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Biologically Structured Water (BSW) - A Review (Part 1): Structured Water (SW) Properties, BSW and Redox Biology, BSW and Bioenergetics

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Abstract:

A review of biologically structured water (BSW) is needed to support a more convincing argument of the significance of organized water to the overall health of living organisms. Research phrases related to BSW water are energized, hexagonal, interfacial, or bound water because they refer to biological water with similar structural, functionality, and general water properties. Structured water is formed by shortening hydrogen bonds (H-bonds) in free water, forming various polymeric water structures. In living organisms, BSW water has liquid crystalline properties that have excellent redox qualities due to the energized state of the hexagonal ring structure. Each hexagonal ring has a vortex of delocalized electrons and protons that form pi orbitals above and below each ring, contributing to myriad redox reactions within cells. In addition, the energized hexagonal water rings can be readily split or ionized with minimal energy inputs, providing the oxygen-based ions needed to initiate water respiration. The water respiration pathway can convert the high-grade chemical energy stored in energized, biologically structured water into supplemental energy for cells. The water respiration theory based on interfacial structured water is revisited due to recent findings of superconductivity water properties. The contribution of energized BSW water to redox biology and water respiration can be associated with improved metabolic efficiency and enhanced physiological performance in all life forms. Finally, this article will review recent findings involving quantum biology and BSW water. When BSW water is confined in extremely small sites such as proton wires or water wires, the water properties take on strange quantum properties that stretch the accepted theories of chemistry and physics.

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1. INTRODUCTION

The first article in this three-part review of Biologically Structured Water (BSW) water will describe structured water (SW) and BSW water along with the associated water properties. Also, the first article will focus on the interplay between BSW water and bioenergetics, broadly defined as all aspects of energy related to biology. The second article in this series will review several natural and man-made SW water sources and how to monitor health-related biomarkers to evaluate any improvements in well-being or stress resilience. The second article will also cover BSW water and immunity to diseases. The third article in this series will review several methods to generate man-made SW water and several methods to verify the quality of the generated SW water. Finally, the third article will briefly outline the diverse relationships between BSW water, biological coherence, and super coherence.

Decades of water, SW, and BSW research have yet to fully acknowledge the unparalleled importance of BSW water for maintaining biological health and vitality, increasing longevity, and enhancing resilience to many biotic and abiotic stressors. The ongoing debate is partially due to the reductionist approach to fundamental sciences. Biological research typically involves highly complex, multi-factor study designs conducted under dynamic conditions with high uncertainty built into even the most straightforward studies. The complexity and uncertainty of biological research have much to do with the continuing debate on the biological effects and significance of BSW water. However, as scientific advances in knowledge and instruments unfold more puzzle pieces, the evidence is becoming more irrefutable that BSW water is essential for life, vigor, and well-being. A basic premise of BSW water is that under biological conditions, water structure is as important or more important than water content for maintaining metabolic, redox, signaling, energy, and coherence functions in most life forms. However, as animals or plants age or are exposed to high-stress levels, the BSW water content decreases, compromising the health and vitality of life. Given this general principle of BSW water reduction due to age and stress, an ensuing question is how to maintain adequate BSW levels during aging and stress exposure. This review will also offer several suggestions for increasing BSW levels in plants and animals. These suggestions are based on a holistic review of the scientific evidence for generating high-quality BSW water and rehydration treatments with natural and man-made SW water sources.

Structured water (SW) is defined as multiple water molecules joined by hydrogen bonds to form a range of molecular structures, from dimers to buckyball structures. The most common water structures range from dimers (two H_2O bonds) to hexamers (six H_2O molecules bonded together). The most common biological structures are pentamers and hexamer designs with five and six rings of H-bonded water molecules. Water research terms varied over its history, starting from anomalous and polywater to two-phase water, coherent domain water, activated water,H-bonded water, hexagonal water, low-density water, super-cooled water, polymeric water, clustered water, vitalized water, or energized water due to a researcher's preference for defining the multi-molecular water structures. Research terms used to describe BSW water have included membrane hydration water, vicinal water, interfacial water, tightly bound water, non-freezing water, glassy state, liquid crystalline, and exclusion zone (EZ) water. All these research terms for SW or BSW water are broadly defined, with vague descriptions. This review included most of these research terms to maximize the information collected from literature searches. These terms are relevant to water structure descriptors, resulting in more comprehensive research findings and sometimes revealing unique insights into this complex field of study. Other related fields of study for water research include vortexed, magnetized, or cold plasma-generated water. These water treatments typically increase water structure, resulting in water properties like BSW water properties. This review will use the term liquid water to refer to unstructured water, even though most sources of liquid water contain a varying percentage of structured water under ambient temperatures and pressures.

A recurring dilemma in research fields is finding umbrella terms that still need to be used in the basic sciences. For example, bioenergetics has already been defined as a subcategory of biochemistry that typically focuses on a limited set of energy relationships with biology. The energy relationships generally originate with stored chemical energy and energy derived from redox reactions such as electron exchange down electron transfer chains. A broader definition of bioenergetics should include other *in vivo* energy sources such as energy derived from energized

electrons returning to their base state, membrane potential, biomolecular vibrations/oscillations, resonance, piezoelectric/mechanical or even bioluminescence, which are all familiar biological sources. Many of these energy sources emit very weak or subtle electromagnetic field (EMF) waves, which are exceedingly difficult to measure and detect due to the variety of energy sources. The weak EMF fields combined with so many possible *in vivo* sources have baffled the best biological scientists. This intractable dilemma has been a source of many calls for pseudo-science and mysticism. However, recent bioenergetic research has shown that many weak or subtle EM fields exist *in vivo* and can be amplified, emitted, stored, and received to activate metabolic functions and achieve coherence in organisms. These bioenergetic findings will be reviewed in Part 3 of this article series. Several researchers have associated energy medicine with the much broader definition of bioenergetics described above [19 - 20]. The use of the bioenergetic term in this review will also be based on thebroad definition.

