

Review Article

Quantum food and nutrition: Subatomic approaches to nourishment for health and well-being

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Nutrition science has been represented as biomedical, environmental, societal and economic field, but quantum biology is sidestepped, thereby obscuring cognate problems and solutions. We are generally nourished for health, optimal well-being, longevity and personal security through sustainable livelihoods. Our nourishments include not only food and energy but also light from the sun, the firmament and the earth itself, along with information transmitted in subatomic particles and electromagnetic wave forms. We propose 'quantum nutrition' as an approach to reconcile quantum phenomena with nutritional biology. Appreciating quantum nutrition and recognizing its potential applications will provide opportunities for future health and well-being and for planetary habitability.

Key Words: quantum biology, quantum ecobiology, bioenergetics, biorhythms, nutrition

INTRODUCTION

In the 20th century, minds such as those of Einstein and Schrodinger developed a more universalistic understanding and enquiry of our place in the scheme of things through mathematical constructs of time and space and with 'quantum mechanics'. Quantum biology has consequently and progressively gained recognition.^{1,2} A review of how we consider that we are nourished for optimal well-being, health, longevity, habitability, and personal security through sustainable livelihoods is needed. The reconciliation of quantum mechanics and electromagnetic field (EMF) phenomena with nutritional biology necessitates a dialog about 'quantum nutrition (QN)'.

In developing the field of QN, we choose to speak of *nourishment* as well as food since our health and well-being require derivation of material not necessarily understood as food or nutrients. Given the universality of our connectedness and its representation by subatomic particle and wave forms, the term 'nourishment' is more encompassing. Nourishment represents the assimilation of environmental and cosmological factors with potential for effects on the health and well-being of living things (Table 1).

Homo sapiens has evolved and functions as an extensive integral of microbiomes, including archaeal, viral, bacterial, and fungal domains, in all of its anatomical

eukaryotic interfaces with the prokaryotic world. The evidence that this integral is operative through quantum ecobiology is being unraveled. Exemplification is offered by how food and its components deliver nourishment through nutrients that are modifiable in their subatomic properties with functional relevance. Electron tunnelling and other quantum mechanisms emulate the energy transduction of photosynthesis, which is dependent on chlorophyll and ferritin, and in turn increase bioenergetic efficiency. EMF phenomena may nonsynaptically connect and affect tissues distant from the gut, as with the 'gut-brain axis'. Perhaps even more profound is that our cross-kingdom obligatoriness demonstrates how our nurturing and well-being reflect and expose our ecological

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Table 1. The nourishment concept and its itemization

- Food and water: nutrients, food structure and color, organoleptics (taste, sight, smell, touch, and arguably sound (phonons))
- Atmosphere
- Electromagnetic fields (EMFs)
- Sunlight
- Moonlight
- Starlight
- Cosmic dust (microasteroids/micrometeorites)
- Pollutants (nanoplastics and ‘forever chemicals’ (FECs))

strength and vulnerability.^{3, 4} Its quantum characteristics add a cosmological orientation and security requirement.

Such examples from the human body and natural world, as we know them, can introduce possibilities conducive to sustainable earthly habitability by virtue of quantum sensing with interconnectedness⁵ and more efficient use of available energy. Hormetic factors, including personal behaviors, are probably involved not only in bioenergetics but also in inflammation and its chronicity, in aging and in lifespan and in intergenerational information storage architecture and transmission.⁶

The intransigent problems now faced by food insecurity, food system inequity, sustainability, and nutritionally related health outcomes may be undertaken with quantum insights and ‘neural pathway analysis’ via quantum computing, an evolving technology with a future articulated by investigators such as Michelle Simmons. This flip-flopping between traditional nutritional science and QN requires speculation about how food systems are configured in quantum terms and interface with health systems and the problems that they currently face. The reconceptualization and interfacing of the prevailing and quantum nutritional sciences can begin in several areas. Areas to shape quantum nutritional sciences range from a shift in

cosmological appreciation and relevance to socioecological understanding, the notion of QN and its system dependency, intra- and intergenerational connectedness, and clinical and public health relevance (Figure 1).

