresponds brings together notions of: Rice, air, space, opening, and generation. For me, there is a sense in the foregoing set of ideas that the Chinese character might be seeking to draw attention to a dynamic that takes place in the spaces around us as well as within us, or, alternatively, draw attention to a dynamic which is present in the air that surrounds us and which we breathe into ourselves.

In addition, based on clues which have been provided by Dr. Keown in his book, the Chinese character associated with "Qi" also appears to be alluding to a dynamic that gives rise to the manifestation of a potential within whatever is being subjected to the on-going dynamic that is being referenced by "Qi" (i.e., the process of being cooked and popping open with a potential that is within the rice). The rice, air, space, opening, and generation constitute an exemplar that gives particularized expression to a more abstract underlying concept which captures something of the dynamic which is going on all about us, as well as is going on within us, and which is essential to processes which are fundamental to the manifestation of any potential which encounters that dynamic.

The foregoing principle is scientific, philosophical, and spiritual at the same time. Moreover, that principle can be engaged in both objective terms as well as in subjective terms and, consequently, it has something to tell us about the nature of the world outside of us as well as well as something about which to inform us in conjunction with the world within us.

Dr. Keown maintains that “Qi” makes reference to a force which is created by an objective world and when “Qi” flows through us, it has the capacity to power the biological processes which take place within us. However, he does not indicate how “Qi” is made by the so-called objective, external world, nor does he specify what the nature of the dynamic is which underwrites the “power” that “Qi” makes possible.

“Qi” is described as being a form of intelligent organization. As a result, Dr. Keown refers to metabolism as being dumb, while “Qi” is a form of manifested intelligence which provides metabolism with the energy which is needed for metabolism to become functional.

Although the following comment will be developed more in a subsequent chapter, saying something of relevance with respect to that forthcoming discussion seems to be an appropriate thing to do at the present time. More specifically, metabolism is not dumb, but, rather, metabolism -- as well as a more generalized and expansive set of biological dynamics (i.e., epigenetics) – is “Qi” in action.

One can agree with Dr. Keown when he refers to “Qi” as constituting a dynamic of intelligent organization. As such, it regulates the way in which metabolism and epigenetics take place, and, therefore, without the presence of “Qi,” there is no metabolism and no epigenetics … dumb or otherwise.

Moreover, there are a variety of questions which arise when one refers to “Qi” as being a force or power. For instance, what kind of a force or power is it?

The dynamic of intelligent organization might be what “Qi” does. Nonetheless, this does not tell us what the nature of the dynamic is which makes such intelligent organization possible.

What is the nature of the relationship between "Qi" and, for instance, electromagnetic energy or the strong force or the weak force or gravity? If dark energy and dark matter are real, what relationship, if any, does "Qi" have with them?

Is it possible that "Qi" – as a principle of organized intelligence – directs the flow of, for example, electromagnetic energy through the human body? If so, this is somewhat reminiscent of David Bohm's notion of a "pilot-wave" (and more will be said on this issue in a forthcoming chapter on Bohm).

After all, one might well ask: How do the electromagnetic and other forms of energy in an organism "know" where to go or where such energy is needed? Perhaps, just as it is the case in various advanced technological societies that techniques and procedures exist which are dedicated to steering various kinds of energy to their destinations, so too, biological systems are in need of a system which is capable of transporting or transferring energy to processes which require its presence, and, conceivably, "Qi" might intelligently organize the distribution of various kinds of energy via a sort of just-in-time delivery dynamic.

Previously, a critical comment had been made concerning Dr. Keown's use of terms such as: "Spontaneous" and "self-organizing as a way of "explaining" (but not really) how certain kinds of biological dynamics take place. Perhaps, one might come a little closer to the truth of things if one were to consider the possibility that what is meant by "spontaneous" dynamics or "self-organizing" activities could have something to do with the manner in which the intelligent organizational capacities of "Qi" seek to regulate what transpires in a given biological context … such dynamics and activities only seem 'spontaneous' because we fail to grasp or observe the way in which "Qi" organizes those phenomena in intelligent ways.

The foregoing issues are not intended to create doubt concerning the existence of "Qi." Rather, they are intended to induce the reader to begin to think about the possibility of the existence of a some form of: Life force, vital force, subtle principle, or dynamic of intelligent organization and, further, to induce a reader to seriously consider, and begin to explore (if the individual is not already doing so) the sorts of questions which are being raised above.

For instance, during some of the previous chapters in the present book, research concerning the existence of microzymas, somatids, and bions has been discussed to varying degrees. Let us assume that 'Qi' is a reality – a reality which has been studied for thousands of years by Chinese and other cultures – so, what is the nature of the relationship, if any, of "Qi" with microzymas, somatids, and bions? Is it possible that "Qi" and, say, microzymas (or Naessens' somatids, Reich's bions, as well as the endobionts of Günther Enderlein) interact with one another and help regulate what takes place in the human body, or helps regulate what takes place in any life form?

Is it possible that microzymas, somatids, bions, or endobionts serve as transducers for "Qi"? In other words, irrespective of whatever kind of energy "Qi" might turn out to be (and to refer to it as a "life energy" or "vital energy" doesn't disclose much of anything), that energy might enter the body through microzymas, somatids, bions, or endobionts, and, maybe, in the process, aspects of "Qi" could be translated or converted into electromagnetic energy as well as, say, various forms of biophotonic energy?

In addition, perhaps not only can aspects of "Qi" be transduced into different kinds of energy as it enters the body, but, maybe, "Qi" also enters the body as a source of biological organization that orders certain facets of epigenetics. After all, when someone says that there are channel-ways in the fasciae that provide pathways through which "Q" journeys about the body, then, what is the array of functions to which the flow of "Qi" gives expression?

Is the flow of "Qi" only about providing certain kinds of biologically useful energy? Or, might the flow of "Qi" also be involved with organizing the dynamics which simultaneously are being energized through its – possibly -- transduced presence?

Pleiomorphism is generally frowned upon in the circles of Western biology and medicine. Part of the reason for this resistance is because although those who acknowledge the reality of that phenomenon – which is based on experiments which have been observed by them in real time beneath the microscope – nonetheless, the how of pleiomorphism has been relatively elusive. However, the possible transduction of "Qi" by microzymas, endobionts, bions, or somatids (which might be the same entity or closely related entities), could provide an answer to the foregoing, previously elusive "how" in which, depending on biological conditions, "Qi" is transduced in different ways by microzymas, somatids, endobionts, or bions in response to those conditions, thereby giving rise to the 16-stage pleiomorphic somatid cycle which, based on considerable scientific work, was established by Naessens.

Dr. Keown contends that the science of piezoelectric phenomena are still incompletely understood, and, as a result, although we know, among other things, that mechanical or pressurized deformations of, for example, collagen can generate electricity, he maintains there are many details which are missing which would enable us to more fully understand that sort of transduction process. If microzymas, endobionts, bions, and/or somatids are involved in transducing "Qi" into various kinds of energies and/or forces of biological/epigenetic organization, then, perhaps, like the case of piezoelectric phenomena, there is much which remains to be discovered concerning the nature of such possible transduction processes but, for now, we are limited in various ways about what can be said with respect to those sorts of issues because, to date, our empirical investigations have been limited in the manner in which they are, and have been, conducted.

Irrespective of whatever relationship, if any, "Qi" has with: Microzymas, endobionts, bions, and/or somatids, nevertheless, all of those notions share one thing in common. They all are, and have been, ignored -- if not actively suppressed -- by Western science, and evidence to this effect already has been provided in previous chapters which have featured the work of – and difficulties encountered by -- Béchamp, Reich, and Naessens, as well as by the testimony provided by Dr. Keown in his book: *The Spark in the Machine*.

