

Paper Title: EVOLUTION? LOOKING AT THE BIGGER PICTURE OF LIFE'S DEVELOPMENT

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Abstract:

The National Academy of Sciences recently referred to evolution as the best theory to explain how life developed. Since it is a theory, why is it taught as if it were a proven fact. The problems of its factuality burst forth the moment we look at the big picture of life's development.

Let's start at the beginning of the evolutionary process. The first question we might ponder from a secular stance is why is there existence? Why is there anything, why is there a universe within which life developed, rather than nothing? Why was there a big bang, a creation of the universe? Well we can't really answer that, but it's worth thinking about. So we can start our quest after the beginning. Just what did the big bang produce? We know science thinks it was the beginning of time and space. But what about matter? That is considerably more enlightening, literally. The big bang did not produce matter as we know it, not protons, neutrons or electrons. The only material product of the big bang was light beams, super powerful beams of energy. Electro magnetic radiation is the proper term, but that masks the wonder of it all. I mean who can visualize electro magnetic rays. But light beams we can wrap our minds about. And then over eons of time, thanks to a transition discovered by Albert Einstein (that famous equation $E = mc^2$) those light beams changed form and became solid matter and finally life itself. Now that is a cause for wonder. It is science that discovered this reality. Light beams became alive.

In one hand I hold a block of ice and in the other a kettle out of which emerges a spray of white steam. Steam looks nothing like ice, but both made of water. I'd say it was fantasy if I didn't know the truth. Ice is low energy water. Steam is high energy water. We humans and all the matter we see about us may not look like light beams, but we are. We are medium energy light beams. It's not new age flaky talk, or guru wishing. It's established scientific reality. We are the condensed energy of the creation. We witnessed that creation and its genesis, first as light beams, then as parts of stars and the star dust of supernovae, then as the rocks and water on the surface of the earth, which in a geological blink of the eye became alive.

And tucked within that wonder of the first life was the ability to reproduce. Reproduction is purpose driven, the preservation of the species. The first forms of life had purpose within their genetic make-up.

The basic problem in teaching evolution is that we get so involved with the minutiae, that we neglect the really crucial questions. When you give all the facts, even those for which there are no facile answers, you come up with an answer that smacks of teleology.

Biography:

Gerald Schroeder teaches topics related to the confluence of the discoveries of modern science with ancient biblical commentaries on the 'creation chapter' of Genesis. Schroeder earned his B.Sc., M.Sc., and Ph.D. all at the Massachusetts Institute of Technology. He was on the staff of the M.I.T. physics department for seven years prior to moving Israel where joined the Weizmann Institute and then the Volcani Research Institute with laboratories also at the Hebrew University. He now teaches at Aish HaTorah College of Jewish Studies in Jerusalem. He has over 60 publications in leading scientific journals on topics as diverse as the metabolism of breast milk and the radon atmosphere of the moon, and in arms control research has witnessed the detonation of six atomic bombs. Schroeder has served as scientific advisor to countries around the world. He is the author of *Genesis And The Big Bang*, *The Science Of God*, and, *The Hidden Face Of God*. *The Science Of God* in the first full year of its publication was the largest selling book in the Amazon.com category of science and cosmology. He lives in Jerusalem with his wife, author Barbara Sofer, and their five children and changing number of grandchildren.

Paper:

The evolution of life is perhaps better described as the development of life since the term evolution has become such a politically loaded term. Though The National Academy of Sciences has referred to evolution as the best theory going to explain how life developed, evolution remains a theory, and a theory within which a myriad of unproved assumptions has been absorbed. Random mutations yielding variations in progeny, with the more fit progeny surviving the rigors of natural selection is the catechism of the day. Certainly this sounds logical – provided we ignore the most basic and pivotal questions of our cosmic and earthly origins. And unfortunately when evolution is taught, these most crucially significant points of transition are most often ignored. Life's progress involves vastly more than how you might evolve a frog out of a fish.

Just how did life develop - or if you insist, evolve? To answer that, we'd best start at the beginning and work our way forward.

The first requirement for life's evolution is a universe within which life may or may not find its home. But why is there a universe; why is there any thing rather than nothing? We take existence as an obvious given. But that ignores the most basic conundrum of all. Why is there an 'is?' It is ignored because there is no secularly logical reason for the existence our magnificent universe, or for any form of existence. There may be no answer to the 'why' of existence, still it is a puzzle well worth pondering.