COSMOLOGICAL CONTEXT

We are obligatorily earthbound and maintain our lives with sustenance, the required socioecological connectedness, and biorhythms, which depend on the solar system and alignments beyond. We are still coming to grips with the basis, nature and essentiality of optimal nourishment and of its evident rhythmic synchronicity. For the former, it is already clear that a nutrient-alone descriptor of food dependency is too biologically simplistic. A food systems, food component and structural complexity descriptor, which is health-characteristic, is needed, as is a sociodemographic appreciation of livelihood suitability to specify suitable nutriture. Our food and fluid intakes have their own quantum properties when their subatomic composition is considered. Manifestations of these properties are recognizable by molecular differences and disorders that are evident only in electron spins,⁷ by photons or luminescence⁸ and EMF susceptibility.⁹ On Earth, the cosmos remains omnipresent and active by way of cosmic

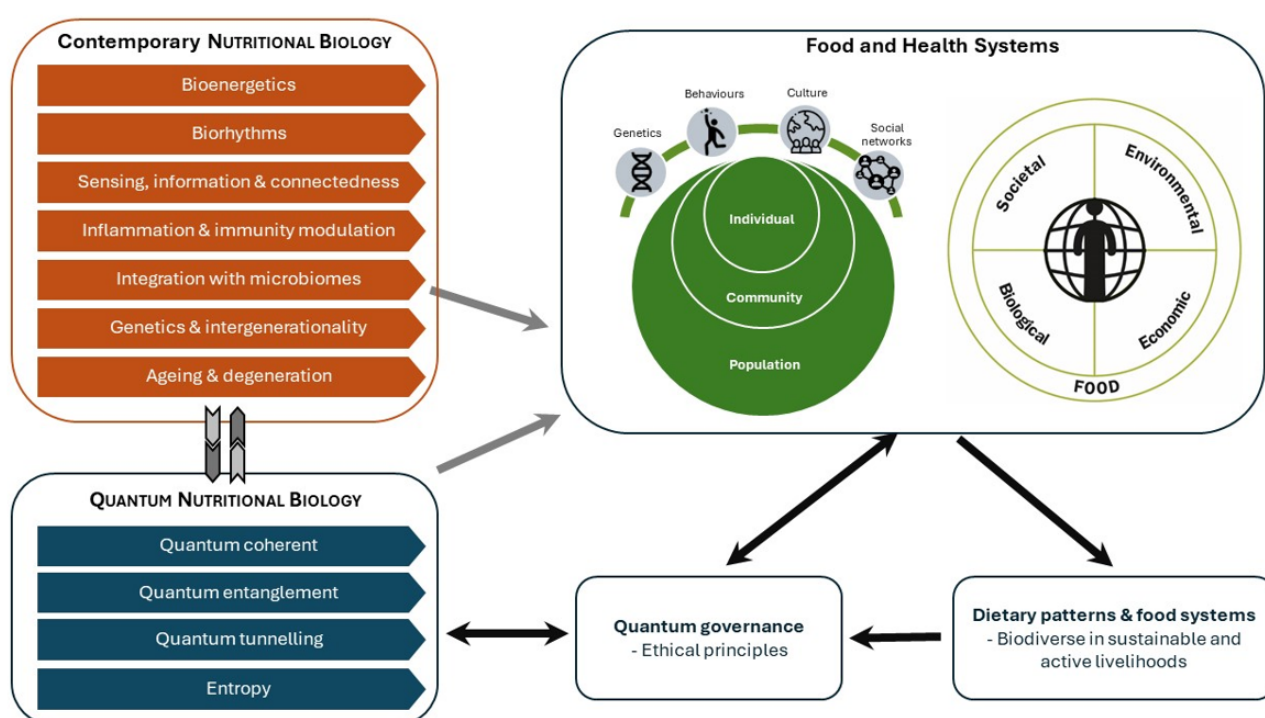


Figure 1. Interplay between contemporary and quantum nutritional biology and its applications to food and health systems.

rays,¹⁰ and the continuing rain of cosmic dust and micro-meteoroids is ubiquitously discoverable in gardens, foods, waterways and roof tops.^{11, 12} Furthermore, for a QN approach to our well-being, there is a need to consider the universality of general gravity since it is an essential feature of our ecobiology.¹³

Insofar as biorhythms are concerned, these are coordinates of the Earth's relationship with the sun,¹⁴ moon and firmament,¹⁵ along with seasonality,¹⁶ ecology,¹⁷ and cross-kingdom genomic and microbiomic associations,¹⁸ including clock genes. For these various biorhythmic exposures, there will be a spectrum of benefits, risks, and costs.

