

How Evolution Really Works

THE QUANTUM SECRET

By

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INTRODUCTION

We do not need to be shoemakers to know if our shoes fit, and just as little have we any need to be professionals to acquire knowledge of matters of universal interest.
—Georg Hegel

Ever since discovering the biochemical basis for heredity, scientists have universally agreed that random genetic mutations subject to Darwinian natural selection are largely what account for biological evolution. Because any suggestion to the contrary—no matter how esteemed the source—is subject to merciless ridicule and unrelenting scorn, few will dare to publicly challenge this view on ‘scientific’ grounds. But we shall confidently do so here, in part by demonstrating that the question of how life evolved is no less a *logistical* problem than a scientific one. And while conceding that mutations are no doubt the primary fuel for evolution’s fire, we’ll come to learn that these cannot be “haphazard and aimless” as modern evolutionary theory demands. The eye-opening answer to “How could it possibly be otherwise?” is convincingly revealed through a novel analytical approach and level-headed appeal to the principles and forces of non-classical (quantum) physics.

1 A Blatant Misconception

Old beliefs die hard even when demonstrably false.
—E.O. Wilson

1.1 Do you believe in “evolution?”

That most of us will respond to this question with a simple “Yes” or “No” unmasks our failure to properly distinguish fact from theory—in this case having mistakenly equated *whether* evolution happened with *how*. Largely attributable to the unrelenting battle between science and religion over whether evolution occurred at all, such confusion curiously serves both sides of this bitter controversy; but especially evolutionary biology whose theory cites as evidence the very fact it purports to explain.

1.2 Evidence of what?

Science has amassed a wealth of irrefutable physical evidence proving beyond doubt that life in its many forms gradually appeared over geologic expanses of time. This evidence is so utterly convincing, and so voluminous, that to deny it is to denounce the validity of science altogether. But while the *fact* of evolution has mountains of incontrovertible data to support it, the theory itself—simple, elegant, and seductive though it may be—actually has little to none to account for life’s considerable novelty and, especially, complexity.

Exhibit A: *Dermatobia hominis* (compelling houseflies to be their unwitting couriers)

2 Modern Evolutionary Theory

When men are most sure and arrogant, they are commonly the most mistaken, and have then given views to passion, without that proper deliberation and suspense which can alone secure them from the grossest absurdities.
—David Hume

2.1 One-way street

The physical (phenotypic) changes within a given population over time are predominantly attributable to random genetic fluctuations—the occasionally favorable ones tending to be preserved while those unfavorable are prone to be lost. It would seem, in other words, that evolution’s strikingly non-random gains in environmental adaptation and advancing complexity could *only* have arisen through random mutations subject to the pragmatic sieve of natural selection. But appearances can be deceiving. (Just because a mutation is “random” does not guarantee that its outcome will be purely haphazard.)

2.2 Neither wrong nor right

Neo-Darwinian theory fails to satisfactorily account for the fact of bioevolution because its two central assumptions are mistaken. First, the critical source of evolutionary variability is not random mutagenesis *as it is currently understood*. And second, natural selection is not a principal determinant of evolution’s course and direction, regardless. Furthermore, having erroneously presumed that only classical (Newtonian) forces play a significant role in biological evolution, theorists remain blind to the vital role played by quantum mechanical dynamics in life’s emergence and subsequent evolution.

2.3 No accident here

Nature is by no stretch of the imagination subordinate to science. On the contrary, whatever science may learn of Nature’s truth must be respected—no matter how paradoxical or unintelligible or absurd it may seem.¹ Just as they ought to grant the legitimacy of the bizarre reality decreed by quantum mechanics, for example, so too should scientists concede that Nature holds absolute dominion over an all-encompassing cosmos that ultimately *is what it is*; no matter how much (or little) sense we can make of it. Once recognized that the process of evolution is no less “alive” than the life forms it creates, process and outcome become indistinguishable. And conversely, for so long as the universe is taken to be little more than “one big accident,” the true origin and nature of living things shall remain elusive.

Exhibit B: *Ampulex compressa* (a wasp that performs brain surgery on a cockroach)

¹ We’ll define Nature here simply as “that which is responsible for everything in the cosmos, including itself.”

3 Under the Hood

The real voyage of discovery consists not in seeking new lands but in seeing with new eyes.