The big bang creation marks the start of life's progress. Prior to 1965, the scientific community was divided between those favoring an eternal universe, that is the Greek view of nature, and those who read the same data and concluded that there was a

beginning. Then in 1965, Arno Penzias and Robert Wilson, two scientists at the Bell Labs in New Jersey, discovered that the universe is immersed in a field of radiation characteristic of a black body cooled to 3 degrees Kelvin above absolute zero (-270°C or -450°F). P. J. Peebles, professor of cosmology at Princeton University, also in New Jersey, realized that this black body background of microwave radiation was the stretched, cooled remnant of the once majestically hot burst of energy we refer to today as the big bang creation. The discovery of Penzias and Wilson enhanced by the insights of Peebles changed humankind's paradigm of existence. Our universe had a beginning. What caused the beginning remains a mute point. For the theologian, the answer is God, the Creator of all. For the secularist, the reply is more complex but still tenable. The laws of nature, as manifest within quantum mechanics, quantum uncertainty and a quantum fluctuation can in theory produce the physical from the non-physical, the metaphysical. Provided that the laws of nature (not nature, only the laws) are eternal. Some non-thing that is eternal produced the universe. This is not so different from the theologian's description of God: eternal, metaphysical and did produce the universe. The basic difference being that if you spell your creator God than your creator is interested and active in the universe It created. If you consider your creator to be the laws of nature, than other than those finely tuned laws being active in the universe, there is no willful interaction between the creator and the created.

There are other theories of existence such as multiple universes, with ours being only one among the myriad (c.f., the feature article in Scientific American, May 2003). It is instructive to quote the logic behind the claim of Scientific American for multiple universes. "Cosmologists infer the presence of level 11 parallel universes by scrutinizing the properties of our universe. These properties [here the key laws and properties of nature are listed] ... were established by random processes during the birth of our universe. Yet they have exactly the values that sustain life. That suggests the existence of other universes with other values." Of course it suggests nothing of the sort. As a scientist I find it embarrassing that such convoluted logic could make its way past the editors of a scientific journal. One of the main hints for this theory, they write, is that the laws of nature in our universe are perfect for sustaining life. What SciAm has admitted is that if our universe is the only universe than we are living in a Designer universe, with a capital D. This of course is untenable for a view of life steeped in the material myth.

The big bang creation marked the appearance of a minuscule speck of space from absolute nothingness. That iota of existence housed all the energy that would eventually form the entire material world. The stuff of a hundred billion galaxies each consisting of a hundred billion stars held within a volume not larger than the back of an eye. That dot of existence was not a speck in a vacuum. A vacuum is space. This primordial iota was the entirety of existence. There was and is no outside. If there is an edge to our universe, it is an edge with an inside but no out side, a concept impossible for the human mind to envision. Our marvel filled world is filled with aspects totally illogical to the human concept of logic. Among them is the fact that the universe is expanding, not by new space being formed or created, but by the original space stretching. And with that expansion, the original energy of creation becomes ever more dilute, till today it is just three degrees Kelvin above absolute zero.

Exactly what the temperature (or equally termed, the energy level) of the universe was at its creation is not known. However, by approximately 0.00001 seconds after the creation, space had expanded to somewhat greater than the size of our solar system today. The temperature had 'fallen' to a mere 10.9 trillion (i.e., million million) degrees Kelvin, the threshold temperature of protons and neutrons. At this reduced energy/temperature, these sub-atomic particles were able to form in stable configuration, eventually combining as the 92 elements of the material world. Their first products were hydrogen, the lightest of elements (one proton and one electron; atomic number one, atomic weight one) and helium (two protons, two neutrons and two electrons; atomic number two, atomic weight four). The universe today retains a composition very similar to that of the first few moments, approximately 78% hydrogen and 22% helium. The heavier elements, even though they seem so very abundant in our bodies and in our region of the universe, account for only a fraction of a percent of the total matter of the universe.

Glossed over in the usual description of the evolution of life is a life giving nuance of this early era of existence. When photons of energy combine to form condensed matter (at this stage, quarks, and then protons and neutrons), the matter is always formed in pairs as matter and anti-matter. When matter and anti-matter collide, they annihilate and revert to the energy of their making. The density of the universe at this early period of nucleosynthesis (the entire universe packed into the space of our solar system) was so great that total self-annihilation should have occurred. The matter anti-matter interactions should have been complete. No particles of matter should have remained. And in fact it was almost complete. Somehow a 'slip' in the accounting must have occurred. A small amount of matter (about one part in approximately 100,000) survived the annihilating onslaught. It is because of that tiny fraction that we and our cosmic predecessors were able to form. Had this unpredictable extra of matter not occurred, the universe today and forever would be an ever more chilling sea of radiation, devoid of all solidity. Somehow the excess formation of matter must have been written into the fabric of the big bang creation itself.