BIOENERGETICS

The energy required for life of any kind on earth is ultimately derived from the sun. When energy in the form of visible light is absorbed by an object, it is converted into heat. Cyanobacteria, algae and plants transduce light, principally solar energy, into energy and information with the aid of the remarkable molecular apparatus or organelle known as the 'chloroplast' through photosynthesis. In turn, ATP is formed and powers the production of glucose and oxygen from CO₂ and water.

In eukaryotes, including animals, mitochondria are the equivalent of chloroplasts. For humans, from conception to reproduction and death, we are nourished by circadian light and energy in complex cosmic pathways in which the chloroplasts and mitochondria, with their own DNA, are quantum transducers and health determinants.⁶ Mitochondria appear to provide coherence within and between the classic world and the quantum universe. In so doing, electron and proton tunnelling, superposition, electron entanglement (nonlocality) and quantum inter alia are deployed;¹⁹ the adaptability and resilience of the prevailing redox state is referred to as mitochondrial hormesis and is indicative of how optimal the state of health of the mitochondrion is.⁶ The high-spin Fe²⁺ ions within the electron transport chain can generate an effective magnetic field that can reduce the production of reactive oxygen species, a quantum protective mechanism. Mitochondrial function has wide relevance to human health and well-being, notably for neuromuscular competence.²⁰ Mitochondrial dysfunction is perhaps the most pervasive among nutritional disorders, and these disorders include mitochondrial myopathies, post-viral syndromes, chronic fatigue syndromes and more.²¹

The customary way of thinking about human bioenergetics on the basis of daily energy requirements of approximately 8000 kJ is conceptually misleading. This method is theoretically based on bomb calorimetric measures of the energy values of the macronutrients (water factors), fat (37.7 kJ/g), carbohydrates 16.7 (kJ/g), protein (16.7 kJ/g) and alcohol (29.3 kJ/g), regardless of the food matrix and digestive factors. Indeed, the energy requirements of several biological processes, such as enzymatic reactions, are high and must proceed with underappreciated efficiency.²² Quantum biology indicates that quantum tunnelling may account in part for the discrepancies.²

BIORHYTHMICS AND BIOPHOTONICS

Sunlight has a complex essentiality for humankind and all other forms of life. Several biological effects of sunlight are mediated by various pathways, including the modulation of clock gene function and related cryptochrome proteins;²³ sleep, wakefulness and consciousness;^{24, 25} sterol conversion to vitamin D;²⁶ and effects on gut motility and microbiomics.²⁷⁻²⁹ Evidently, light has effects on well-being, and these effects are dependent on the biorhythmic natural world along with its role in sustenance, whether terrestrial or aquatic.³⁰

One of the most illuminating features of quantum biology relevant to nourishment and well-being is the apparent universality of biorhythmic synchronicity for at least eukaryotic, and probably prokaryotic, forms of life.³¹ There are biological clocks with a genetic basis dovetailing with the quantum world.^{32, 33} Early in evolution, some lichen-forming fungi appeared to have circadian clocks interacting through symbiotic involvement with algae or cyanobacteria, even irrespective of direct connectedness with sunlight or moonlight.³⁴ This phenomenon may apply to the human gut and its microbiome without direct light exposure, which may be driven by bioluminescence, for example, or regulated by the human body itself.³⁵ Interestingly, a photosynthetic apparatus may exist in the gut, as evidenced by the ingestion and function of chlorophyll and perhaps ferritin. Nonetheless, the underlying biological clock capacity must be responsive to changes in living locality, time zone and nourishment.