While "Qi" tends to be translated as a 'life energy' or 'vital energy', conceivably, "Qi" might also be a form of cosmic, or even metaphysical, energy that, among other things, could make quantum phenomena possible. If this were the case, then "Qi" would constitute a species of hidden variable phenomena which could have determinate impacts on why quantum events turn out the way they do and, in the process, allude to the possibility that what many quantum physicists and other scientists assume to be random in nature is not necessarily random after all.

Putting such considerations aside and returning to the issue of Acupuncture, as I understand things – and this might turn out to be: "Not at all" – Acupuncture is a process of intervention which seeks to re-set the way in which "Qi" flows through the body. From the perspective of Chinese medicine (and I realize there are other methods of treatment in Chinese medicine beside Acupuncture), pathology arises when something goes awry with the flow of "Qi", and, therefore, following a process of differential diagnosis which is based on principles inherent in Chinese medicine, the techniques of Acupuncture might be used in order to re-normalize the flow of "Qi" in various parts of the body.

If the foregoing characterization is – to some degree – correct, then, in many ways, this aspect of Chinese medicine resonates with certain facets of Western medicine. More specifically, just as Western medical clinicians don't necessarily understand how an off-label drug does what it does as long as use of that drug is efficacious and has a reliable safety profile, so too, an individual doesn't necessarily have to understand what "Qi" is -- or how, exactly, it does what it does -- in order to have an understanding of how "Qi" is believed to flow through the body or how that flow could become problematically affected in different parts of the body, or how to diagnosis the presence of such forms of pathology, or, finally, how to go about trying to right whatever problem has been diagnosed with, for example, the right sort of placement of Acupuncture needles according to one's understanding of how "Qi" needs to be able to flow through the body and one's diagnosis concerning where blockages of "Qi", or a dysfunctional flow of "Qi", might have arisen.

People could have an appreciation of, or even a deep understanding of, what roles "Qi" plays in the body and how it operates in the body. Yet, nonetheless, having such an appreciation or understanding is not necessarily the same thing as being able to understand what "Qi" is or how it does what it does.

One could, if one wished, further complicate the foregoing considerations while, simultaneously, lending support to them by including a discussion of "Qi"-like forces, energies, and phenomena from other cultural traditions. For example, "prana" (which has been translated as "breath", "vital energies", and "vital principle,) is a term that has played a fundamental role in the 5,000 year old form of healing known as Ayurveda medicine.

Alternatively, one might also make reference to the notion of "nur." In Islam, an-Nur (the Light) is one of the names of God as well as the name given to the 24th surah or chapter of the Qur'an, and the phenomena of nur is intrinsic to the mystical dimension of Islam known as 'tasawwuf' -- or, in the West, the Sufi path -- and is believed to give expression to fundamental dynamics on all levels of existence, including biological existence.

One could focus -- as is being done, for the most part, in the present chapter – on one particular term, such as "Qi". However, one also could join the foregoing terms together (for example: "prana-nur-qi") as a tri-partite way of simultaneously referring to the possible "one underlying reality" to which all those terms are alluding.

The notion of "prana-nur-qi" is a way of indicating that the vital principle, energy, or force being alluded to -- and to which each of the component parts of the foregoing invented term gives expression -- refers to phenomena which have been explored for five thousand years, or more, across a wide swath of cultures and spiritual traditions around the world. One could add in words with similar meanings from other cultural and spiritual traditions as well, including: The Māori of New Zealand and Polynesia; the Aboriginals of Australia; many, if not most, of the indigenous peoples of North and South America; various Shamanic traditions, and the Jewish form of energy healing in which pathways (mitzvot) within the body are referenced which are considered to be connected to Hashem or the Source of Life.

Of course, one could simply dismiss all of the foregoing as so much misguided mythology which, supposedly, has been debunked by modern science. Or, one could have some humility and realize that – as the present book is trying to make evident in various ways – there might be many truths and dimensions of reality which are more deeply hidden than we might like to suppose.

The lure of 'certainty' is like a drug to which we are addicted, and, yet, frequently, all that is delivered through the presence of some sense of certitude is the empty shell of an emotional state rather than any reliable, substantive experience involving certainty's epistemological realization. Having to live with uncertainty, doubt, and unanswered questions tends to make us uncomfortable, but, rather than leverage such discomfort as a way of motivationally subsidizing exploratory expeditions into the unknown, oftentimes, we merely settle for a feeling of certitude even when, as a result of willful blindness, we try to deny the ignorance which we know, with some degree of certainty, is present in our lives.

The foregoing several pages of possibilities are hypothetical in nature. The reason for advancing such considerations is intended to serve no other purpose than, hopefully, to induce readers to engage in a rigorous process of critical reflection concerning such issues and, thereby, begin to ask fundamental questions that probe the nature of life and which probe what makes life possible, as well as to seek to come to an understanding – as much as is humanly possible – concerning how life works and to conduct such an exploratory process in a way that the willful blindness, arrogance, and self-absorbed conceit of many aspects of Western medicine tend to -- in the form of knee-jerk-like automatic responses -- reject in a dismissive, out-of-hand manner, and, as well, Western medicine and science often try to create a variety of obstacles (via media as well as educational, governmental, economic, financial and corporate collaborators) that are intended to prevent other people from pursuing such issues in a truly open, objective, fair, empirical, rigorous, and critically reflective manner.

Chapter 13: Biophotonic Plasma

Plasma exists throughout the universe – both without us as well as within us. Some people have maintained that the universe is 99% plasma, and depending on what one considers the universe to be, that claim might, or might not, be true.

Before exploring the nature of plasma within human beings and considering how, or if, biophotons are related to the existence of plasma states within us, taking a look at some of the history surrounding the discovery of, and investigation into, the phenomena of plasma in the external world might be of value. Among other things, this will help to provide a context or framework for subsequent considerations concerning some of the features of plasma within us.

The term "plasma" was introduced by Irving Langmuir in 1927. He chose that word because the manner in which ionized gases behaved in the presence of electrical fields reminded him of the sorts of dynamics which he had observed taking place in the protoplasm of red blood cells.

Plasma is defined as a state of matter which is characterized by the presence of charged particles which consists of a mixture of freely moving electrons which are negatively charged, as well as different kinds of elemental ions, including former hydrogen atoms which, in one way or another, have been stripped of their electrons and are positively charged.

In space, the chemical composition, particle density, and temperature vary from place to place. All three of those properties can modulate the way in which plasma is manifested in conjunction with those conditions.

Moreover, one of the features which the aforementioned researcher, Irving Langmuir, had observed in plasma systems is the way in which plasma tended to form wall-like structures around the charged particles within it. These are referred to as "double layers" or "Langmuir sheaths."

These double layers have charges which are opposite to one another. As a result, there is a strong electrical field which forms across those layers, with a weaker electrical field forming on either side of that double layer structure.

The formation of the ‘double layer’ effectively insulates the charged particle from the rest of the plasma field which surrounds the sheathed charged particle. Furthermore, depending on the circumstances within, and around, any given sheathed charged particle, the double layer phenomenon is often associated with a capacity to accelerate particles to the level of cosmic ray energies – which is considerable – and, Hannes Alfvén, who won a Nobel Prize for his early work involving magnetic fields and plasma, indicated in 1987 that gamma ray and X-ray bursts which can be observed in distant regions of space might be due to dynamics involving such double layers in plasma fields.

The plasma cells which emerge in relation to sheathed charged particles can interact with one another. That interaction is often in the form of electrical currents which are induced in one another as they move past each other.

Electric currents generate magnetic fields. Magnetic fields have their own modulating character within plasma.

Given that particle density, temperature, chemical composition, ionic composition, the formation and dynamics of double layers, as well as the generation of electrical currents and magnetic fields can all impact what takes place in any given plasma, there are a vast array of possible kinds phenomena which are possible in plasma dynamics. Because of the foregoing potential for interactional complexity, many astronomers and astrophysicists have strenuously avoided trying to mathematically capture that complexity, preferring, instead, much less messy (and quite distortive) mathematical models based on an almost complete absence of plasma phenomena as emphasis is directed toward topics such as how ionized gasses (devoid of any presence of plasma) are affected by a gravitational field.