As the universe expanded, galactic sized clouds of the primordial hydrogen and helium drew together by their mutual gravitational attraction. Clusters formed within these huge clouds. Internal pressures increased leading to fusion of hydrogen into helium with the inherent energy release of that process. A star was in the making. Gravity pulled inward while the pressure of the released radiant energy pushed outward. A balance of the forces was reached. But in time the hydrogen would be consumed. The outward radiant pressure would cease but the inward force of self-gravitation remained unabated. The star implodes and in rebound explodes with the majestic force of a supernova. The pressures of the explosion force nuclei join, combining to yield the heavier elements so essential for life. Space was now seeded with these building blocks of life.

Then in this corner of the universe, the cosmic debris of by gone supernovae, literally star dust, mixed with the primordial hydrogen of the big bang, to form a central star, our sun, and a system of planets, one of which has just the perfect properties to sustain life. Those properties include being located far from the densely packed center of the galaxy and also between the arms of our spiral galaxy, and hence far from other stars that might in time

explode, destroying life in our solar system by lethal radiation. Being located just the right distance from our star, the sun, so that temperatures are in the range where water can be liquid. Having a planetary gravity able to hold an oxygen and nitrogen rich atmosphere, but being weak enough to allow the lighter highly reactive hydrogen to escape to space. Being far enough from the sun so that its gravity does not, via tidal drag, force only one side of the planet to continually face the sun, resulting in drastic inequalities of temperature between sun lit and shaded sides of the planet. Having giant planets, such as Jupiter, to help clear the region of deadly missiles known as meteors, but located far out from the star and therefore not close to the earth. If close to the earth, the gravitational interplay between the giant and the sun would tear the earth apart. The asteroid belt, a collection of boulder sized rocks that had it not been for Jupiter's gravity might have coalesced to form a planet, brings clear witness to the effects of such interaction. The list of needs for life goes on and on.

Let's make some guesstimates of the likelihood of finding in our universe the criteria needed for life as we know it. We can base our calculations on cosmological observations of the other galaxies, the distribution of stars and planets in our galaxy, the Milky Way, and the distribution and characteristics of planets in our solar system:

- 1) the frequency of isolated spiral galaxies is about one galaxy in ten or 0.1
- 2) fraction of stars in the galaxy located in a region of low local density of stars, that is between the spiral arms and far from the galactic center 0.001
- 3) fraction of stars in the galaxy located in a region of high local density of metals 0.01
- 4) fraction of stars with a mass similar to the Sun's mass 0.05
- 5) formation of a stellar system around the remnants of a second or third generation supernova within a few billion years of the most recent supernova 0.1
- 6) fraction of planets that are metal-rich planets 0.4
- 7) fraction of planets that have low (relative to asteroid composition) carbon content 0.3
- 8) fraction of planets that have low (relative to asteroid composition) water content 0.3
- 9) fraction of planets that have molten iron-rich core 0.4
- 10) fraction of planets with mass (gravity) able to hold oxygen rich atmosphere but not hydrogen 0.2
- 11) fraction of planets with continent-forming plate tectonics 0.1
- 12) fraction of planets with nearly circular orbit 0.1
- 13) fraction of planets approximately 150 million km from a Sun-like star 0.1
- 14) fraction of planetary systems with huge outer planets 0.001,
- 15) fraction of planetary systems with no huge inner planets 0.01
- 16) fraction of planets with a period of planetary rotation in the order of days 0.5
- 17) fraction of planets with a moderate tilt to the planet's axis of rotation 0.2
- 18) fraction of planets with a large moon 0.05

Notice that none of these variables attempts to estimate how likely or unlikely it is that life could have formed from the rocks and water and few simple molecules that were characteristic of the early Earth or of any young planet. There are no data upon which to base such a calculation. It would be pure speculation. Also we take as givens the existence of a universe with stable laws of nature that provide a reproducible physics and chemistry, having three spatial dimensions and one time dimension. There's no attempt to ask how unlikely it is for chance to have constructed such a universe with just the correct physics. Scientific American already went that route and concluded that if our universe is the only universe then we are a designer product. If I'd read it anywhere other than the avidly materialistic journal that SciAm is, I might not believe it. But if that's SciAm's conclusion, it is good enough proof for me that our universe and our planet are both very special.