—Marcel Proust

3.1 Nature's building blocks

It is not by accident that all living things are comprised of the same basic stuff (amino acids, DNA, RNA, proteins, and so forth). This book maintains that life came to exist through the same forces that shaped the universe and everything within it—that the process of evolution is neither peculiar nor unique to living things, but is instead universal and ubiquitous. Nature established and leveraged cosmic forces and their constants, quarks, atoms, molecules and so on, to distill somethingness from nothingness: a self-organizing backdrop from which life could subsequently arise and unfold.

3.2 The only game in town

Life's instructions are molecularly encoded and self-contained. And a given population's change in appearance (phenotype) is precisely mirrored by biochemical changes to those instructions (genotype). Evolution is therefore the wholly determined product of genetic fluctuations (mutations) over time. A given mutation must, presumably, be either random or non-random, i.e. haphazardly indiscriminate and essentially aimless, or actively influenced in its course and direction by some purposeful external agency. Notwithstanding genetic engineering, life's genetic fluctuations are surely passively random rather than actively directed. We should further agree that the process of natural selection is the only mechanism (short of divine intervention) capable of sculpting these slews of hereditary accidents into favorable long-term biological outcomes. Evolution then, at least according to contemporary thinking, is a characteristically gradual process whose course is governed by the process of natural selection acting upon beneficial variations arising from the random (undirected) spoils of mutagenesis.

3.3 Constraints and the bottom line

Imagine, however, just for the sake of argument, that the various exhibits and analyses herein will convince you that complex life forms could have arisen *neither* via a series of chance (albeit occasionally favorable) genetic anomalies, *nor* in the painstakingly gradual manner prescribed by neo-Darwinian theory. But then how – having already agreed that the process of random mutation is surely what ultimately drives evolution – could this be?! How could random mutagenesis be undoubtedly responsible for evolution, yet powerless to fuel it? Logistics tell us there is but one way out of this conundrum: randomness, in the context of genetic information processing, must be something other than just “hit-or-miss.” Mutations, in other words, would have had to occur *in anticipation* of their future collective value in order to produce the exquisitely orchestrated biological machines we see all around us. The challenge then is to uncover a scientifically-grounded alternative to neo-Darwinism by which evolution becomes an inherently anticipatory process marshaling random mutagenesis in such a manner as to pursue an ultimately purposeful course.

Exhibit C: *Cycnia tenera* (a moth that defends itself using ultrasonic counter-measures)

4 Making the Impossible Possible

The eye sees only what the mind is prepared to comprehend.
—Henri Bergson

4.1 The “directed” mutation controversy

A basic assumption in modern evolutionary theory is that the random mutations driving evolution are not inherently biased to be beneficial in some way. (If anything, a given mutation is far more likely to be *unfavorable* simply because there are many more ways for it to be harmful than to help.) “In no event can mutations be directed to serve a particular need of an organism at a particular time,” insists biology’s orthodoxy. Yet evidence to the contrary—admittedly still hotly disputed—has been reported in experiments (primarily with yeast and *E. coli*) published since 1988. *The Quantum Secret* argues that directed (also called adaptive) mutation is, in fact, a genuine phenomenon that its thesis both predicts and can readily account for.

4.2 Two kinds of randomness

Coin flips, dice rolls and lottery drawings are familiar examples of “classical” randomness. Given sufficient information all such events are potentially predictable, hence only *pseudo* (superficially) random. By contrast, quantum phenomena, such as radioactive decay, electron spin, and photon polarization, are unpredictable in principle, i.e. *genuinely* (intrinsically) random. Quantum events are categorically unpredictable because their cause is not just unknowable, but non-existent. The question to ponder is, “Could genetic mutations ever be intrinsically random (i.e. uncaused)? And if so, in what way (if not through causation) would they arise and differ from ordinary classical mutations?”