2. SHORT HISTORY OF STRUCTURED WATER (SW) AND BIOLOGICALLY STRUCTURED WATER (BSW)

The earliest pioneers in water chemistry interactions with biology can be traced back to Russian scientists in the 1800s [1]. In the 1930s, the pioneering work of Dr. Szent-Gyorgyi (Nobel Prize winner) was instrumental in discovering the importance of water and the redox exchange of electrons and protons in biology [1-2]. His pioneer work included brief forays into activated water as an alternate energy source for cells. However, this research was so innovative and controversial that it took almost another 80 years to be rediscovered. The cumulative advances in basic sciences have shed new light on the possibilities of water respiration in cells, which involves energized water molecules within BSW water. These recent advances will be explored in more detail in the last section of this article. In 1949, a study by Henniker [3] stated that water near hydrophilic surfaces forms a new water structure. The interfacial water in his research had properties much different than bulk water when measured in terms of refractive index, x-ray diffraction, viscosity, and adhesion. In the late 1960s, Russian researchers discovered “polywater” in narrow capillary tubes due to its unique water properties [4]. Shortly after this discovery, American scientists refuted their polywater claims as they tried to replicate the studies due to contaminants in the water. This was a significant setback in water research due to the counterclaims and professional fallout for the Russian scientists. It took another two decades before a French scientist named Benveniste claimed that water could be structured, and such “biologically active water” could be imprinted with “information” from biomolecule vibrations [2, 5]. Benveniste and his colleagues coined the term “water memory” and proposed a theory of imprinting energy-based resonance in water. When his water research was replicated by visiting scientists, the water memory results could not be re-confirmed [2]. The lack of replicated confirmation led to a prompt dismissal of the water memory theory by mainstream scientists. Another pioneer in SW and BSW water research was Dr. Gilbert Ling, who published his first paper in 1962 on the association induction hypothesis theory as an alternative to the membrane pump theory for the transport of ions across cell membranes. In 1965, Dr. Ling proposed the Polarized-Oriented Multilayer (PM or POM) theory of cell water. His POM theory claims that cell water is polarized, oriented, and thus dynamically structured [6-7]. Despite a 45-year struggle to recognize his research findings, Dr. Ling died in 2019, just one month short of 100 years old, without achieving notable success or credit for his pioneer work. In 1986, a Korean scientist named Dr. Mu Shik Jhon presented his structured water theory with his paper "Molecular Water Environment." After 25 years of studying structured water, he published a book in 2004 that was titled “The Water Puzzle and the Hexagonal Key.” His short book briefly describes structured or hexagonal water and its basic properties. His decades of research held him to conclude that aging in humans causes an irreplaceable loss in hexagonal water that results in many age-related diseases. Also, he claimed that as humans replenish or rehydrate with hexagonal water, there is an improvement in vitality, longevity, and resilience to diseases [8]. By the 1990s, research involving SW and BSW subjects became acceptable and worthy for scientists to receive funding and explore new avenues of investigation. Notable scientists who have advanced water research include Linus Pauling, Mae-Wan Ho, Gerald Pollack, Martin Chaplin, Luc Montagnier, Emilio Del Giudice, Giuliano Preparata, Claudio Messori, Ignore Smirnov, Vladimir Voeikov, and Ignat Ignatov. Short SW and BSW research histories exist in several articles [9-10] and books [2, 11-12].

The history of SW and BSW research is littered with remarkable claims and theories that were often met with skepticism or even hostile reactions that led to the

loss of their scientific reputations and the labeling of their findings as hoaxes. In many cases, the claims of pseudo-science for the early SW research findings were later found to contain a grain of truth. For example, the poly water claims mysteriously led to the fictional “ice nine” scare made famous in KurtVonnegut’s book Cat in the Cradle [12]. This pseudo-science episode was followed shortly after that by another radical claim when the French scientist Benveniste published his research on water memory. His theories were quickly denounced but were soon followed by two scientists who conducted independent research that also claimed variations on the water memory theme. The first scientist was Dr. Marcel Vogel, whose research with BM in the 1980s led to many discoveries in crystallography and liquid crystals. His research later became more radical as he researched the crystalline properties of ice and the liquid crystal nature of structured water as ice melted. His research became ever more radical when he proposed that crystalline structures such as liquid crystal water could store ‘information” that could be sent and received as signals [13]. Later, he became involved in collaborative research with Cleve Backster, which found a connection between structured water in plants and a plant’s ability to display conscious emotions or feelings in response to its environment using lie detector instruments [14-16]. Dr. Vogel’s research with plants culminated in a collaborative book titled “The Secret Life of Plants” [17]. Dr. Vogel’s more radical research on telecommunications and plant emotions/consciousness has been vehemently discredited over the intervening years. However, as with other venerated scientists such as Tesla, they eventually develop a mystique that borders on reverence, and decades later, their radical theories are rediscovered and found to be not so radical after all.