Multiplying these admittedly gross estimates, but none-the-less, estimates based on the conditions observed within our life-supporting galaxy and solar system and on our nurturing Earth, the likelihood of finding, anywhere in our universe, a planet able to support complex intelligent life is one chance in 10^{21} . The estimated number of stars in the entire visible universe is in the order of 10^{22} . Comparison of these two values indicates that there might be a few planets able to support life in the universe but not many. We know of only one thus far. It's Earth.

This estimate relates only to the possibility of finding conditions that would nurture life once it started. We learn nothing here concerning the inception of life. Since we have not a clue as to how life started on earth, and started in a geological blink of the eye, there are no data on which to base a calculation that might indicate the likelihood of life originating on one of those rare friendly planets.

The problems of evolution do not start with how a fish may or may not become a frog. The problems of evolution start long before that, with the forming of a finely tuned stage on which life might play out its role.

Though we do not know yet the properties required to start life, the fossil record has revealed that life started in a geological blink of the eye on the just cooled surface of the earth. And not after the billions of years once posited as the time required for random reactions to form life in some fantasized pond brimming with chemical and energy sources. The discoveries of Elso Barghoorn of Harvard University in the mid and late 1970's destroyed that theory when he discovered that the oldest of rocks able to bear fossils already have fully formed fossils of one celled life. Among the fossils of this early life are those caught in the act of mitotic reproduction.

Logically, the first forms of life must have known how to reproduce. If they did not, then as their molecular machinery of the cell degraded, the cell would die. Any beneficial mutations the cell might have accumulated during its span of life would be lost and life would then have to begin again de novo. Even the so called simpler forms of life are so complex and the mechanisms so similar across all forms of life (DNA structure, systems for reading the DNA information and translating that information into proteins, energy

extraction from glucose, ATP, ADP), that there seems to have been a single common source. The implication is that life started once, and somehow 'knew' it had to be able to reproduce in order to continue its life line. Reproduction is purpose oriented. Life appeared with purpose already as part of its birthright.

All forms of animal, plant and bacterial life exhibit the same mechanisms for cell division. And that mechanism is strikingly more than merely chopping a cell in two. Mitosis is nothing less than an exquisitely synchronized ballet on a molecular level.

In simple terms, let's review what is involved in mitosis.

First nature had to invent a cellular membrane that would enclose the cellular mechanisms. This membrane would keep the good stuff in and the bad stuff out of the cell. It did this by forming a bi-molecular layer having water (i.e., polar) loving (hydrophilic) heads on both sides of the membrane and oil (i.e., non-polar) loving (hydrophobic) legs within the membrane. Since life as we know it is water based, the cell finds itself at home in this medium, both inside and outside. Then nature had to provide gates, controlled passages, through the membrane so that nutrients could enter and waste and designated products could exit the cell.

With that in place the cell can now function. There are a host of textbooks that describe molecular functions of DNA duplication, protein formation, energy extraction, transport within the cell of nutrients and products. Here I only outline the ballet of mitosis. First the DNA and crucial organelles must be duplicated in a period of an hour or so. In mammals there are some three billion data points on the strands of DNA. The molecular reader active in this replication reads these data at 50 points a second (50 a second!). But even at that amazing rate, three billion divided by 50 a second gives us 60 million seconds for the job. Well, 60 million seconds comes out to be some 20 thousand hours. But we only have an hour or so for the task. So nature invented a system where thousands of readers are zipping along the DNA, each reading and replicating its own section and then joining these thousands of pieces into the coherent chromosome strands of DNA, getting it all in the correct order, not reading the same passage twice. Not bad for a bunch of molecules to have pulled off. Were getting the hint that there might be a sort of conductor, perhaps a molecular mind, synchronizing this dance.

Now with the duplicated DNA and necessary organelles on site, the DNA assembles in the center of the cell, along something like an equator. Cables with a thickness of a molecule link the pairs of duplicate chromosomes to opposite poles of the cell and a molecular motor reels in the cables, pulling the DNA strands to opposite poles of the cell. A molecular sized belt now forms around the outside of the vacated cell center, the equatorial region of the cell, and a molecular motor tightens and tightens and tightens the molecular belt till, pop, the cell pinches in two.