Since Newton’s work in the 17th-18th centuries, astronomy and astrophysics have been dominated by scientists who believed that the force of gravity was, and is, supposedly, what is responsible for the way the universe is structured. However, starting with the research of Norway’s Kristian Birkeland in the late 1800s, another perspective has begun to emerge concerning the nature of a different set of phenomena that is believed to constitute the dominate force with respect to the structuring of the universe as well as giving expression to all of the phenomena which such structuring dynamics entail.

Birkeland arrived at his understanding concerning the way certain aspects of physical reality work on the basis of observation and experiment. For example, in 1889-1890 he conducted a field trip into the Arctic to study the phenomenon of auroras.

Included among his research efforts were the first measurements of the magnetic field in the region of the North Pole. Based on those measurements, joined together with other observations, Birkeland came to the conclusion that the auroras were the result of charged particles that had originated in the Sun, traveled to Earth, and, then, interacted with the magnetic fields of the Earth to produce the aerial display known as the "Northern Lights."

The foregoing field expedition was supported by experiments which he had conducted in his lab. For example, in his lab he had constructed an Earth-like object – known as a 'Terrella (little Earth)', as well as a magnetized metallic sphere which stood in for the Sun.

He placed those objects within vacuum-like conditions. Then, he generated electrical charges between the objects.

The foregoing set-up enabled Birkeland to produce scaled-down displays of aurora-like phenomena. In addition, he also was able to generate other kinds of phenomena such as sunspot-like activity as well as ring-like structures which can be observed around some planets.

Based on his experiments, Birkeland maintained that electric currents seemed to be inclined to flow along magnetic field lines which had been induced by electric currents. In addition, he discovered that when two plasma filaments came close to one another, they often would begin to rotate around each other.

When those filaments rotated in the foregoing manner, a magnetic force of repulsion arose that insulated the two filaments from each other. The result was an interacting duo of electrical currents that were woven together in rope-like structures.

To whatever degree the two electrical filaments came close to one another, their rates of rotation increased. In the process a plasma whirlwind or vortex would form.

The foregoing phenomenon is known as a 'Birkeland current.' It constitutes a natural form of current flow within plasma, and Birkeland's findings in this regard actually confirmed some of the earlier work of André-Marie Ampère that described how forces of a magnetic nature could attract electrical currents toward one another when they are running parallel to each other.

The term: "Birkeland current" didn't enter the scientific literature until 1969. Moreover, Birkeland's hypothesis concerning the role which plasma played in the generation of auroras did not become confirmed until -- starting in 1963 -- satellite data began to demonstrate that Birkeland had been right more than 70 years before and, consequently, in the interim period other scientists had been pursuing something other than science when they ignored, or denied, his research due to their theoretical biases and paradigmatic commitments.

One of the theoretical biases and ideological commitments of a technical nature being alluded to in the foregoing paragraph had to do with the belief that space was considered to be a total vacuum and, therefore, a perfect insulator. As a result, those who thought in this fashion believed that electrons were unable to flow through empty space.

The notion that space is a perfect vacuum was not based on experimental data. Instead, Birkeland's experimental data (both in the field and in the laboratory) was ignored or rejected because it clashed with the views of those who had the power to serve as gatekeepers with respect to what ideas got promoted and which ideas (like those of Birkeland) were buried and forgotten in so-called scientific circles.

Even after Langmuir had conducted considerable research during the late 1920s concerning the phenomenon of double layers in plasmas, nonetheless, astronomers and astrophysicists continued to think of plasmas as being a function of nothing more than fluid-like and gas-like phenomena that could be described through equations rooted in the mathematics of Newtonian mechanics. In part, this investigatory inertia was because Langmuir's previously noted experiments (exploring the nature of double layer dynamics in plasmas) indicated that those dynamics involved charge separation, yet such concrete, evidential findings were inconsistent with the theoretical belief which held sway amongst astronomers and astrophysicists at the time – namely, because space was believed to be a vacuum, separation of charges could not possibly take place … Langmuir's experimental work notwithstanding.

Initially, the plasma research of Hannes Alfvén into magnetohydrodynamics seemed to lend support to the prevailing paradigm concerning the alleged fluid-like properties of plasma. More specifically, Alfvén conducted experiments which led him to conclude that magnetic fields became trapped or frozen in plasmas and tended to remain fairly static in this sense.

He received a Nobel Prize for the foregoing research. However, during his Nobel Prize acceptance speech, Alfvén tried to persuade the audience to disregard his early research which suggested that magnetic fields were relatively static entities within plasmas, and, instead, he maintained, based on further research, that magnetic fields did not become trapped or isolated in plasmas as he previously had believed but were actively involved with, and generated by, the electric currents which rippled through plasmas in space.

Notwithstanding the foregoing admission during his 1970 acceptance speech, and notwithstanding the satellite evidence (starting in the 1960s) which indicated that Birkeland had been right all along concerning the existence of charged particles streaming through space (that interacted with the Earth's magnetic field in the polar region and, in the process, gave rise to the auroras phenomenon) nevertheless, many scientists continued to maintain that charge separation in space could not occur. However, by taking the stance that he did during his acceptance speech for the Nobel Prize, Alfvén exhibited one of the qualities of a true scientist – someone who was willing to publically admit that he had been mistaken about a previous understanding and that additional evidence pointed in a different direction than the one to which he had been committed previously.

Alfvén indicated that in order to properly understand the behavior of plasmas in space one had to grasp the way in which electric currents were able to arise in plasmas. Those currents gave rise to magnetic fields which, subsequently, interacted with the electric currents that had generated them, and, in the process, led to even more complex forms of dynamics which, when taken into proper consideration, were capable of accurately describing many phenomena which occurred in space in ways that could not be plausibly explained by traditional approaches to those phenomena.

As noted previously, traditional theories of plasmas had treated the latter phenomena as consisting of nothing more than fluid-like and gas-like dynamics which could be captured and understood through the use of mathematical equations largely rooted in Newtonian mechanics. Birkeland, Langmuir, Alfvén, and others had begun to indicate that circuit theory and electrodynamics might be more appropriate for the study of plasma phenomena.

There was one other substantial difference between, on the one hand, the research work of investigators like Birkeland, Langmuir, or Alfvén, and, on the other hand, the explorations of many astronomers and astrophysicists who plied their trade during the same timeframe. The work of the latter individuals tended to be largely theoretical or speculative in nature, whereas, the electrodynamic research into plasmas was rooted in laboratory experiments that produced results which could be scaled up to the level of astronomical events without any change in the physical principles that were being studied in the laboratory.

Black holes, dark matter, and dark energy are all heavily immersed in, and shaped by, largely theoretical considerations. However, plasma research that is engaged through the lenses of electrodynamics is capable of exploring the phenomena to which the aforementioned theoretical notions allude and developing alternative ways of accounting for the phenomena mentioned at the start of this paragraph – descriptions and accounts which are based in actual experimental evidence rather than theoretical speculations.

The foregoing experimental evidence might not always give correct answers to the questions which are being asked. Yet, one of the advantages which experimental-based processes have over speculation is that the former processes can be repeated in ways which yield further evidence that can be critically reflected upon in order to refute, support, or raise more questions about earlier experimental data.

Speculation, on the other hand will always remain speculation. As a result, it does not possess an intrinsic, reliable, self-correcting potential for constructively improving on its way of characterizing the nature of reality, and, instead, usually just ends up adding new speculations in an attempt to save the appearances of the old speculations.