4.3 Two kinds of mutations

The above rarely cited yet vitally important distinction between genuine and pseudo randomness is the linchpin for the book’s main thesis that only the former supplies the anticipatory and purposeful character needed to create and evolve living things. All mutations fall into one of two categories we’ll call *extrinsic* (classical and purposeless) and *intrinsic* (non-classical and purposeful). The extrinsic (pseudo-random) mutations of neo-Darwinism arise spontaneously from classical events such as exposure to radiation, a chemical mutagen, or merely the occasional glitch in transcription fidelity. Such genetic fluctuations are commonplace and natural selection can certainly operate on them; but this *reactive* form of evolution accomplishes little more than to purge the unfit and occasionally ‘tweak’ an already well-established biological motif. Underlying the book’s principal arguments, and one of its two landmark discoveries, is that *all non-trivial evolutionary advances* are the product of an innately coordinated progression of intrinsic mutations whose course naturally unfolds in an inexplicably advantageous and unambiguously purposeful manner. We’ll call this process *proactive* (or *quantable*) evolution to distinguish it from its comparatively impotent classical counterpart.

Exhibit D: *Nasonia* (a wasp whose stinger/ovipositor sports a zinc-encrusted tip for drilling)

5 Noctogenesis

Discovery consists of seeing what everybody has seen and thinking what nobody has thought.
—Albert Szent-Gyorgyi

5.1 Out of thin air

The book's exhibits will convincingly show that novel physiological systems cannot have gradually evolved as neo-Darwinian theory dictates. Classically random mutagenesis would, for one, have fallen terribly short of serving up each and every required variation—nevermind at an opportune time—in every case. And, regardless, no “higher” organism could have possibly survived the *developmental dissonance* that would at some point prove fatal if an evolving species were to be dispatched prematurely (launched “half-baked,” if you will). Because the changes to genetic code necessary to beget new species are surely accumulated over innumerable generations, *their phenotypic expression must have been silenced* (through gene regulation) until whatever ‘work-in-progress’ had sufficiently advanced to be successfully deployed. Radically new phenotypes must therefore have been forged *quiescently*—their myriad of transformational structures and functions lying dormant for millennia in a latently evolving genome—and unleashed only when the time became ripe to do so. Because Nature necessarily created novel life forms “in the dark,” so to speak, we’ll coin this process “noctogenesis.”

5.2 An unexpected ally

A basic premise of noctogenesis is that future genes and genetic networks are created and configured far in advance of their actual use: that every organism's phenotypic potential is genomically coded early on in its evolution and kept “under wraps” until whatever disruptive innovation has sufficiently developed to be overtly expressed without causing the organism harm. Metaphorically speaking, “Nature loads its gun well in advance, pulling the trigger only when the target is well within range.” Unintended support for this view comes from evolutionary developmental biology (“evo devo” for short), which has come into its own in recent years as our understanding of the genomic machinery driving embryological development has dramatically expanded. In his book “Endless Forms Most Beautiful,” for example, evolutionary biologist Sean Carroll points out that the genetic infrastructure needed to assemble the bodies of modern animals “long predated the appearance of those bodies in the Cambrian explosion.” To which he adds, “The genetic potential was in place for at least 50 million years, and probably a fair bit longer, before large, complex forms emerged.”

5.3 At face value

If noctogenesis is indeed the mechanism by which new species are born, the fossil record ought to be devoid of specimens looking like “works-in-progress” since none would have ever existed. One would find no birds with partially developed wings, for example; nor spiders with partially developed structures for producing and delivering venom. By contrast, had speciation truly occurred in the gradual manner required under neo-Darwinian theory, one would instead expect to find at least *some* (but more likely a great number of) intermediary specimens in various stages of morphological transition. Yet not a single example of such has ever been found—neverminding the likes of *Archaeopteryx* (a sort of cross between dinosaurs and modern

birds) and *Tiktaalik* (similarly sandwiched between primitive fishes and tetrapods), neither being even remotely *transitional* in the sense intended here.

Exhibit E: *Microstomum caudatum* (appropriating its nematocyst weaponry from a hydra)

6 Two Physics, Dual Realities

The important thing in science is not so much to obtain new facts as to discover new ways of thinking about them.
—Sir Lawrence Bragg

6.1 Size matters

The equations of classical physics that work so beautifully on larger than atomic scales curiously begin to falter and eventually fail completely as objects become submolecularly small. But why? Because *everything* changes ... reality included. Quantum physics, being neither an extension nor revision of the Newtonian description of the universe, demands a perplexing redefinition of reality that is fundamentally incompatible with our understanding of the everyday world as reflected in our thinking and language. This chapter introduces the bizarre science of quantum physics, providing the groundwork needed to appreciate its crucial role in biological systems. A lucid, non-mathematical treatment covers the basics: the concept of quanta, wave-particle duality, Planck's constant, the Heisenberg uncertainty principle, etc.