Several decades later, another scientist made a remarkable radical claim that biological water could store information that could be emitted as wave signals that mirrored the previous claims by Benveniste and Vogel. This researcher, however, was a Nobel laureate French scientist named Luc Montagnier, who previously discovered the genetic code for HIV. Using his renowned research skills, he designed an impeccable protocol to investigate the ability of biological water to receive and transmit DNA codes between two isolated test tubes [12]. His protocol involved a DNA fragment of HIV. He amplified the fragment using PCR until a DNA fragment was found with a detectable electromagnetic (EM) wave signal in a serial water dilution. This water was placed in a test tube, which was then placed next to a test tube filled with pure water [18]. The elaborate study protocol was designed to test specifically whether the EM waves emitted from the DNA fragment into the diluted water in the first test tube could be transmitted into the pure water in the second test tube. The second test tube contained all the ingredients to synthesize the original HIV DNA code, such as nucleotides, primers, and DNA polymerase enzyme. When placed together, the two tubes were exposed to amplified resonance waves known as Schumann resonance. After 18 hours of exposure to the amplified Schumann resonance, they found a single DNA fragment in the second test tube. Incredibly, the HIV fragment had a DNA sequence code that was 98% accurate to the DNA code in the first test tube. His test protocol was so well designed that his experiment was successfully replicated 12 out of 12 times [12]. His study was also repeated with other DNA fragments from the bacterium that causes Lyme disease. These findings were so radical and startling that it was promptly discredited and labeled as pseudo-science by many highly respected mainstream scientists. In the intervening years since Montagnier’s study, biological research has shown that all biomolecules, such as DNA, vibrate at specific frequencies and that these very weak or subtle EM energy waves can be amplified by resonance [12, 19-20].

The radical ideas and pseudo-science theories proposed by these pioneer scientists have quietly moved into mainstream science as researchers gained a better understanding of the broad field of investigation known as bioenergetics. These concepts of biomolecular vibrational energy, energy amplification by resonance, and synchronization of these EM waves into biological coherence as related to BSW water will be discussed in more detail in Part 3 of this review. The findings of these pioneer scientists were often deemed too radical for their times. Still, as biology and other related disciplines advanced and a holistic approach was taken to incorporate new findings related to BSW water from related research fields, radical theories have proven to have a verifiable scientific basis. This three-part review aims to collect, summarize, and synthesize the findings from different scientific disciplines to understand better the interplay between bioenergetics and BSW water and between BSW water and biological well-being. A secondary goal is to present enough verifiable scientific evidence on BSW water and its biological significance that there will be

fewer calls of pseudo-science and hoaxes than exhibited in the early history of SW and BSW water research. The volume of research related to BSW water is rapidly exploding, making reviewing the literature a monumental task. A comprehensive review of the BSW water literature would fill several book volumes; thus, this three-part review will only underscore the principal highlights and biological significance of BSW water. Several science-based books on BSW water and many others focus on the holistic aspects of BSW water as it relates to human health and well-being. This review's readers are encouraged to delve into the scientific literature and these books to get a much more detailed and in-depth understanding of BSW water than can be presented in this three-part article series.

3. DESCRIPTION OF STRUCTURED WATER AND COHERENT DOMAINS

After more than 50 years of water research, a widely accepted theory has emerged that states that liquid water is made up of two phases [21-26]. This theory suggests that water has a high-density phase (non-coherent and unstructured) and a low-density phase (coherent and structured) that exist together. Most forms of water contain a combination of structured and unstructured water under normal conditions. It can be confusing to differentiate between the two phases using density terms since structured water is sometimes called gel or liquid crystalline water, which has high viscosity properties. However, gel water can have higher viscosity but lower density than liquid water due to stronger H-bonds, which make the water less fluid. To remember that structured water is less dense, one can think of ice, which is 100% structured and has a crystalline lattice of hexagonal rings but is still less dense than unstructured water and, therefore, floats on top of it. When the H-bond strength increases to provide more structure to water, it becomes less fluid, with higher viscosity and less dense.

There still needs to be more disagreement about the specifics of water structure [25]. However, a growing consensus is that water has structure, especially under biological conditions [26]. Shi's recent water structure study [23] offers modeling and spectroscopic evidence that liquid water has two coherent or compatible phases. Different water structure theories tend to align or agree with the basic principles of a researcher's field of study. When considering water structure, distinguishing between natural or bulk water and water structure associated with life and biology is of utmost importance. Multiple energy fields and sources surround water in living organisms. When water is in intimate contact with energy fields, it naturally manifests into various water structures. These structures range in size and duration depending on the intensity and frequency of the energy fields and their duration. This review focuses on BSW water structure and its biological effects and is therefore inherently intentional about associating water structure with biological energy fields.