To provide a concrete example of the nature and scope of plasma phenomena, consider the dynamics of lightning. Traditionally, atmospheric physicists have explained lightning as a function of localized circuits of electricity generated in water-laden clouds in which wind-driven charge separation occurs leading, eventually, to discharges to the surface of the Earth.

However, lightning has been observed in conjunction with Io, one of the moons of Jupiter. Io has no atmosphere, and, therefore, the traditional account of lightning provided by atmospheric physicists doesn't apply.

Furthermore, lightning phenomena also have been detected in connection with Venus. Yet, the atmosphere of Venus consists of a high-temperature mixture of gases and particulates which is devoid of water.

Plasma physicists have another way of understanding the phenomenon of lightning. The short account is that lightning is part of the set of electrical circuits which link (primarily) Earth with the Sun, as well as link the Earth with the rest of the galaxy.

Different kinds of electrical phenomena have been associated with lightning, almost all of which occur above the level of the clouds which bring the rain associated with a thunder storm. Since these phenomena occur at heights well above the storm clouds, those clouds do not appear to be the source of such electrical phenomena.

For example, sprites (often red in color), jets (usually blue) and elves (an acronym, of sorts, for "emission of light and very low frequency perturbations due to electromagnetic pulse sources") have, relatively recently, been detected in the upper atmosphere during thunderstorms. Other kinds of lightning-related optical phenomena which have been detected at different levels of the upper atmosphere are known as: "Beads," "tendrils," "gnomes."

Elves occur around 62 kilometers above the Earth. They tend to be quickly (lasting less than a thousandth of a second), expanding (up to

300 miles across) disk-shaped forms of luminosity. Sprites usually are manifested about 40-45 miles above the Earth during a thunderstorm and last for only a few milliseconds.

When sprites occur, aspects of the phenomena can extend both upwards and downwards. In the former case, there is a faint, wispy luminous structure which extends upwards for 10 miles, or so, whereas in the latter case, the lightning-associated phenomena often assume blue, tendril-like forms of luminosity which can extend as much as 20 miles below the main 'sprite' area.

'Jets' are blue. They usually extend upward (up to about 25-30 miles) in narrow cone-like structures that radiate at 15 degree angles from the top of thunderstorm clouds and last for just a few tenths of a second.

Gamma ray bursts have also been observed in conjunction with thunderstorms. These bursts last only a millisecond and are believed to originate somewhere about 18 miles above the Earth.

Trans-Ionospheric Pulse Pairs (TIPPS) are very high frequency pulses. They are up to 10,000 times more powerful than what is observed with respect to usual lightning activity.

Collectively, the foregoing phenomena are known as "transient luminous events." The differences among the various kinds of transient luminous events tend to be a function – at least in part – of the different atmospheric densities in which they occur.

Although some individuals describe the foregoing transient luminous events as constituting upward forms of lightning, there is no plausible account accompanying such a description that explains why those phenomena occur in the way they do and at the heights they do. However, such dynamics do seem to make sense if one treats them as manifestations of plasma dynamics which occur as a result of electric currents that run from the Sun -- and, possibly, from elsewhere in the galaxy as well -- to the Earth and which, depending on the density and conditions of the atmosphere through which such currents flow will be manifested in different ways.

Conceivably, the conditions in thunderclouds are conducive to clouds serving as capacitors. Capacitors accumulate and store energy, and when conditions are 'right', then, all, or part, of that accumulated and stored energy is discharged.

The foregoing approach is consistent with the work of individuals such as Birkeland, Langmuir, and other explorers of plasma phenomena. For instance, researchers at Stanford University determined in 1998 that within a very short time following a lightning strike (a second or so) significant changes were detected across considerable swaths of plasma in the ionosphere, some 62 miles above the Earth.

The foregoing dynamics didn't just relate to the lightning activity taking place on Earth. The measurements indicated that the changes in the Ionospheric plasma were also associated with the Van Allen Radiation Belts which run between 621 and 7,456 miles above Earth.

The Earth is not electrically isolated from the Sun or the rest of the Galaxy. That electrical connectivity is often mediated by plasma dynamics.

Similarly, human beings are not electrically isolated from their ecological surroundings. Some of that electrical connectivity might be in the form of plasma dynamics.

For instance, consider the 2015 release of research which was conducted by James F. Meadow and to which six of his colleagues contributed. The article was entitled: "Humans differ in their personal microbial cloud".

Their research indicated that human beings emit biological particles greater than 0.5 μm diameter in size at a rate of 10^6 per hour. Some unknown percentage of those emissions is in the form of microbes.

The controlled climate chamber in which the studies were conducted was specially prepared to ensure that there would be very limited, if any, biological contamination due to particles entering the chamber from outside the testing area and, in addition, precautions were taken to eliminate most biological particles that might have been part of a previous experimental trial. The air supply for the chamber was filtered, and all subjects wore identical, minimal, newly purchased clothing (tank top and shorts) in order to try to control for clothing-related particle emissions.

Moreover, studies by other individuals had indicated that the tracking of airborne microbes by researchers could be undermined as a result of various kinds of activity on the part of experimental subjects which led to settled materials becoming resuspended in the air. Consequently, the movements of subjects were minimized.

Whatever the percentage of the aforementioned 10^6 biological particles that are microbial in nature, there are enough airborne microbes emitted every hour to generate detectable, measurable microbial clouds. Moreover, the Meadow (et. al.) research noted that the microbial clouds released by the human beings in their study appeared to be unique for many (but not all) subjects and such differentiated identification could be made within a 1.5 hour to 4 hour timeframe during which data was being collected.

In other words, the microbe cloud being emitted by any given subject generated a statistical profile concerning the kinds and numbers of: (a) airborne microbial life forms which were being released by a person, as well as the numbers and kinds of: (b) biological particles that settled out around an individual. Both of the foregoing profiles (i.e., airborne microbes and settled particles) could, in many (but not all) cases, be used to reliably differentiate one subject from another.

In outer space, there are plasmas which contain various kinds of dust. Such dust can carry a charge and, therefore, become part of the dynamics of charge separation through which electric currents and magnetic fields are generated within those plasmas.

Similarly, in the case of the microbial clouds which surround human beings, there might be dust particles of one kind or another (e.g., due to, say, dead skin cells or microbial carcasses which get resuspended in the airborne microbial cloud as we move about and stir things up) which could carry positive or negative charges. Furthermore, some of the airborne microbes themselves might carry electrical charges.

The Meadow study doesn't indicate what the size of the microbial cloud is that envelops an individual. Nor does that study appear to determine what would happen to that microbial cloud if an individual were to move about in a given environment.

Conceivably, as Robert Temple suggests in his book: *A New Science of Heaven*, the conditions in the microbial clouds being described here might be sufficient to give rise to weak plasmas that are generated by, among other possibilities, the movement of charged materials (such as dust particles) within that cloud. In addition, one might also take into consideration the contributions which could be made to those microbial clouds by electrical currents and magnetic fields that are being generated by the living human beings who are enveloped by those same microbial clouds.

For example, in 1963, the existence of biomagnetic fields in human beings were detected and measured for the first time. More specifically, Richard McFee and Gerhard Baule discovered that not only was there a magnetic field associated with the heart which moves from left to right across the chest, but, as well, there are biomagnetic fields which emerge in the left hemisphere of the brain, proceed around the head, and, re-enter the brain through the right hemisphere.

Ten years later, David Gaselowitz released an overview concerning research that had been conducted in the area of biomagnetism. Among other things, he indicated that the biomagnetic fields associated with the heart are a million times weaker than the magnetic field of the Earth, and, moreover, the magnetic fields associated with the brain are, relative to the Earth's magnetic field, even weaker than are the biomagnetic fields in the heart.

Magnetic fields are generated by electrical activity. One might suppose that the presence of electromagnetic dynamics in the heart (as well, presumably, in the brain, and in other parts of the body) might interact with (at least, to a degree) the microbial cloud which envelopes the body.