While the bioluminescence of oceans and other waterways is known to reflect the photogenic capacity of microscopic and macroscopic aquatic life, it is also evident in terrestrial plants and creatures, including food stuffs such as insects and legumes.³⁶ So too do humans emit low levels of biophotons.³⁷ It is likely that these biophotonic phenomena represent sensing and regulatory systems across the natural world and beyond, including ourselves.³⁸

INHERITANCE AND INTERGENERATIONALITY

The modulation, reparation, or mutation of DNA can be affected by EMF-sensitive proteins and energy-efficient tunneling.^{39, 40} Presumptively, this modulation could accelerate favorable or unfavorable evolution and, if gametes are involved, have intergenerational consequences, as with epigenetics, of which it may be a type.^{41, 42}

Given the present recognition of epigenetics and how this may provide for lifespan and intergenerational accumulation of biological responses to personal behaviors and the environment through DNA alteration, the question is whether quantum nutritional effects on human biology may also be imprinted and operationalized within and between lifetimes of the same and related individuals in an intergenerational sense. It is conceivable that quantum-related events based on electron entanglement may be a form of epigenetic modification.⁴³ In this case, parents-to-be, and mothers-to-be in particular, may need to be aware of quantum exposures with these longer-term consequences. A measure of optimism about such possibilities is justified knowing that the quantum phenomenon of DNA repair may be continuously operative across the lifespan and intergenerationally.⁴⁴

NUTRITIONAL IMMUNOINFLAMMATORY PHENOMENA

One of the most encouraging quantum-based revisions in nutritional biology may involve nutritional immunoinflammatory pathways and their implications for innate immunity, successful vaccination and wound healing.⁴⁵⁻⁴⁷ The basic contributors to innate immunity, which include dendritic cell and macrophage responses, can be modulated by quantum mechanics. The nutritional biological challenge with an infectious agent or the rectification of tissue damage is that inflammation and oxidation are required to quell the injury, whereas anti-inflammation and antioxidation may be critical in the medium to longer term; this is a process sometimes considered ‘hormesis’.⁴⁸

Difficulties with wound healing are among the major challenges in improving outcome prospects after surgery and trauma, whether accidental or due to conflicts or violence. The evidence that wound healing can be facilitated by the judicious use of EMFs is gaining credence. It appears that cytokine profiles and cell migration in the wound vicinity can be optimized with EMFs,⁴⁹ thereby expediting healing.

TIME, SPACE AND AGING

The nature of life is that it provides continuity, regeneration, and connectedness on the basis of the perpetual transduction of photons into various forms of energy, with water as a vehicle, and their integration with atomic and subatomic particles and cosmological derivation. Thus, we need to think of ourselves in terms of ‘universal time and space’, and by definition, humans are earthly in space and time in the so-called ‘present’. Our universe is reckoned to be expanding with increasing ‘*entropy*’, which seems to suggest irreversibility; if so, our interest in the reversal of *aging*, admittedly over a very small ‘time frame’ from a cosmological perspective, would be unrewarding notwithstanding current biomedical measurements of aging directed toward healthy life extension.⁵⁰

Nonetheless, we also need to understand the extent to which we are what we are considering gravity. If gravity is sufficiently powerful, it might be able to bend light back on itself in loops, the so-called closed time-like curve model of the universe.^{51, 52} Such excursions into the quandary of time, lifespan and mortality may not dispel the disquiet about who and what we are but offer opportunities for health system advancement beyond more finite attention to biorhythms as a key nourishment. The increased integrated digital connectedness of food and health systems at the interface of the classic and quantum realms shows promise.

SENSE OF IDENTITY, NEUROPHYSIOLOGY, CONSCIOUSNESS AND MENTAL HEALTH

The systems that provide our nourishment, where and how we effect it, confer in large measure our sense of identity, along with our health and well-being. This process and its transduction into our biology are more quantum in nature than we have heretofore considered.^{53, 54}

It has become clear that what we currently regard as neurophysiological mechanisms with an anatomical framework from the brain through the brainstem and spi-

nal cord to the periphery may reflect a broader neurological conceptualization and integration of organs and systems through quantum mechanics. The brain and nervous system deploy several subatomic mechanisms that enable us to realize ourselves as living creatures. These mechanisms involve energy transduction, ultimately from photons, animate and inanimate connectedness, movement, reproduction, regeneration, thought and cognition.⁵⁵ Consistent with a more integrated quantum mechanical approach to neurophysiology, growing evidence suggests that neurotransmission may be nonsynaptic and dependent on EMFs, which would extend the notion of neurological pathogenesis beyond the anatomical nervous system.