Structured water formation is a function of the hydrogen bond strength [28-31] or the number of hydrogen bonds [32-33]. Structured water can be created naturally in high-altitude streams, from glacial runoff, or by biological activation in cells. It is widely recognized in the research literature that stronger H-bonds have a higher stability under ambient conditions, i.e., weaker H-bonds tend to degrade faster and revert to unstructured water [28, 29]. Also, stronger H-bonds are associated with water structures with or by several different technology systems. All structured water formation or generation methods involve shortening H-bonds between water molecules [28-31]. As the H-bonds shorten and strengthen, the H-bond angles widen from 104.5 to 109.5º. Also, as H-bonds shorten, water molecules start to cluster into a range of structural designs, depending on the formation method. The H-bond strength is an almost linear relationship with the H-bond length between O-H [28, 29]. The H-bond length is just four picometers shorter between water molecules in ice than in liquid water, which is all needed to convert water from the liquid phase to the solid phase [28]. The hydrogen bond in water is part (about 90%) electrostatic and part (about 10%) electron sharing, which is covalent [30]. A trade-off exists between H-bond and covalent bond strength in water [30]. Based on the strength of bonding, hydrogen bonds have been classified as weak (with energies between−2.4 and −12 kcal/mol), strong (with energies between −12 and −24 kcal/mol), and very strong (with energies more than −24kcal/mol) [34]. Magnetic fields increase H-bond strength and increase water structure [35]. The strength of H-bonds in water is affected by electromagnetic and magnetic fields [30]. Magnetic fields weaken the van der Waals attraction between water molecules, thereby strengthening the H-bonds and increasing water structure [30].

The relationships among delocalized protons, H-bond strength, and water structure are still being investigated due to their deemed importance in biology

[9, 12, 29]. Due to several critical factors, the importance of delocalized protons in water structures is hard to over-emphasize. Delocalized protons are associated with proton hopping, superconductivity, and quantum tunneling across energy barriers [9, 12, 36-39]. The strength of the H-bond has important implications for proton transfer (PT) rates due to the proton-free energy profile and the PT energy barrier [9, 12]. Very weak H-bonds in free water are associated with single-well proton-free energy profiles and high proton transfer barriers. As the H-bond strength increases and the water becomes more structured, the proton-free energy profiles progress from asymmetric double-wells to symmetric double-wells with a concomitant decrease of the proton transfer barrier. In other words, as water becomes more structured, some protons have low energy barriers and, with negligible energy inputs, can join with H2O to form hydronium ions (H30), a carrier for H^+ [9, 12]. Also, delocalization energy in protons is associated with higher H-bond strength [29], and delocalization energy is defined as the extra stability of a molecular structure due to delocalized electrons. An excellent online scientific literature review of water, H-bonds, delocalization, and structured water, written by the eminent water scientist Martin Chaplin, provides much more detail on these subjects than can be covered in this review [40]. In summary, the degree of structure in water is strongly correlated with H-bond strength, which is also highly correlated with delocalized protons and electrons. The biological significance of delocalized, quasi-free electrons and protons in BSW water is emphasized by the unparalleled importance placed on redox reactions in current biological research. The relationships between redox biology and BSW water will be detailed later in this review.

Natural water sources, bulk water, or tap water all contain structured, unstructured, or liquid water based on the two-phase water theory [21-26]. As SW water research grew in the 1990s several scientists proposed a theory titled Coherent Domain for the SW water found in bulk water [18, 47-51]. According to this theory, bulk water contains Coherent Domains (CD) in water, which are clusters of water molecules linked by hydrogen bonds that are created as the molecules resonate with electromagnetic (EM) fields [9, 12, 41-52]. Coherent domains are small, approximately 1000 Å (0.1 μm), each containing about 5.5 million molecules [9, 12, 41 - 52]. As the water molecules oscillate in phase with an electromagnetic field, it creates a resonating cavity produced by the electromagnetic field that ends up trapping specific wavelengths in the field. The non-vanishing EM field doesn't dissipate, tends to resonate with other CDs coherently, and is available as an energy source for cellular or enzyme reactions. The energy field allows the coherent domain water molecules to flicker between two electron cloud configurations where themolecular electrons rapidly fluctuate between being strongly bound (ionization potential 12.60 eV) or entering an excited configuration (12.06 eV) in which one electron per molecule is "quasi-free" (9, 12]. The coherent domains exist in liquid water at ordinary temperature and pressure [41 - 52]. Each coherent domain contains millions of quasi-free electrons in the π orbital's that circle the ring structures of the H-bonded water molecules [9, 12]. Structured water containing coherent domains transforms ambient incoherent frequencies into a coherent high frequency that may be used for cell functions. [4-8, 11-13]. At a temperature of 30 C, structured water usually consists of a mixture of 40% CD structures and 60% incoherent bulk water, depending on how it was created or generated [11, 12]. In contrast, most animals have an average BSW water content of 20 to 30 %, with the remaining biological water classified as "free water" or unstructured water [54-55].

Based on the Quantum Electrodynamics (QED) field theory, the SW water scientists Preparata, Del Giudice, and others have proposed that bulk water is a two-phase system, a coherent (structured phase) and incoherent phase (unstructured phase) [8, 47-52]. The QED theory supports the ability of water in the coherent phase to oscillate between two electronic configurations in phase with a resonating EMF field. The CD becomes a resonating cavity produced by the EMF (a self-produced cavity resonator for the EMF) [42-43]. In other words, bulk water may convert into SW water by resonating with and collecting coherent EMF fields, which can be generated from either *in vivo* or environmental sources [41-53].