If this occurs, then, perhaps, the activity of the bioelectric and biomagnetic activity of the body could modulate and shape (in however small a way) the nature of the plasma cells that might form in the microbial cloud due to the possible presence of charged materials -- such as dust -- that exist in that cloud. In conjunction with the foregoing electromagnetic activity, there could be mutual forms of attraction between the body and the microbial cloud which might serve to tether the cloud to the body (at least to a degree) through various forms of bioplasma dynamics.

Like the cartoon character, Pigpen, in Charlie Brown, the interaction between, on the one hand, the electromagnetic activity of a person's body and, on the other hand, the microbial cloud which envelopes the body could, together, establish a fairly stable form of bioplasma activity near to the surface of a human being in which new microbes are continually being added while, simultaneously (or nearly so), current microbial residents of that cloud are either dying off or, in one way or another, are being dislodged from the cloud and, as a result, are being shed into the environment.

As noted previously, double layers or Langmuir sheaths, can arise within plasma systems. Aspects of the aforementioned microbial clouds might develop such sheaths in relation to the human beings that are being enveloped and, in the process, provide some degree of protection from other kinds of plasmas which exist in the environment – including the microbial bioplasmas that surround other individuals.

Furthermore, if one accepts the ideas of the proponents of an "electric universe", then, some of the possible plasmas connected with the Earth have to do with the electric circuits which wire together (and, perhaps, beyond) the Milky Way Galaxy, and as the phenomena of the auroras and lightning appear to demonstrate, the Earth constitutes a node on the galactic network of circuits. To what extent the bioplasma surrounding each of us is affected by such galactic circuitry is unknown, but, perhaps, if the microbial clouds-bioplasmas which envelop us do give rise to Langmuir sheaths – even if relatively weak – these sheaths offer a certain amount of protection in relation to some of the plasma dynamics set in motion by the Earth's electromagnetic interaction with the Sun, other planets in our solar system, as well as the rest of our galaxy.

Another set of unknowns involves the possible relationship, if any, between, on the other hand, the microzymas of Béchamp (or the endobionts of Enderlein, or the bions of Reich, or the somatids of Naessens -- which might, or might not, all refer to the same entity), and, on the other hand, the microbial clouds which surround us. The foregoing entity or entities have been observed in connection with a wide variety of life forms (including bacteria), and they have been described (whether correctly, or not, remains to be seen) as being more fundamental than cells, and, possibly, even DNA (Naessens indicated that he believed somatids might be pre-DNA in some sense).

In addition, the somatid cycle established by Naessens (via the Somatoscope optical device he invented) gives expression to a pleiomorphic dynamic consisting of some 16 morphologically and functionally distinct microorganisms that come from one, and the same, somatid starting point. Do such somatids (microzymas, etc.) feed into, or modulate, or contribute to the microbial-bioplasma clouds which surround human beings in various ways, including in the form of weak electromagnetic currents or even through biophotonic activity?

The previously mentioned Meadow research concerning the existence of microbial clouds which envelop human beings indicated that there were a great many unknowns with respect to what made the composition of those clouds uniquely identifiable in relation to specific individuals. Meadow and his colleagues stipulated in their study that they were uncertain what role, if any, temperature, skin conditions, illness, and diet played in generating or constructing such clouds, and, consequently one might have to add somatids (microzymas, etc.) to the list of unknowns concerning the nature of the relationship between individuals and the microbial clouds-bioplasmas which envelop them.

In his aforementioned book, Robert Temple adds to the foregoing set of unknowns when, in passing, he notes that very little is known about the extent, if any, to which the microbial clouds-bioplasmas surrounding different individuals interact with one another. Nonetheless, despite acknowledging the presence of such unknowns, he immediately launches into a commentary about how the existence of those clouds is a confirmation of the alleged wisdom of the six-foot rule during Covid-19 and how such a rule might have helped to prevent people from becoming infected with the SARS-CoV-2 virus.

Based on what he says in his book, Temple doesn't seem to understand that the nature of the aforementioned crisis is not what he seems to believe is the case (in this respect, take a look at my commentary concerning COVID that is listed in the Bibliography), nonetheless, Temple remarks that at the time of the COVID-crisis, most doctors were unaware of the Meadow research involving the existence of microbial clouds which envelop human beings. He goes on to indicate that, notwithstanding such ignorance, doctors promoted the six foot rule because, instinctively, they were in-tune with the Meadows research and were trying to protect people from contracting viral infections.

Neither Temple nor those doctors had any knowledge concerning whether, or not, viruses were responsible for what happened during COVID, let, alone, whether, or not, those entities were actually present in the microbial clouds which envelop us. As noted earlier in this book, substantial evidence has been accumulated which indicates that no one has either: Properly isolated SARS-CoV-2 and, thereby, shown that it exists, nor: Have medical doctors and virologists been able to show that any given alleged sequencing of that supposed virus can be verified in a way that is independent of the computer algorithms which are used to arbitrarily construct -- or, better yet, invent – viral sequences.

Like Hannes Alfvén in 1970, John Enders – another Nobel Prize winner – attempted to tell people that his experiments which purported to prove the existence of the measles virus were not conclusive because he had run a control experiment which indicated that the same cytopathic event occurred in cultures irrespective of whether the sample placed in those cultures was from a healthy person or a sick individual, and, therefore, one could not conclude that the presence of the alleged measles virus is what was causing cells in the culture to die. Just as astrophysicists didn't want to listen to Alfvén when he sought to persuade them not to pay any attention to his early research on magnetic fields and plasmas because he had gotten things wrong, so too, virologists, microbiologists and medical doctors didn't want to pay any attention to Enders' comments that using cultures to prove the existence of viruses was inherently problematic.

In his aforementioned book, Robert Temple goes on to outline his theory that the COVID-19 virus (for which he offers no proof of its existence) were present within charged plasma clouds (for which he offers no proof concerning their existence) that were carried about by winds and other atmospheric conditions (for which he provides no proof). Eventually, the alleged viral contents of those clouds were released, possibly (according to Temple) through the dynamic impact which thunderstorms had on such plasma clouds (a dynamic for which, like the supposed existence of the COVID-19 virus, Temple provides no rigorously developed evidence).

During the foregoing speculative venture, Temple indicates that his perspective explains why people who were working on cargo ships suddenly became ill six, or more, weeks after having contact with what was transpiring on land. Actually, his perspective is more of a narrative than an explanation because the sort of independently verified causal evidence which would make it an explanation is missing from his account.

Although Robert Temple does engage in a fair amount of speculation throughout his book (some of his speculation seems more plausible than other instances of it), nonetheless, he did explore a lot of different topics during the course of that work and, in the process, provided a considerable amount of interesting, useful, and well-documented information. While there were aspects of his book with which one might find fault – as the foregoing discussion concerning viruses and COVID-19 suggest – nevertheless, on the whole, his research was quite intriguing and induced considerable critical reflection in this reader.

For instance, at one point in his book, he provides an overview concerning the work of Albert Szent-Györgyi, who won the Nobel Prize for Physiology or Medicine in 1937. Although for many years, the study of physics and biology had been kept separate from one another, Szent-Györgyi sought to induce researchers to bring the two together.

In 1957, Szent-Györgyi released *Bioenergetics*. In that book, he indicated that semiconductors, of one kind or another, were present in the human body because they were necessary for the regulated flow of electricity in the body

Before moving more deeply into the foregoing topics, two issues should be disentangled from one another. More specifically, contending that there must be some means within the body for regulating the flow of energy is one thing, but maintaining that semiconductors are the means through which this is done is another thing.

Semiconductors might only be functionally homologous with respect to the actual process or processes through which the flow of energy is regulated in the human body. In other words, while semiconductors of the right kind might have the capacity to regulate the flow of energy, whether energy is regulated in the human body through semiconductors is a separate issue.