6.2 Reality's dual nature

The universe is comprised of two fundamentally different realms. One, the *macroverse*, is the everyday physical world we experience through our senses and quite accurately describe using classical (Newtonian) physics. The other is the subatomic *microverse* which is governed by the bizarre, yet incomparably accurate and prolific, rules of quantum mechanics. We cannot help but believe that all "things" exist and are unfailingly governed by causality. But the arguably more fundamental realm of the unimaginably small is populated not by things at all, but by wisps of potentiality capable of *becoming* things in a manner whose future behavior, unknowable in whatever course they may come to follow individually, is nevertheless precisely predictable in aggregate through the equations of quantum mechanics.

6.3 Superposition and the wave function

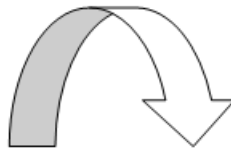
Quantum mechanics tells us that the physical reality we experience originates in *non-things* occupying virtual states smeared across countless potentialities until "an observation" causes just one of them to instantaneously actualize in the "real" world. It also precisely quantifies the probabilities associated with the future evolution of such systems, i.e. their various potential outcomes and the likelihood of each to be observed upon what's called wave function "collapse." Unlike classical probabilities, however, whose outcomes are discreet and mutually exclusive, quantum probabilities are *omnipresent*—i.e. all potential outcomes are manifest simultaneously in a virtual (non-classical) arrangement called a *superposition*. Being wave-like in nature, superpositions are subject to constructive or destructive "interference" (as beautifully illustrated by the celebrated "double-slit" experiment) thereby influencing their evolution in potentially dramatic ways peculiar to quantum dynamical systems.

6.4 Determinism lost

Because quantum mechanics provides our most complete and accurate description of the world on both micro and macroscopic scales, its prescription for reality—despite being profoundly unsettling and largely incomprehensible—must not be glibly ignored. We have no choice but to relinquish, for one, our deeply-seated notion that all events happen for a reason. They *don't*. One must instead see the universe as only superficially deterministic, leaving us to wonder if heretofore overlooked non-classical forces (acting *acausally* on submolecular scales) struck those chords that would come to reverberate with life. A careful and thorough logistical analysis indeed reveals that the macroscopic embodiment of that “vitality” we call life could only have its roots in the probabilistic soil of quantum uncertainty.

Exhibit F: *Meloe franciscanus* (blister beetle larvae: deceptive and deadly hitchhikers)

TWO PHYSICS



DUAL REALITIES

	CLASSICAL	QUANTUM
Existential Domain	Macroverse	Microverse
Existential Expression	Actuality	Potentiality
Mathematical Formalism	Deterministic	Probabilistic
Ontological Basis	Causality	Expectancy
Driving Force	Entropy	Syntropy
Conceptual Framework	Intuitive	Non-intuitive
Predictive Power	Approximate	Precise
Randomness	Pseudo	Genuine
Mutagenesis	Extrinsic (causal)	Intrinsic (acausal)
Evolutionary Process	Reactive (Darwinian)	Proactive (quantable)

7 Predicting the Unpredictable

A paradox is truth standing on its head to attract attention.
—Nicholas Falletta

7.1 The fortuitous paradox

Precisely when a particular radioactive atom will undergo decay is totally variable and unknowable, yet the average behavior of a very large number of such atoms is perfectly predictable. A great paradox lies in the fact that while quantum events are truly random individually, their participation in a sizable distribution of equivalent events isn't random at all. This capacity to 'predict the unpredictable' is not unique to quantum physics, however. It speaks also to the heart of bioevolution where one finds scores of individual mutations collectively achieving non-random (and often impossibly favorable) phenotypic outcomes. The question the book goes on to answer is, "How might this be accomplished?"