Real-world evidence of the interplay between bulk water, EMF energy, and the creation of SW water with CD domains has been investigated for lighting resonance in the ionosphere and ion cyclotron resonance studies. It is well known that energy released from lightning strikes on a global basis in the ionosphere creates the Schumann Resonance (SR) frequencies [56-60]. The Schumann Resonance frequencies range from 7.8, 14.1, 20.5, 26, 33, 39, and 45 Hz, but the fundamental frequency centers around 7

to 8 Hz. The alpha frequency of human brains also averages 7.8 Hz, which shows that humans are intimately connected to the fundamental SR frequency. The importance of this fundamental SR frequency is highlighted in the DNA replication study by Montagnier [12, 18]. In his study, DNA replication was only successful when a resonator coil with a 7.8 Hz frequency was activated in the first test tube. The other SR frequencies of importance range from 14 to 26 Hz, almost matching the Beta frequencies (12-25 Hz) in the brain. The significance of the Beta brain waves matching a section of the SR frequencies is that the Beta brain waves are associated with the cognitive state of consciousness and the outside world. Also, the Beta waves affect alertness, decision-making, and the ability to focus the mind. Due to the 11-year sun cycle, there is a recent surge in studying the association among sun flares, disruption of the SR resonance patterns, and brain activities [56-60].

Another set of landmark studies investigated the effects of Ion Cyclotron Resonance (ICR) on water structure [61 - 64]. The initial ICR study by Mohri *et al*. [61] found that hydronium ions (H_3O^+) resonate at 7.85 Hz, the primary Schumann Resonance wavelength. They found that a hydronium ion twin ICR radiation treatment added “self-organization” or structure to unstructured water. A similar study by D'Emilia*et al*. [62] investigated the effects of a hydronium ion (H_3O^+) ICR resonance treatment for unstructured water. They state that the ICR treatment increased the concentration of EZ water, which validates the pioneer study by Mohri *et al*. [61]. A second study by D'Emilia*et al*. [63] also investigated the effects of hydronium ion (H_3O^+) ICR resonance treatments on unstructured water. The ICR radiation treatment in the second study also increased water structure, confirming the first study's findings. These studies were followed by an applied research study in 2022 by Liguori *et al*. [64]. Their study involved ICR resonance treatments in a human clinical trial. The ICR resonance treatments included a set of frequencies applied in succession to the patients: 1.89, 7.88, 15.6, 30.44, and50.19 Hz at 15 min. spaced intervals. The frequencies included the Schumann Resonance (7.88 Hz) and several mineral ion frequencies in the sequential wavelength ICR treatment. They found that the intracellular water content, based on bio-impedance meter readings, was increased by the ICR treatment. Intracellular water in humans is virtually 100% BSW water, as will be discussed in further detail in Part 2 of this series. In summary, the wavelengths of these ICR resonance treatments match the Schumann Resonance of 7.8 Hz, and all four studies validate each other in that the ICR resonance treatments increased water structure. In addition, these findings hint that Schumann Resonance at 7.8 frequency may add structure to biological water, creating BSW water that can be imprinted with DNA oscillation codes. If this supposition is possible, then these findings also add substance and indirect evidence that the Montagnier DNA replication study may be based on real science after all [18]. The interactions between BSW water and biology-based or environmental energy fields would fill multiple book volumes. As previously stated, BSW water is immersed in a virtual ocean of energy fields profoundly affecting water structure and functionality. Part 3 of this review will briefly discuss the effects of energy fields on water structure and function, highlighting the most important relationships.

Recent SW studies used Transmission Electron Microscope (TEM), Atomic Force Microscopy (AFM), and Scanning Tunneling Microscopy (STM) to detect and image supramolecular water structures [65 - 68]. The first two studies took TEM and AFM images of CD domains in liquid water. The following four studies took molecular scale images of hexagonal water structures after liquid water was absorbed onto Cu, Ni, or Fe metal surfaces [65 - 68]. These four studies created SW water structures by attaching a molecular layer of water to the metal surfaces with kosmotropic water properties, i.e., they add structure to free water molecules [8]. The interaction energy for Cu, Ni, and Fe soluble ions with water in solution is +49.8, +51.0, and+51.9 kJ/mol. In contrast, the interaction energy for Ca and Na soluble ions is +32.3 and +3.3 kJ/mol, respectively [8]. The electrostatic attraction of these ions reduces water vibrations or movement, thereby increasing H-bond stability and water structure. The review article by Ho [65] shared TEM and AFM images of supramolecular water structures in liquid water. The AFM images revealed water supramolecules of various sizes and shapes that may comprise millions to billions of clustered water molecules. Each macro-molecule structure comprised much smaller “spheres” resembling CD domains. The supra-molecules had rod-like or spiral helical structures with soft, gel-like properties, and the structures were stable for weeks or months at room temperature and pressure [9]. The TEM images revealed that the spheres' outer shell was electron-dense, indicating that the outer shells were a cloud of quasi-free electrons [9]. The TEM images provide direct evidence that the smaller spheres were

probably CD domains that contained rings of water molecules with delocalized electrons in t *pi Orbital's* that acted as quasi-free electrons [9]. It is reasonable to assume that the TEM images show the π electrons circling each hexagonal water ring and that each 10 nm dia. CD may contain millions of water molecules. This vortex of negative electrons also attracts a vortexs warm of positive protons (H+) in the liquid water interface between each CD sphere. These two vortex swarms of quasi-free electrons and protons form the basis of the astonishing redox properties of SW and BSW water. The TEM scans are taken with a high-energy electron beam. The images become darker if the electron beam is scattered due to a dense or electron-dense surface. The darker the TEM image, the denser the atom or the higher the electron density of the scanned surface. The TEM scans shared by Ho[65] show that the CD water spheres have a dark surface, indicating that the water clusters have a shell of quasi-free electrons swarming the surface of each CD sphere or shape (Figure. **1**).