In support of the foregoing claim, Szent-Györgyi made reference to the way that chloroplasts in plants are able to store energy in the form of photons that had been gathered during the process of photosynthesis, and, then, under appropriate conditions, that photonic energy could be discharged. He went on to contend that such released energy had the capacity to be transmitted through, and affect, protein molecules (something which had been experimentally confirmed), and, due to such considerations, he felt that if quantum physics were applied to the realm of biochemistry, that form of investigation would bring considerable dividends.

Another theme which was explored in *Bioenergetics* concerned some of the research of Percy Bridgman, a rigorously intrepid thinker and scientist who taught and carried out research at Harvard University and who had won a Nobel Prize in 1946. Among other things, Szent-Györgyi was interested in the different forms of ice which Bridgman had generated through the application of high-pressures.

The water from which Bridgman had generated different ices was normal in all respects. However, Bridgman discovered that by simply changing the nature of the pressure which was used, he could transform one kind of ice into many of the other kinds of ices (nine of them) which he had been able to produce.

Nearly half a century later, the number of different ices which had been discovered through altering the nature of the pressure which was applied to water or ice had risen to 12. Another 18 years passed, and the number of different forms of high-pressure ice had been increased to 18.

The foregoing ices were described as giving expression to different phases of ice in a crystalline state. Research indicated that while the oxygen atoms in the ice tended to retain the same position in the crystalline state relative to the other atoms in each of the ices, the position of the hydrogen atoms changed from one form of ice to the next.

Although Szent-Györgyi was interested in the ice research, he was more intrigued by the potential of water to assume different forms under different conditions, and the different ices were confirmation of water's hidden potential. In *Bioenergetics*, he referenced to the research work of Fowler and Bernal which had revealed that quartz-like crystalline structures could be detected in non-ice forms of water and Szent-Györgyi also noted that the possibilities concerning the dynamics of water became even more nuanced when one takes into consideration the manner in which water interacts with certain kinds of solid surfaces.

In other words, contrary to what many people had assumed, water was not necessarily required to be monomolecular in nature. Rather, under the appropriate circumstances, water had the capacity to enter into collective forms of dynamics which led to the emergence of certain kinds of structured order across a given region of water.

Szent-Györgyi's interest in the anomalous properties of water resonates with the interest which Gilbert Ling had with respect to the way in which water helped shaped the dynamics of the nano-protoplasm units which were discussed in an earlier chapter in this book concerning Ling's research. As well, Szent-Györgyi's interest in the different forms and dynamics which characterize water under various conditions foreshadowed the interest which Gerald Pollack had concerning the dynamics of the 4^{th} phase of water that will be explored in the next chapter.

Eleven years after the 1957 release of *Bioenergetics*, Szent-Györgyi released a second book which was entitled: *Bioelectronics*. Just as he had sought to advance science in his earlier book by melding physics and biology, in his subsequent work he indicated that the next advancement in biological research should involve peering beneath the realm of molecular dynamics and beginning to explore the electrical properties which shaped and modulated those molecular dynamics.

Szent-Györgyi believed that plasmas were present in cells. In fact, he believed that plasma dynamics permeated the dynamics of electrons and molecules within every cell.

He also began to discuss the issue of biophotons. Among other things, he maintained that one could diagnosis the condition of health or pathology in an individual by paying attention to the way in which biophotons were emitted and distributed.

In his aforementioned book, Robert Temple spends some time discussing the work of Brian Josephson, a 1973 Nobel Prize recipient. Eleven years prior to receiving the foregoing award, Josephson had advanced a mathematical account that described how an electrical current might be able to traverse an insulating medium between two superconductors through a process of 'quantum tunneling."

As previously noted, providing a mathematical account is not necessarily the same thing as providing a physical explanation concerning what is being described mathematically. Josephson's mathematics indicates that under the right conditions, the foregoing potential could be realized, but his mathematics does not disclose the nature of the actual physical character of the dynamics through which an insulating barrier is by-passed or traversed.

One can physically demonstrate that the occurrence of the tunneling phenomenon is more than a mathematical possibility. Nonetheless, the specific character of the physical event which takes place during that occurrence is not known.

As Temple points out, Josephson's discovery has played a major role in the development of both semiconductors and quantum computers. More specifically, the notion of Josephson Junctions arose which provided a means for regulating the 'tunneling' process despite the fact that no one actually knew what was transpiring during that event.

Given, among other things, the belief that Szent-Györgyi had about the existence of semiconducting-like dynamics in living organisms, a variety of individuals began to consider the possibility that something similar to Josephson Junctions might exist in living systems that would be able to regulate the flow of electrical currents in various biological systems. Initially, the existence of biological counterparts to semiconductor-related Josephson Junctions was considered in terms of being a switching dynamic that might regulate certain biological dynamics by providing a means for turning certain neurons or nerves on and off.

Irrespective of whether, or not, something akin to Josephson Junctions exist in biological organisms, such potential regulators do not necessarily regulate themselves. Something turns them on and off at appropriate times of epigenetic dynamics, and, consequently, while the possibility of such semiconductor-like dynamics in biological organisms is intriguing, nonetheless, that regulatory dynamic is, itself, in need of regulation, and, therefore, one must continue to search for that which is responsible for regulating those sorts of regulating switches, to whatever extent they exist.

Temple does indicate that, among others, researchers such as Freeman Cope and Antoni Antonowicz conducted studies which were laying the groundwork for the idea that superconducting electrical currents regulated by Josephson Junctions-like dynamics might be able to take place at room temperatures. Among other things, these sorts of dynamics would make it possible for organisms to detect and, presumably, respond to the presence of weak magnetic fields and microwave radiation.

Even when the foregoing possibilities are rooted in demonstrable physical phenomena (some of which Temple has documented), suggesting that those possibilities are taking place in living organisms is one thing. Accounting for how, in specific terms, biological organisms would be able to realize those possibilities is another matter.

In 1916, Leonard Troland introduced the term “photon”. It referred to the particle-like properties which were displayed by light under certain circumstances.

“Biophotons” is the word (coined by Fritz-Albert Popp) that is employed when referring to the particle-like manifestations of light which are generated in the context of living organisms. Photons and biophotons arise in connection with changes in the energy state of electrons.

Plasmas are characterized by the dynamics that occur when a medium undergoes a separation of charge. As a result, ions begin to move about, undergo changes in their energy states, create electrical currents that give rise to magnetic fields, and establish conditions in which, among other things, Langmuir sheaths may arise in which certain parts of that plasma form cells or regions which are insulated, to some degree, relative to the surrounding plasma.

The energetic properties of electrons are subject to changes amidst the dynamics which take place within plasmas. Presumably, therefore, photons will be emitted in conjunction with some of the foregoing transitions in energy levels undergone by various electrons, and, consequently, one of the ways in which biophotons are linked to plasmas is as a potential function of plasma dynamics.

One could assume that the generation of biophotons is merely an incidental by-product of the dynamics in which electrons are entangled. Alternatively, one might also suppose that the release of those biophotons is not necessarily incidental but could be playing a constructive role in a more complex set of dynamics.

For instance, earlier, passing mention had been made concerning Szent-Györgyi contention that biophotons could be used to diagnose the wellbeing of an individual. This suggests that biophotons might participate in shaping the well-being of a human being and that when there are changes of certain kinds with respect to the presence of biophotons, then, at a minimum, this could be correlated with the health condition of an individual and, consequently, be used as part of a diagnostic methodology.

A Russian researcher, Alexander Gurvich (often spelled "Gurwitsch" in the West), conducted the first experiments into the phenomena which, later, would be associated with the term, "biophotons." For a number of years, he had been exploring the dynamics of growth in plants, and based on his research, he hypothesized that there was a field-like phenomenon connected with that growth which he referred to as a "morphogenetic field."