7.2 The quantum secret

Whatever happens on macroscopic scales is ultimately dependent upon (but not necessarily reducible to) microscopic quantum interactions. Because they are configured on submolecular scales, the genes that molecularly encode life's heritable instruction set are directly susceptible to quantum dynamical forces. These indeterminate forces somehow enable Nature to foresee the potential outcome of every possible intrinsic mutation, and every possible *series* of such mutations, allowing the most prolific to naturally unfurl. All significant evolutionary advances, in other words, are the result of the non-classical unfolding of optimal biodevelopmental paths blazed by a *retrospectively purposeful* succession of genetic fluctuations. Genomes, like a cheating gambler's dice, are thus "loaded" to probabilistically favor evolutionary outcomes no less astonishing in their creativity and bioengineering perfection than they are unlikely to have occurred at all.

7.3 Nature's invisible hand

Although individually uncaused and, therefore, unpredictable in-principle, quantum events as noted earlier will collectively exhibit perfectly predictable *probabilistic* behavior. This strikingly counter-intuitive posture—attributable to what physicist Heinz Pagels called "the invisible hand" of Nature—is what empowers random genetic fluctuations to spark retrospectively purposeful evolutionary gains. That said, and more fundamental still, how Nature manages to ensure that a large population of equivalent quantum states -- collapsing to a variety of singly-indeterminate macroscopic outcomes -- will precisely conform in aggregate to the equations of quantum mechanics *without their having been causally induced* may be the cosmic mystery to end all mysteries.

Exhibit G: *Cordyceps (a fungus that turns ants into flowerpots)*

8 The Dawn of Quantum Biology

A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it.
—Max Planck

8.1 Rocks and hard places

After a century of avoidance, resistance, wishful thinking, and flat out denial, biologists can no longer fend off the encroachment of quantum physics on their most hallowed ground: the science of living systems. (Whether biologists like it or not, their chosen field is based on chemistry which, in turn, is based on physics. And insofar as fundamental matters are concerned, physics always has the last word.) This section introduces the strikingly peculiar aspects of quantum behavior: coherence, superposition, entanglement and tunneling (and in the next goes on to more closely examine their known and suspected roles in biological processes).

8.2 Another quantum revolution

An ominous cloud looms large over contemporary biology as more and more evidence suggests that most, if not all, “energetic” biological processes are fundamentally quantum mechanical. And while biology has yet to officially acknowledge (let alone embrace) its nascent offshoot, a handful of biophysicists-cum-quantum biologists are slowly but steadily rewriting the book on some key physiological processes, most notably at this writing: photosynthesis, olfaction and avian magnetoreception. So it is that a second quantum revolution—this time in the life sciences—appears inevitable and, indeed, imminent.

Exhibit H: *Ichneumon eumerus* (a wasp that delivers a dose of temporary insanity)

9 Reality Revisited

According to the Second Law of Thermodynamics, the general direction of physical events is towards decrease of order and organization. In contrast to this, a direction towards increasing order seems to be present in evolution.
—Ludwig v. Bertalanffy

9.1 Entropy and syntropy

Entropy, the universal tendency towards disorder, works relentlessly to destroy life. *Syntropy* (proposed here to be entropy’s antithesis) strives to increase order, self-organization and vitality. Just as entropy doesn’t *do* anything to bring about increasing randomness and disorder, neither does syntropy explicitly advance its own reciprocal agenda. “Self-organization,” for example, simply happens (i.e. acausally) through its natural propensity to counteract entropy’s disorganizing and destructive forces. Evolution is not—as we have been erroneously led to believe—accomplished via a slew of ‘scattershot genetic hiccups’ subject to environmental pressure, natural selection, and the sway of population dynamics; but rather, through the passive unfolding of syntropic biopotentiality. What was once inanimate, one could say, evolved to become life-like simply because *it could* ... not because something overtly caused this to happen.

9.2 The teleoverse

Contrary to prevailing scientific sentiment, living things could not have spontaneously emerged from an inanimate universe on the heels of a succession of fortuitous accidents. Rather, life inexorably unfolded once the stage had been set for naturally self-organizing molecular biomachines to precipitate from an organic soup that Nature had prepared for that singular purpose. Life gradually arose, that is, in the wake of syntropy exploiting a virtual realm we'll call the *teleoverse* – an endless sea of potentiality exactly mirroring the gamut of countless classical trajectories emanating from every possible outcome (of every possible instance) of quantum collapse. Among them lie the innumerable paths through which a series of intrinsic genetic fluctuations might potentially cascade—including those yielding not just favorable but characteristically optimal biological outcomes. Although not existing in any physically real sense, the teleoverse is nonetheless the wellspring for everything that is, was, and could ever be.