A similar but independent SW trial to the Cardarella *et al*. study reviewed by Ho [65] study was conducted at the Konovalov lab in Russia [27]. They also found supra-molecular structures in serially diluted water that formed when exposed to EMF fields [27, 9]. They also took AFM images of the supra-molecules, which produced images of rods and spiral-helical structures like the study reviewed by Ho [65]. In addition to these pioneer SW water studies, three other studies have also used AFM and STM microscopy to take much more magnified images at the molecular scale of the hexagonal ringed structures in SW water. The STM studies by Gerrad *et al*. [66] and Merte *et al*. [67] and the AFM study by Shioteri and Sugimoto [68] (Figure. **2**) all produced molecular images of hexagonal water structures. These AFM and STM images revealed that pentameric and hexamer nanosized water structures can be created using kosmotropic metal surfaces. Another ATF study by Ma *et al*. [69] revealed ice's hexamer or hexagonal two-dimensional (2D) water structure. They concluded that 3D AFM images of ice would be extremely difficult to image. However, they postulated that dangling H-bonds from a single, 2D ice layer could seed the growth into multiple layers of hexagonal-ringed ice structures.

4. COHERENT DOMAINS AND LIQUID WATER

Several scientists from Del Guidice and his co-authors [47 - 52], Pollack *et al*. [11, 71, 79-82], and Ho *et al*. [9, 12, 83-84] have postulated and presented evidence that the concentration of CD domains in liquid water and natural water sources can increase after exposure to EMF radiation. A literature search on SW water reveals examples of liquid water treatments and natural water sources with higher concentrations of structured water. These articles provide direct evidence that liquid water can have a wide range of SW water and show that SW natural water samples can be stable over long periods. The QED theory postulates that EMF fields can increase overall water structure by increasing the concentration of CD domains in liquid water [47-52]. The EMF fields originate from the sun in the form of infrared and red-light wavelengths. They also indirectly originate from SR resonance frequencies due to lightning strikes that ultimately get their energy from the sun.

An imaginative study by Madl *et al*. [70] investigated the coherence water properties of waterfall mist collected from the Austrian Alps. The co-authors of this study included Del Giudice and Voeikov, which

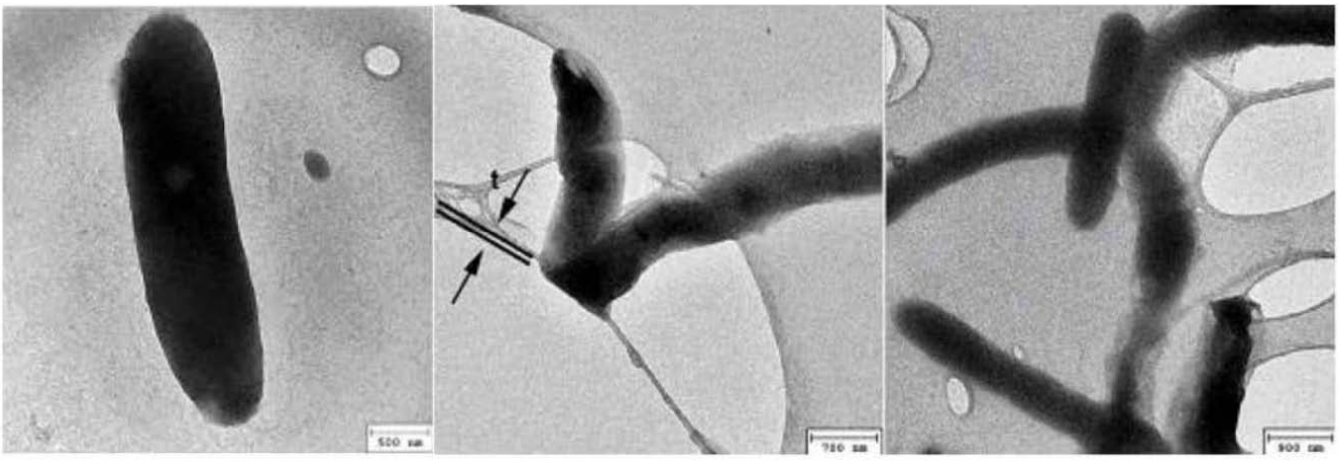

Figure 1: Transmission electron microscopy (TEM) images of supramolecular water clusters [65].