An underlying quantum-related cellular disturbance in some neurobehavioral functions occurs in microtubules, on which, according to Penrose and Hammeroff,^{25, 56} consciousness may be a cellular phenomenon. It is conceivable that proneness to microtubular dysfunction, which could be the basis of mental health disorders, may operate beyond the anatomical nervous system yet to be interpreted as primarily neurological.⁵⁵ These mental disorders include schizophrenia, in which the perception of locality, circumstance and reality may be compromised; Alzheimer’s disease, in which microtubular tau protein phosphorylation is disrupted; and prion diseases, in which abnormalities in protein folding may reflect the compromised status of electron spin.⁵⁷ Such disorders may reflect altered bioenergetics and substrate utilization and be diagnosable and amenable to therapeutics with quantum dot technology.^{58, 59}

ENVIRONMENTAL SENSING AND CONNECTEDNESS

Our sensing biology resides at interfaces with the cosmos, natural world and others in terms of sight, sound, smell and taste, touch, proprioception, gravity, movement, pain, inflammation, immunocompetence, and various EMF forms. Integrated, this sensing biology allows for the presence of awareness and connectedness with others, mobility, rest, recreation and sustenance. It provides a sense of being which is that basically of a quantum collective of subatomic particles and wave forms. However, it is conceivable that our connectedness with each other, the natural world and the cosmos, is more overlapping than that at interfaces when our quantum biology and nourishment are considered.

Environmental and sociological sensing by sound as “phonons”, in audible and nonaudible ranges, is intrinsic to human health and well-being. This, by way of nature, involves appreciation, environmental connectedness and social discourse and music.⁶⁰ These phononic inputs are often associated with those by way of photons, enriching collective quantum nourishment. Insofar as health and well-being are concerned, eating with others represents the social function of food beyond its components, and the sound of chewing and mastication is a food attribute value in many cultures. We may look to the even more extensive potential of eating in health and well-being, as environmental sensing is connected to more favorable nourishment outcomes. Furthermore, in birds and mammals, sensing capabilities extend across light, sound and

magnetic fields;⁶¹ understandably, quantum sensing may involve complex inputs to achieve functional outcomes.

Overall, ecological connectivity is the framework of our evolution, propagation, and migration globally. Its dysfunction and intractability are now an existential threat. Its amenability to quantum analysis and management may be one of the last survival options we have for a habitable planet.

QUANTUM FOOD PATTERN, SYSTEM AND FRAMEWORK GUIDANCE

Various lines of contemporary nutritional science evidence, biomedical, environmental, societal and economic, are concordant in recognition that the best way of eating for *Homo sapiens* is one that is biodiverse and omnivorous, involving cooking, boiling of beverages or infusions, sometimes fermentation and minimal storage, with proximity to sources, whether gathered, harvested, hunted or fished. However, there are many probable quantum properties of food that are not captured in food regulation or compositional guidelines and tables. These include appearance and color, physical structure,⁶² smell and fragrance.⁶³ In turn, these properties need representation at their source or in the course of the food system. The dietary pattern of these properties should optimize health and well-being outcomes will be characterized by diversity and associated physical, mental and social activities.⁶⁴

It is increasingly clear that a more complete understanding of the relationships among food, nutrition, health and well-being requires a quantum as well as a conventional scientific approach. This type of approach would allow management of the interface between contemporary and quantum nutritional sciences. The question then is to what extent food characteristics, choice, consumption, context or security and the food system as a whole can be improved to health and well-being advantages.