That, in an embarrassingly simplified form, is mitosis. Nature invented this and the first forms of life were in on the secret. Based on numbers and arrangements of passive mutations, it appears that the first forms of microbial life were thermophilic. This makes

all the sense in the world. They formed shortly after the crust of the once molten earth had solidified and cooled to the temperature that allowed for water, though still quite hot, to condense. This is another piece of evidence confirming Barghoorn's discovery that life formed immediately after the earth's crust formed.

For the next three billion years, as measured by the time space coordinates of the earth, life remained one celled, a size that required a microscope to see it. And then with no hint in the underlying fossil record, "a remarkable burst of evolutionary creativity simultaneously gave rise to the basic body plans of all modern, multicellular animals" (Scientific American, November 1992). That event is known as the Cambrian explosion of life. Simultaneously every body plan (phylum) burst onto the stage of life. Prior to this in the fossil record, complex body structure is absent. Then animals with limbs, mouths and most amazingly eyes suddenly and simultaneously appear. "Until very recently we contented ourselves with notions of a gradual progression of structural organization from a few simple types in the early Cambrian to the abundance of organisms alive today. The reinterpretation of the Burgess shale fossils initiated by Conway Morris and Whittington [in 1985] changed all that. Representatives of every phylum except Bryozoa have been found from early or mid Cambrian. ... [This] raises enormous questions concerning the radiation of body plans. ... No new body plans have evolved since" (B. K. Hall, *Evolutionary Developmental Biology*, 1992; pp. 214, 215). These fossil data are so unexpected and so contrary to concepts of neo-Darwinian evolution that SciAm asked "Has the mechanism of evolution altered?" No, it is not the mechanism of evolution that has changed. It is our understanding of life's flow that must change.

And notice Hall's subtle back-peddling. "[W]e contented ourselves with *notions* of a gradual progression of structural organization." The idea of the gradual progression of life was never presented as a *notion*. It was taught to primary, secondary and university students as a *fact*. And that so called fact is embedded in our brains. First came sponges and then came worms and then came insects and then came mollusks and then came, and then came and then came. This lie is so deeply within our psyche that even as I teach the reality of the Cambrian explosion, emotionally I fight its truth all the way.

Niles Eldredge, curator at the American Museum of Natural History wrote in the New York Times some years ago (4 November 1980), "The pattern we were told to find in the fossil record does not exist. ... Species simply appear at a given point in geologic time, persist largely unchanged for a few million years and then disappear." An article in the esteemed, peer reviewed journal *Science* (R. Kerr; volume 267, 1995) entitled "Did Darwin Get It All Right?" had the subtitle that "Species appear in a most un-Darwinian like fashion." Darwin was so very correct when he wrote that to believe in his theory we should use our imagination, not the fossil record.

The crucial pieces of information at each point of cosmic transition are neatly ignored in the argument for randomness as the source of life's wonder. The existence of existence itself, the surprising excess of matter over antimatter, the intricate formation of the elements within the alchemy of stellar furnaces and supernovae, the unique positioning of the earth in a life-friendly zone our galaxy, the sudden and immediate appearance of life

on the just solidified crust of the earth, the ability of that nascent life to perform the purpose driven act of reproduction, the Cambrian explosion of life marking the simultaneous appearance of all the animal phyla, that the pattern we were told to find in the fossil record does not exist, that commonly the fossils reveal that a species simply appears at a given point in geologic time, persists largely unchanged for a few million years and then disappears.

All these facts and many others are brushed aside or just ignored when trying to make a logical case for randomness as the driving force behind evolution. They are ignored because when we list them as a group, we come up with an answer that smacks of teleology. Some driving force, an intelligence, seems to be active in this scenario.