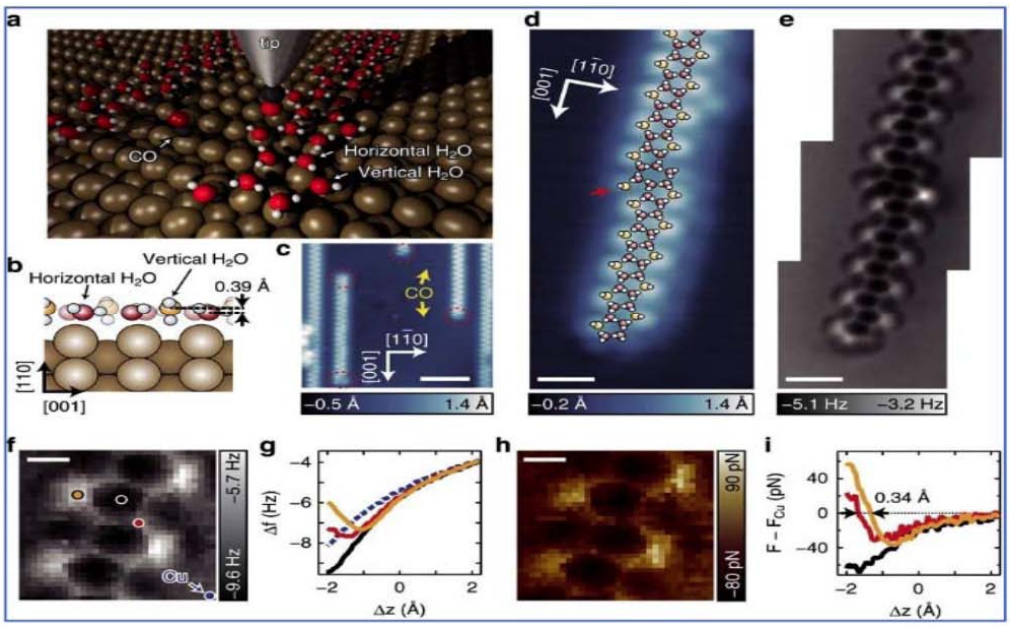

Figure 2: Images of AFM microscopy of water structures on Cu surface [68].

a) Schematic of STM/AFM measurement for pentagonal water chains on Cu(110) with a CO-terminal tip. Red, black, white, and brown spheres show O, C, H, and Cu atoms, respectively. (**b**) Side-view schematic of the water chain 22. Red (yellow) spheres represent O atoms of horizontal (vertical) H_2O. (**c**) STM image of the water chains on Cu(110) with a CO-terminal tip (sample bias V=30 mV, tunnelling current I=20 pA). The zigzag chains have terminals (red ellipses). (**d**,**e**) STM (V=30 mV, I=20 pA) and AFM (V=0 mV, oscillation amplitude A=2 Å) images, respectively, of a water chain including a kink and a terminal. An atomic structure of the chain is superposed in **d**. The other possible structure is shown in Figure. **5**. The tip height in **e** was set over the bare surface under the same conditions as in **d**. (**f**) Δf map of the pentagonal chain at a tip height Δz=−2 Å (A=1 Å). (**g**) $\Delta f(\Delta z)$ curves recorded over the markers in **f**. (**h**) Force map of the chain at Δz=−1.95 Å after subtraction of the force for the bare surface F_{Cu}. (**i**) Force curves over the makers in **f** after subtraction of $F_{Cu}(\Delta z)$. Scale bars, 50 Å (**c**); 10 Å (**d**,**e**); 3 Å (**f**,**h**).

explains the continued relevance of their findings even today on coherent domains and SW water properties in natural water droplets and cloud formation dynamics. They found that the waterfall mist had two size categories: small droplets averaging a “few hundred water molecules” and a larger set of droplets containing millions of molecules [70]. These 100 nm droplets had a strong negative ionic charge yet remained stable enough to travel over half a kilometer with minimal losses. They postulated that the larger droplets had SW properties that were aggregates of CD domains. A conceptual paper by Pollack [71] postulated that CD droplets did not disperse due to their negatively charged surfaces due to a proton vortex formed in the liquid water adjacent to each CD sphere. In other words, the negatively charged CD was attracted to the positive-charged proton outer shell formed in the liquid water adjacent to each CD domain. A study by Yablonskaya *et al*. [72] investigated the effects of infrared radiation on humid water vapor passing over liquid water. They found that the surface of the liquid water had SW properties. Two other studies by Dombrovsky *et al*. [73-74] found that infrared radiation stabilized water clusters. A study by Rosen field and Woodley [75] found that cirrus clouds contained stabilized, super cooled water levels at 1.8 g/cubic m at-37.5 C with an average droplet size of 17 µm. Super cooled water at this temperature is virtually 100% hexagonal-ringed SW water [8].Together, the findings from all these studies suggest that cloud formation may start with the condensation of vapor into liquid water molecules that could readily form more stable CD spheres when exposed to IR and UV radiation. Finally, these stable CD spheres may coalesce into larger 10 nm aggregates, such as the waterfall droplets mentioned by Madl *et al*. [70], due to the electron attraction to the proton shells surrounding each CD. This mechanism for cloud formation was postulated by Pollack and hinted at by others, but the SW concept has not been well received by other water and atmospheric researchers.

Density Functional Theory (DFT) is a computational quantum mechanical modeling method used to investigate the electronic structure of molecules in their ground state [76]. Recent studies, however, have tested add-on functions to the DF algorithms to simulate electron density distributions for energized

molecules [77]. Several researchers have used modified DFT programs to simulate the H-bonding in a range of water structures. The DFT findings are technical and not geared toward the general public. Some exciting findings from the DFT studies by Zhang *et al*. [78] and Tao *et al*. [29] suggest that charge transfer among the molecular structures significantly influenced delocalization energy in the water structures. Charge transfer may occur when higher concentrations of H+ or OH- ions are present in the water sample. Both authors state that computed values of delocalization energy impact H-bonds and may favor stronger H-bonds depending on the water structure configuration. Most of the literature shows that when liquid water is exposed to different EMF frequencies, the energy input can alter H-bonding patterns in liquid water. The energy inputs can increase water structure in liquid water depending on the energy intensity, frequency, and exposure time. Different methods of generating structured water will be presented in Part 3 of this series.