He believed that mitosis, or cell division, which is an essential part of the growth process, required some kind of an initiating signal. Furthermore, given his belief in the need for an initiating factor to induce the process of mitosis, he also maintained that whatever was receiving the foregoing signal must, in some way, be able to detect or perceive the presence of that signal, and, as a result, came up with the idea of a receptor to account for such a capacity for detecting the presence of a biological signal.

With the foregoing considerations in mind, Gurvich set out to try to determine the specific nature of the dynamics which he had been theoretically proposing. Therefore, he conducted an experiment which focused on the growth that took place in the tips of onion roots.

He discovered during his experiment that when he placed the tip of one onion root at right angles to the root of another onion root, there were more cells which developed in the root tip of the latter onion root than were found in the root tip of the former onion. As a result, he inferred that something was being transferred or transmitted from the onion root tip with less cell growth to the onion root tip with more growth, and the challenge, then, became to try to determine what was being transmitted or transferred during the experiment.

He decided to place different kinds of barriers between the root tips of the two onions. In one experiment, Gurvich placed a thin glass plate between the two onion root tips, while in the other experiment he placed a plate made of quartz that was transparent in nature.

The glass plate prevented whatever was being transmitted from the first onion root tip to be able to reach the second onion root tip and, as a result, no cell growth was observed. However, the transparent quartz plate did not prevent cell growth from occurring in the second, targeted onion root tip,

Given that whatever was being transmitted was stopped by the glass plate but was not blocked by the quartz plate, Gurvich concluded that the signal was not chemical in nature because if it were, then, both plates would have prevented cell growth from taking place in the second onion root tip. The only logical conclusion which seemed to be left was that energy in the form of light was passing between the two onion root tips.

Gurvich reasoned that the energy of the transmitted light must be in the ultra-violet range. This was because glass plates block ultraviolet light, while quartz plates permit ultraviolet light to pass through them.

The light energy that was helping to induce cell-division in the onion root tip was termed “mitogenetic rays” by Gurvich because of their role in the process of mitosis. Nearly half a century later, those rays became known as biophotons.

Subsequently, Gurvich discovered that his mitogenetic rays needed to be coordinated through a more complex dynamic involving the organism as a whole. While he believed that his theory of morphogenetic fields was responsible for such coordination, he was unable to determine the specific details which governed how the whole body was involved in the process of coordinating biophotonic flow during the dynamics of cell growth, and such an understanding would have to await subsequent research into the nature of coherence phenomena.

Gurvich suspected that such biological coordination had to do with the alignment of the orientations of many different molecules. This dimension of collective dynamics versus the behavior of individual molecules confirmed, for him, his idea that some sort of field phenomenon was involved in the mitotic process.

He sensed that the foregoing coordinated alignment of many molecules would require a redistribution of energy within cells. However, he did not know what would regulate such a process of energy redistribution.

In 1944, the Russian researcher, V.S. Grischenko introduced the notion of "bioplasma." Some three-plus decades later, Grischenko and another Russian colleague, Viktor Inyushin, argued that, based on their research, there was considerable evidence to indicate that there were plasmas which were present within living organism.

While inorganic plasmas were associated with high temperatures, Grischenko and Inyushin believed that biological plasmas operated at room temperatures. This resonates with the previously mentioned research of Freeman Cope and Antoni Antonowicz who maintained that superconducting electrical currents regulated by Josephson Junctions-like dynamics might be able to take place at room temperatures, and, therefore, a bridge of sorts potentially opened up between, on the one hand, bioplasmas and, on the other hand, research involving superconductors, semiconductors, and Josephson Junctions.

According to Inyushin, bioplasmas give expression to a fifth state of matter which constitutes a fundamental part of the biofield of a human being. Like their inorganic counterparts, bioplasmas involve the dynamics of ions – in the form of protons, electrons, and other kinds of charged particles or entities – which give rise to electromagnetic phenomena.

Moreover, Inyushin indicated that bioplasmas were ideal mediums for the accumulation and distribution of energy. However, what he did not seem to know is the nature of the regulatory process that governed the accumulation and distribution of energy in a manner that would be biologically functional.

Inyushin also maintained that bioplasmas seem to be present in the brain in a concentrated form. In addition, he believed that the foregoing brain bioplasmas might generate phenomena that could extend outside of an individual and serve as the basis for various kinds of psychogenic capacities such as telepathy.

If true, then, the foregoing brain bioplasma might interact with the previously discussed microbial clouds-bioplasmas that are enveloping human beings. The latter, external bioplasma might serve as a medium which is compatible in certain ways with the internal bioplasma of an individual and, thereby, be capable of transmitting data from the internal bioplasma outwardly, as well as be able to transmit data from the external microbial cloud, and whatever that latter cloud engages, back to the internal bioplasma.

At some point after 1967, Inyushin began to do collaborative research with a Polish biologist, Wlodzimierz Sedlak, who, independently, had arrived at conclusions which, to varying degrees, coincided with the work that Grischenko and Inyushin had been conducting in conjunction with bioplasmas and biofields. The subsequent research of Sedlak and Inyushin was directed toward exploring processes involving complex, structured systems of broadband energy that were generated through the dynamics of bioplasmas and which led to the formation of biofields that gave rise to energy networks.

Apparently, however, the aforementioned duo was never able to determine, the nature of the dynamics which induced bioplasmas to form one kind of complex, structured system of broadband energy rather than some other kind of complex, structured system of broadband energy in a given context of metabolic dynamics. In this respect their research was like the previously mentioned work of Freeman Cope, Antoni Antonowicz, and others that had helped to establish some of the empirical groundwork which lent credibility to the possibility that superconducting electrical currents regulated by Josephson Junctions-like dynamics might be able to take place at room temperatures, and, therefore, within living organisms.

In both of the foregoing cases, researchers were able to provide evidence indicating that energy networks of a certain structural complexity were possible, if not present, in living organisms. Nevertheless, none of those researchers knew what regulated the energy flow which took place.

Some investigators want to account for the dynamics which occurred in the foregoing sorts of energy networks through a form of magical-like thinking in which spontaneous forms of self-organization of a just-so kind were presumed to arise, whenever needed, as emergent behaviors. The foregoing approach to things resonates with the perspective of many quantum physicists who have no idea why their calculations work out in the way they do and who often seem to believe that to ask questions about the causal forces underlying those probabilistic calculations is simply unprofessional because, among other things, it raises the specter of hidden variables which everyone knows Von Neumann had shown, almost a century ago (1932), were supposedly unviable … or had he (see the Introduction to, and Chapter 1 of, this book).

What appears to be missing from many of the discussions concerning bioplasmas, biofields, biophotons, and energy networks involves the nature of the regulatory dynamics which induce those bioplasmas, biofields, biophotons, and energy networks to flow in one way rather than another at certain times, places, amounts, lengths of time, combinations, and sequences. The surface features of such systems can be described, but the deeper, more fundamental 'how' which enables those systems to have the properties they do at different points in time and space seem to have eluded discovery so far.

To be sure, modern technology has found ways to: Block, heterodyne, hijack, and pave-over normal forms of biological functioning. However, the foregoing sorts of technological capacity do not mean that the people employing those techniques understand how the indigenous systems of normal, regulatory processes operate in biological organisms.

Rather, such technology merely permits technicians to short-circuit the normal regulatory, or default system, with which human beings are naturally equipped, and, instead, the foregoing sorts of technology seek to superimpose a new system of regulatory control. In effect, they are paving over the indigenous, natural, regulatory systems with which organisms come into this world and substituting or superimposing their own system of epigenetic regulations to run things.

As Joni Mitchell observed in her 1970 hit song, *Big Yellow Taxi*, they are paving paradise, and putting up a parking lot. Once the parking lot has been put up, the technologists and scientist will seek to park whatever technological contraptions they like on the newly paved surface, while they continue to be willfully blind with respect to whatever damage the lights, sounds, frequencies, and pressures of those contraptions will generate once the latter inventions have been put into place.