9.3 Causality and Expectancy

Nature's "invisible hand," without exerting any causal influence whatsoever, allows genuinely random intrinsic mutations to collectively blaze "ideal" evolutionary paths. [The stupefying notion of *retrocausality* is now introduced (i) to correct what was admittedly mislabeled as acausality earlier, and (ii) hoping to have made the appallingly counter-intuitive notion of backward-in-time-causality a bit easier to swallow and digest.] But what, if not causality, could serve as the thread to tie so many discontinuous developmental elements together in so productive a fashion? Careful analysis reveals that it could only be causality's antithesis, something we'll call *expectancy*, which is ultimately responsible for evolutionary outcomes so optimal as to be achievable only through an effectively *retrospectively purposeful* agent. This agency comes in the form of intrinsic (quantum-random) mutations unwittingly participating in a prevailing "chain of expectancy" rendering some evolutionary routes probabilistically more likely to be followed than others. Note that nothing *causes* any of this to happen: it simply does.

Exhibit I: Alpheidae (this shrimp can score a 'knock-out' without landing a single blow)

10 The Myth of Materialism

Everything is foreseen, yet free will is given.
—Rabbi Akiva

10.1 I think, therefore I am not my brain

Because they are irreconcilably dissimilar in their respective natures, no amount of correlation between mind and brain will ever span their essential differences. Materialism, in other words, is untenable. It is no wonder then that classical science has made virtually no progress in piercing the dense veil of mystery surrounding the phenomenon we call "consciousness." Moreover, the conundrum over how a conscious experience can arise from a physical substrate is shown here to be overshadowed by the even greater mystery of why consciousness should exist *at all*? The surprising answer is revealed in this pivotal chapter.

10.2 What is consciousness?

Because it lacks any measurable mass or energy, consciousness has no tangible identity.² Consequently, no attempt to explain either “what consciousness is?” or “how it works?” has ever succeeded. Nor is one conceived via the reductionist framework of Newtonian physics ever going to. Not unlike the “ether” once postulated to pervade empty space, consciousness is describable only in terms of its contrasting nature to material things and the forces acting upon them. Nevertheless, one can at least glean that Nature “somehow” configures and arranges life’s biomolecules in a manner that is conducive to eliciting non-classical (mental) states. The burning question, logistically speaking, isn’t so much “*How?*” as “*Why bother?*”

10.3 What is free will?

Nature instilled its creations with free will in an ingenious ploy to bring a measure of indeterminacy to an otherwise fully-deterministic macroverse. And much as Nature fashioned the universe through a process of quantable evolution (intrinsically indeterminate, yet extrinsically purposeful), living things fashion their environment within that universe through their own conscious thoughts and actions. Volition, the exercise of willful decision-making and associated action, being paradoxically indeterminate in origin yet purposeful in outcome betrays its origins in Nature’s invisible hand—and like its universal counterpart, draws its indeterminate options from the televerse through the mystifying agency of consciousness. It is crucially important to note that the answer to the enigma of how Nature’s invisible hand “chooses without choosing” likewise holds the key to how our determinate acts of volition can arise from the indeterminate underpinnings of free will.

Exhibit J: *Toxoplasma gondii* (a protozoan that reprograms a rat’s brain to seek out cats)

11 Turning the Corner

Science can purify religion from error and superstition; religion can purify science from idolatry and false absolutes. Each can draw the other into a wider world, a world in which both can flourish.
—Pope John Paul II