QUANTUM NOURISHMENT SECURITY

Concerns about food security should extend to the more quantum understandable realm of nourishment, especially our connectedness and relationship with the natural world and firmament. Not to have this functionality is to be insecure and deprived, so-called 'nature-deficit disorder'.⁶⁵ Attention to quantum nourishment would be counsel to go beyond an econutrition concept of the human diet.⁶⁴ Current and future food security depends, among other considerations, on how we manage soil science for food production.⁶⁷ Much of the world's arable land is made available through ecosystem destruction or compromise, and its despoilation occurs through the use of fertilizers, especially nitrogen, phosphorus and potassium. Neural network analysis with sensing and quantum computing technologies should enable the creation of more sustainable ecosystems capable of avoiding the loss of these vital nutrients and increasing their efficiency of use. Moreover, aggressive attention to the role of climate change in ecosystems and the related food security requirements could be effected through the incorporation of quantum methodology into food systems beginning at sources, whether agricultural, horticultural or aquacultural. Health systems will benefit accordingly.

Quantum mechanics could add extensive ecosystem awareness, potential and efficiency to the use of ecosystem services in the interest of nourishment security. The advent of quantum computing should provide opportunities to address the existential problems of dysfunctional human energy utilization and the misuse of ecosystem services, which are exacerbating climate change.^{68, 69}

POTENTIAL APPLICATIONS OF QN

Almost all pathophysiological disorders, diseases and unwellness arise in genomically and epigenetically vulnerable individuals, families and communities on account of the combined exposure to a suboptimal diet and infection (dormant or newly acquired), and the nature of the immuno-inflammatory response is short, medium or long-term.^{70, 71} It is customary for the clinical nutritional diagnosis to be one of particular or general deficiency, an inappropriate dietary pattern, or a metabolic-enzymatic disorder associated with pregnancy, growth or development, trauma, surgery, or secondary to an underlying disease. Any of these situations might be amenable to what we now understand to be quantum nourishment interventions.

Quantum mechanics are inevitably involved and provide therapeutic options such as the use of low-dose EMFs for wound healing, regeneration or the treatment of migraine, possibly in conjunction with contemporary pharmacotherapeutics.⁷²⁻⁷⁴ Another example would be the application of quantum dots as nanocarriers in drug delivery systems.⁷⁵ These quantum dots could be promising interventions for several clinical neurological situations where the microtubular architecture may be a useful therapeutic target, including mood disorders, depression, dementia, Parkinson's disease and schizophrenia.⁵⁵ The ability to interface customarily with quantum therapeutics may represent an understanding of what we currently do or be what we will be able to innovate.

In addition to their applications in therapeutics, the development of quantum dots has provided a greater scope for sensing and diagnostics owing to their reproducibility, stability and multifunctionality.⁷⁶ Furthermore, the use of quantum dots is currently of interest for high-density long-term information storage in the food industry, especially in the primary industry, the supply chain, production processes and safety assessment.^{77, 78} However, there are concerns that some quantum dots pose risks to human health and the environment under certain conditions.⁷⁹

The electron entanglement of qubits allows fast information transfer across what are termed 'complex multi-dimensional spaces'. The challenge for quantum computing is the stability and transportability of these electron compilations. In biological systems, EMF-sensitive molecules and quantum dots may have these properties, allowing myriads of functionalities with ill-defined nutritional and health statuses. However, given their quantum characteristics, EMF-sensitive molecules and quantum dots may operate over pathways and with biomedical and socioecological consequences not currently appreciated.

The sensing with the measurement, modeling, monitoring and surveillance of ecosystems via quantum technologies will provide an opportunity to minimize inhabitability, improve food security and increase holistic nourish-

ment for health and well-being.⁸⁰ Available quantum sensing technologies enable us to assess, predict and possibly prevent adverse environmental situations. These technologies will allow for improved intersystem effectiveness and governance of the socioecological commons within and between communities.^{81, 82} It should be possible with such a design to operate locally, interregionally and globally and in a timely and transparent fashion.^{83, 84} Ecovillages, communities and households can be exquisitely connected for mitigation of the currently emerging and accelerating existential threats we face.⁸¹ The resolution of these threats must aim for optimal nourishment behavioral patterns to be widespread and synchronous with the natural world in terms of biodiversity and interdependencies.