More will be said concerning the foregoing kinds of issues in the chapter on synthetic biology which, hopefully, will appear toward the latter part of this book (if, or when, the current work is completed). For now, perhaps, one might note that there is a difference between what someone can do and what an individual actually understands.

Unfortunately, there is a lot which modern technology can do (in very destructive, presumptuous, non-consensual, and problematic ways) but there appears to be very little that is of value that modern technology understands. While technologists, engineers, and scientists might sense that there could be something more deeply hidden concerning the nature of life and reality (after all, as the foregoing pages of this book indicate, there are many unanswered questions which permeate our lives and point to the possibility of more deeply hidden phenomena), those technologists, engineers, and scientists rarely let matters of truth, fairness, or people's fundamental right to essential sovereignty get in the way of ego, greed, blind ambition, and a deep-rooted desire to control others in ways that can't be justified.

Fritz-Albert Popp, a German research who did a great deal of work in conjunction with biophotons – beyond naming them – believed that biophotons were an expression of Qi (or, to use the term which I have coined – namely, "prana-nur-qi)," the organizational intelligence, which, to varying degrees, was discussed in a previous chapter. While we do not necessarily know what the nature of Qi is (in other words, we tend to be more familiar with what it can do and how it manifests itself in different contexts than what makes any of such phenomena possible), we do know that biophotons appear to be a form of a light that gives expression to frequencies in the ultraviolet range.

If Popp's idea concerning the possible link between biophotons and Qi is correct and biophotons are an expression of Qi, then, one can ask what kind of expression is it. What is the nature of the relationship between biophotons and Qi?

Are biophotons just another term for Qi (or prana-nur-qi)? If so, then, this would seem to indicate that there might be something more to biophotons than that they arise in conjunction with a change in the energy state of electrons.

After all, from the perspective of Chinese practitioners, Qi entails a capacity for intelligent organization. Consequently, this aspect of things would seem to indicate that if biophotons are some sort of expression of Qi (prana-nur-qi), then, there must be a dimension of biophotons which is more than its being a by-product of changes in the energy state of electrons.

Is Qi (prana-nur-qi) a form of energy or is it something more than that, and, if so, what is the nature of this 'something more'? To say that Qi (prana-nur-qi) has the capacity for intelligent organization describes what Qi does and not what it is or how it does what it does. If Qi (prana-nur-qi) cannot be reduced to biophotons (or vice versa), then what is the nature of the transduction dynamic through which biophotons emerge?

In 2004 a group of Japanese researchers (led by M. Takeda, M. Kobayashi, M. Takayama, and S. Suzuki) discovered that the rate of biophoton emission is affected by the health and age of an individual. More specifically, when people become ill or get older, the rate of biophotons being generated in the body tends to increase.

Moreover, when individuals undergo a stroke, there is an increase in the generation of biophotons on the same side of the body as the stroke. A group of Chinese investigators determined that through an appropriate use of acupuncture techniques clinicians were able to decrease the rate of biophoton emissions and make that rate more balanced between the left and right sides of the body ('*Left-right Asymmetry of Biophoton Emission from Hemiparesis Patients,*' Indian Journal of Experimental Biology).

The foregoing Japanese and Chinese research suggests that biophotons and Qi (prana-nur-qi) cannot be equated with one another. Qi (prana-nur-qi) is considered to be an intelligent form of healthy organization, and, yet, illness and aging are associated with an increase in the flow of biophotons.

Furthermore, whatever the nature of the relationship between biophotons and Qi (prana-nur-qi) might be, nonetheless, in certain circumstances the two seem to become disconnected, and, in the process, something other than an intelligent form of healthy organization (i.e., prana-nur-qi) begins to induce an increase in the flow of biophotons. Apparently, there are thresholds or tipping points which are relevant to the dynamics of biophotons in which below that threshold or tipping point, the body is healthy, but above that threshold or tipping point, illness and aging processes are facilitated.

Research which Popp conducted in 1988 (in conjunction with: K. H. Li, W.P. Mei, M. Galle and R. Neurohr) indicated that under certain circumstances, biophotons exhibit the property of coherence in which individual biophotons are brought together in a way that manifests coordinated behavior. In the 'light' of the foregoing considerations, one might suppose that the source of such coherence could be Qi (prana-nur-qi).

Conceivably, when biophotons lose their connection to the intelligent organizing capacity of Qi (prana-nur-qi) or that link is weakened in some fashion, then, the behavior of biophotons might undergo a phase transition. Under the foregoing circumstances, either: The dynamics through which photons are generated might lose their coherence and, in the process, the rate of biophoton flow increases, or: Some other form of destructive coherence (e.g., cancer could be seen as a form of destructive coherence) assumes control and pushes the flow of biophotons in a problematic direction).

When biophotonic emissions have been analyzed, they have been measured with a range of wavelengths. These extend from 250 to 900 nanometers, and biophotons with different wavelengths appear to be equally distributed which indicates that energy levels are probably represented in fairly equal ways.

It would be interesting to determine if there are significant differences in the wavelengths, frequencies, and/or energies of biophotons under different conditions. Biophotons have been found to be sensitive to a wide variety of external signals, and, as such, biophotons might play a role in molecular communication within an organism.

For example, biophotons have been correlated with increases in temperature. The rate of biophotons will increase with increases of temperature, and such rates of increase might be a way of transmitting certain kinds of signals that lead to the modulation of various aspects of biological functioning.

Following increases in temperature and accompanying sharp upticks in biophoton flow, biophotons undergo other changes. They undergo certain kinds of oscillation and, then, decay, and both the oscillations and decay are consistent with a form of communication which needs to be updated on a regular basis without being unduly biased (thus, the value of decaying states) by what went before.

Franco Musumeci, a physicist who has done research in Sicily, discovered, along with his colleagues, that biophotons often operate in non-linear ways which are not only different from what happens in solid-state devices but often vary in a manner that allows one to differentiate, in an identifiable manner, among those responses. In addition, research indicates that when exposed to stimulated light the nature of the decay kinetics of biophotonic activity tend to be highly correlated with different physiological states, and the high degree of correlation between decay kinetics and physiological states tends to indicate that such a correlation is the result of coherent, coordinated dynamics rather than merely the summation of biophotons acting independently of one another.

We have no way of knowing what the full extent of the electromagnetic properties of biophotons might be. We only know what we can see (that is, measure), and their might forms of biophotonic radiation which occur beyond the reach of the instruments (these tend to be quite expensive) which are used to measure biophotonic radiation.

Conceivably, biophotonic activity could extend beyond the visible range. Consequently, biophotons might have frequencies which encompass microwaves, radio waves, and extremely low frequencies (ELFs), and each of these frequencies, if they existed, could give expression to different kinds of biological functionality

One of the worrisome possibilities associated with the foregoing considerations is that irrespective of whether natural biophotonic activity in biological organisms extends into any of the facets of the electromagnetic spectrum which are beyond the visible range, synthetic, engineered forms of biophotonic dynamics can be, and have been, directed toward biological organisms with problematic, if not destructive, consequences.

Coherence has been demonstrated to be a property of biophotonic dynamics in living organisms. When engineers or biological technologists manipulate the biophotonic dynamics of a living organism, those individuals are the source of the regulatory processes which shape those biological dynamics, but when one removes such individuals from the equation, the nature of biological regulatory dynamics still tends to elude us.

The foregoing lack of understanding remains even if Qi (prana-nur-qi) is the source of natural regulatory dynamics. This is because we still don't know (and we might never know) how Qi does what it does even though, after thousands of years of exploration, we appear to be in a clinical position that enables practitioners to facilitate the flow of Qi in various ways that help balance the manner in which the body operates and, in the process, do away with whatever biological problems might have arisen due to a dysfunctional form of Qi flow in the body.

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