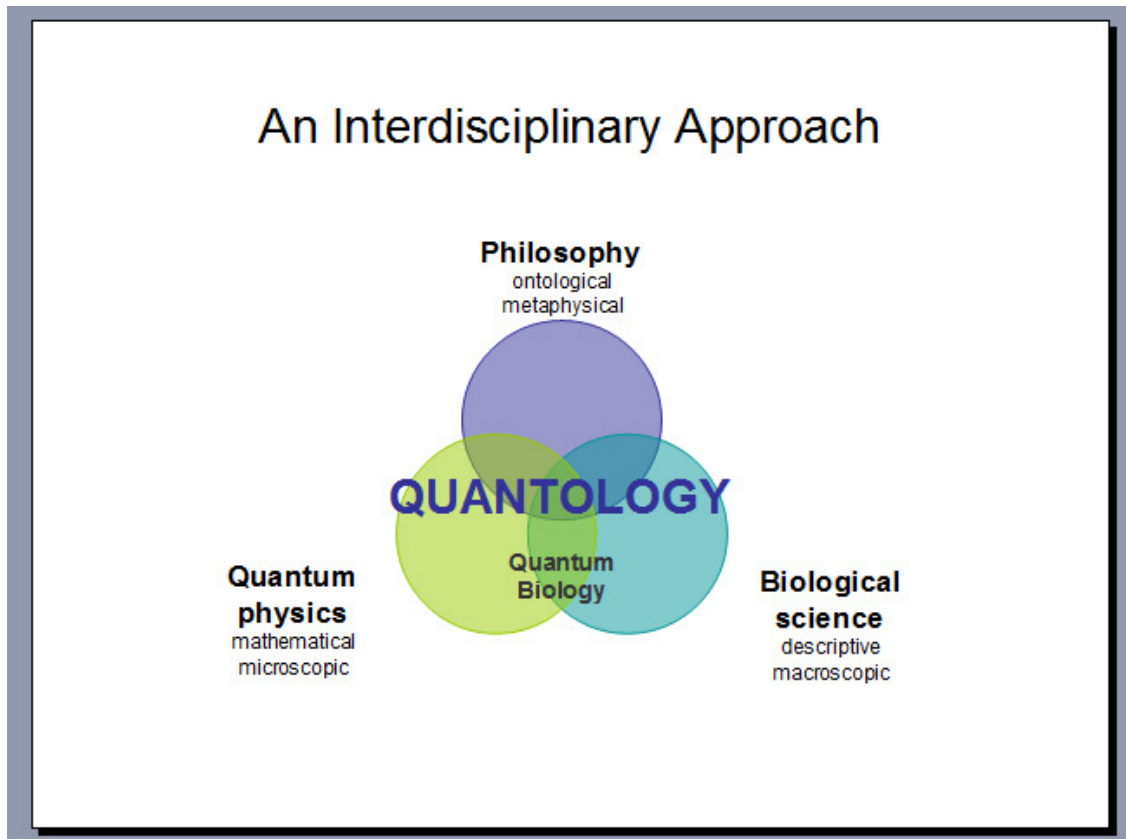
11.1 To live in peace

Those who view science and religion as incompatible fail to appreciate how both can peacefully coexist provided that religion leaves the fact-finding to science, and science leaves those questions it cannot answer (such as whether G-d exists; if we possess a soul that survives death, etc.) to faith. While science rightly reigns supreme over the realm of the objectively knowable, all else should fall to the purview of faith, religion and philosophical inquiry. Whether to attribute *our existence* to the work of “G-d” (religion) or “Nature” (science) will come to be seen as moot in a distant future that finds no good reason to strongly differentiate the two.

² Notwithstanding “brain waves,” for example, which are the result of physiological activity and not directly attributable to consciousness per se.

11.2 Quantology: the future of metaphysics?

As quantum biology matures, quandaries not unlike quantum physics struggling to come to terms with its own competing interpretations will come to light: quandaries that science alone can neither explain nor even effectively explore. Such matters, owing to their philosophical footing, are best approached metaphysically. And so, in a long overdue reunion of science and philosophy, a new metaphysics—one I would propose to call *quantology*—will rise from the still smoldering ashes of reductionism hoping to make sense of what will at first appear hopelessly intractable.



11.3 Into the light

The start to a new and exciting chapter in the book of human knowledge is already well underway. With the inexorable rise of quantum biology, the neo-Darwinian stranglehold on evolutionary theory will end. Thereafter, as the reductionist backbone of contemporary science itself weakens and eventually breaks, philosophy will at long last be free once again to search for *fundamental* truths that lie beyond the totality of knowledge obtainable through scientific inquiry. Answering the primal question, “*What is life?*” shall then preferentially fall to the informed and contemplative intellect rather than purely scientific study. For the answers we seek lie not “out there” waiting to be experimentally discovered, but reside in Nature’s vivid reflection and peerless achievement to date: the human mind.