Nobel laureate, organic chemist de Duve, alludes to this reality in his “Tour of a Living Cell.” “If you equate the probability of the birth of a bacteria cell to chance assembly of its atoms, eternity will not suffice to produce one. ... The speed at which evolution started moving once it discovered the right track, so to speak, and the apparently auto-catalytic manner by which it accelerated are truly astonishing. ... [Yet] chance and chance alone did it all. But it is not, as some would have it, the whole answer, for chance did not operate in a vacuum. It operated in a universe governed by orderly laws and made of matter endowed with special properties. These laws and properties are the constraints that shape evolutionary roulette and restrict the numbers that can turn up. ... *Faced with the enormous sum of lucky draws behind the success of the evolutionary game, one may legitimately wonder to what extent this success is actually written into the fabric of the universe.*” [emphasis added]

I think Noble laureate, biochemist, Harvard University professor George Wald summarizes reality most accurately. Wald in his early years described life’s wonder in totally materialistic terms. In a pivotal publication in Scientific American, ‘The Origin of Life’ (August 1954), Wald taught us that in regard to the origin of life, “Time is in fact the hero of the plot. The time we have to deal with is of the order of two billion years [the time between the origin of liquid water on earth and the origin of the first forms of life on earth; such was the knowledge of the 1950’ and ‘60’s prior to Barghoorn’s discoveries of the earliest microbial life]. What we regard as impossible on the basis of human experience is meaningless here. Given so much time, the ‘impossible’ becomes the possible, the possible probable and the probable virtually certain. One has only to wait. Time itself performs the miracles.” No teleology here. Just time and random reactions. Then came the discoveries of Elso Barghoorn and the billions of years for random reactions to produce the first forms of life in some idealized pond brimming with chemicals and energy just evaporated. Wald realized his error and the thesis of his article, random reactions leading to life, was retracted 25 years later. In a 1979 special edition of SciAm we read, “Although stimulating, this article [Wald’s 1954 article] probably represents one of the few times in his professional life when Wald has been wrong.” No equivocation. The thesis of randomness by itself cannot and does not account for life’s origins.

Five years later, in an article in which Wald discusses the biological wonder of life and human consciousness arising from non-living matter, he abandons his materialist view and embraces a reality built upon the metaphysical. “It has occurred to me lately - I must confess with some shock at first to my scientific sensibilities – that both questions [the origin of consciousness in humans and of life from non-living matter] might be brought into some degree of congruence. This is with the assumption that mind, rather than emerging as a late outgrowth in the evolution of life, has existed always as the matrix, the source and condition of physical reality – that stuff of which physical reality is composed is mind-stuff. It is mind that has composed a physical universe that breeds life and so eventually evolves creatures that know and create: science-, art-, and technology-making animals. In them the universe begins to know itself” (“Life and Mind in the Universe” in *International Journal of Quantum Chemistry: Quantum Biology symposium 11* (1984); 1 – 15.). Mind creating the physical world. Seems almost fantasy, but it is only a sliver more incomprehensible than the proven reality that light beams became alive.

Half a century earlier, Sir James Jeans, knighted mathematician, physicist, and astronomer who helped develop our understanding of the evolution of stars; wrote in his book, *The Mysterious Universe* (Cambridge University Press, 1931):

“There is a wide measure of agreement *which, on the physical side of science approaches almost unanimity*, that the steam of knowledge is heading towards a non-mechanical reality; the universe begins to look more like a great thought than a great machine. Mind no longer appears as an accidental intruder into the realm of matter. We are beginning to suspect that we ought rather to hail mind as the creator and governor of the realm of matter – not of course our individual minds, but the mind in which the atoms out of which our individual minds have grown, exist as thoughts (emphasis added).”

And then Werner Heisenberg, Nobel laureate in physics, one of the parents of all modern quantum mechanics, from his book, “Physics and Beyond.”

“Inherent difficulties of the materialist theory of [existence] have appeared very clearly in the development of physics during the 20th century. This difficulty relates to the question whether the smallest units of matter such as atoms [of which we and all objects from bacteria to galaxies are composed] are ordinary physical objects, whether they exist in the same way as stones or flowers. Here quantum theory has created a complete change in the situation. ... The smallest units of matter are, in fact, not physical objects in the ordinary sense of the word; they are – in Plato’s sense - Ideas.”

These are not the speculative words of philosophy. Nor are they the products of science fiction. And don’t let that exotic technical name, quantum mechanics, deceive you. QM is not some idle theory waiting in the wings for an esoteric application. Every time you turn on your TV, start your car engine, place a phone call, you are putting into operation the insights of Heisenberg. The products of his mind are part of your every day life.

The startling, totally counter-intuitive, yet scientifically proven discovery of science has revealed that our world, at its deepest level, is built not of tangible discrete objects. Rather when we look closely, we find that reality is as gossamer as an unembodied thought.

Evolution? No problem, just give all the facts. When that is done, it is hard to miss the teleological hand, a universal mind, intimate and active at and within each key step along the cosmic road to life.