ETHICAL PRINCIPLES

No matter how sophisticated the system modeling might become using quantum mechanics, the primary question, along with the pathway analysis and unintended consequences, must be uppermost and in accordance with ethical principles.⁸⁵ Mindful of the recent and past history of how nutritional science has been understood and applied, ultimately to environmental and human advantages and detriment, the same lesson should apply to QN. We would appeal to the quest for universal plant-based diets dependent on items such as wild vegetables, grains, legumes and fatty fruits, which have been exploited at the expense of general biodiversity, thus threatening dietary biodiversity.

SUMMARY

We have identified areas of quantum biology relevant to the nutritional and health sciences, which may provide opportunities for dealing with the existential threat posed by food insecurity, potentially unsustainable health costs, gross global and local inequities, and climate change. We have outlined the areas of quantum mechanics applicable

to nutritional science that may offer possible solutions to these challenges (Figure 2). It will be necessary to interface these areas with contemporary nutritional science methodologies and measurements. On this basis, we propose a more inclusive concept of nutritional inputs into health and well-being than food and energy alone, using ‘nourishment’ terminology. Such terminology embraces subatomic particles and EMFs, and it requires familiarity with phenomena such as quantum entanglement, tunneling, coherence and more. The use of this terminology will be crucial to the imminent paradigm shift in food and nutritional science applied to future health and well-being and its sustainability on a habitable planet.

CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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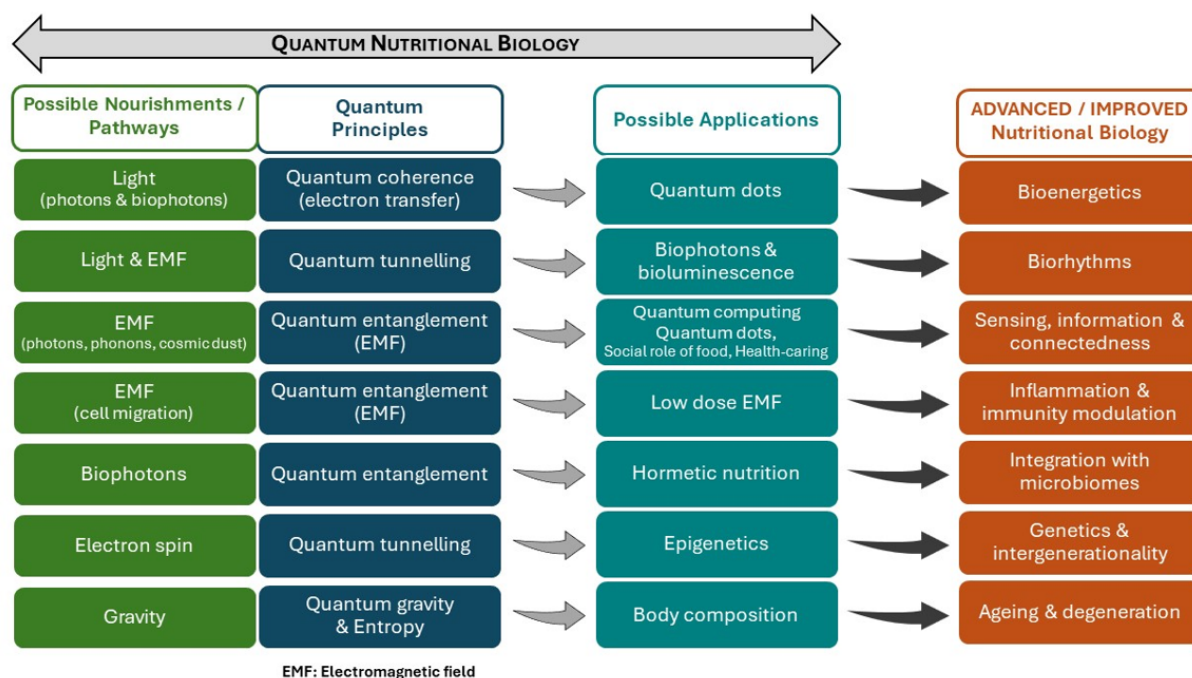


Figure 2. Areas of quantum mechanics that are applicable to nutritional biology

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