5. BIOLOGICALLY STRUCTURED WATER

A broad-based literature search for BSW water reveals a wide diversity of research interests and that BSW water is essential to all plant and animal life forms. Agricultural research covers many aspects of BSW water, such as bound water in fruits and grains that need to be removed in the drying process to ensure longer storage life [85 - 86]. Also, BSW water research shows up in studies investigating extreme drought-tolerant plants and in extreme cold-tolerant aquatic animals and fish [87-90]. Even the latest research with non-invasive monitoring of human hydration levels with terahertz spectroscopy shows that BSW water is present at most cellular interfaces [91-94]. The literature appears unanimous that *in vivo* biological water at the interfacial cell surfaces has unique water properties and functions. However, even after decades of research involving BSW water, there is still much disagreement and controversy over many essential aspects of BSW water. For example, the actual structure of the interfacial water layer is far from settled, the mechanisms for strong adherence of water molecules to lipid membranes, or the properties of BSW water such as viscosity, membrane potential, or freezing point. The functionality of BSW water is still a nascent field of study, including all aspects of redox biology, such as membrane potential and ion exclusion, membrane stability and integrity, protein folding chaperons, conversion of low-grade energy forms into high-grade useful energy, coherence, and super-coherence. A comprehensive review of the biological functions of BSW water is well beyond the scope of several review articles due to a flood of recent research findings related to this subject.

Two types of BSW structures depend on the surface features and functions of the specific BSW biological role. The first type of structure is a self-assembled lattice of stacked sheets of H-bonded hexamer rings of water molecules with semi-crystalline properties that cover cell membranes. The second type of structure hydrates and stabilizes biomolecules such as proteins and DNA. These second structures are generally more string-like and can mold into the microsites of protein folds and DNA grooves.

The self-assembly property of BSW water is an overlooked but important feature that ensures the repeated crystalline structure is maintained as the interfacial water grows in depth or covers newly developed membrane areas. An AFM study by Ma *et al*. [69] took AFM images of ice edges to elucidate how hexamer water structures grew at the edges of the 2D ice crystals. Two quantum computational studies by Nilsson and Pettersson [95] and Tao *et al*. [29] also investigated how H-bonded hexamer water rings self-assembled into liquid or ice 2D crystalline sheets. They both state that the computational complexity of modeling H-bonding dynamics in water 3D crystalline structures is virtually impossible with current computer hardware and speeds. Malkin *et al*. [96] found that when super cooled water was allowed to freeze into ice, the resulting ice structures were hexamer rings. Still, the ice didn't possess hexagonal symmetry or crystalline properties. It may be possible that the self-assembly of SW water into 3D liquid crystalline structures requires resonance patterns only present in biological "*in vivo*" conditions. Based on their H-bonding dynamics, liquid crystalline hexamer structures self-assemble in BSW interfacial water. However, the self-assembly of BSW water and 3D crystalline growth in BSW water is still an unexplored research topic.

Del Guidice and co-researchers [47-52] postulated that CD water structures in liquid water could be converted into BSW water as the CD domains come into direct contact with lipid surfaces that cover cell surfaces. The findings by Pollack *et al*. [11, 71, 79-82] conclude that BSW interfacial water forms an Exclusion Zone (EZ) zone on membrane surfaces. He proposed that the BSW water in the EZ interfacial zone forms a lattice of multi-layers of sheets of hexagonal ringed

water molecules, all H-bonded together [11, 71, 79 - 82]. A study by Zheng *et al*. [97] estimated that EZ water zones could contain up to a million (10^6) stacked crystalline sheets of H-bonded hexagonal water rings. These stacked crystalline layers of hexagonal water rings have delocalized π electrons orbiting all six water molecules above and below each ring. Pollack has published a book and an article that includes microscopic images of EZ zones on Nafion surfaces that excluded microspheres, have a measured depth of up to 250 μm, and have a peak light absorption of 270 nm [11, 82]. A recent study by Sharma *et al*. [98] reconfirmed that strongly hydrophilic surfaces such as Nafion, ghee (clarified butter), and cellulose paper (What man filter paper) can produce EZ water in the liquid and solid state. Their study used UV spectrometry to verify that the spectral signature of the EZ water was about 270 - 280 nm.

The BSW interfacial zone is a liquid crystalline water zone that consists of staked sheets of H-bonded hexagonal water rings [11, 71, 79-82]. The concept of BSW water is not widely accepted, and many have been openly critical of the premise that interfacial water consists of stacked sheets of H-bonded hexamer water rings that cover biological membranes up to 250 μm. In defense of the hexamer water rings, it is widely recognized that molecules in ring structures are in a minimum energy state. Also, the hexamer water rings allow the π electrons to be delocalized and, therefore, have quantum properties, such as tunneling and superconducting speeds, that we are just now discovering. A third advantage of hexamer structures is that they are one of the strongest designs in nature. Hexagonal rings fill a 2D surface with equal-sized units with no wasted space. Nature offers many examples of hexagonal crystals and structures, such as arsenic, quartz, dolomite, emerald, graphite, ruby and ice crystals, and honeycombs constructed by bees [99]. These design properties perfectly align with biological needs for cell membrane stability, durability, protection, metabolic redox functions, bioenergetics, and coherence. Another critique of EZ water is whether the sheets of H-bond hexamer water rings can be stacked, much like the 3D layers of H-bonded ice. As of yet, there are no 3D microscopy images of liquid crystalline structured water due to instrument limitations. However, a 3D graphic image of ice layers has been published by Yang *et al*. [100] (Figure. **3**).

A quantum computational study by Segarra-Marti *et al*. [101] investigated if computational models of anionic and neutral hexamer structures could be π stacked and still have the spectral signature of SW hexagonal ringed water. Their computations revealed that a set of two hexamer rings could be stacked on top of another two hexamer rings if the rings had a neutral charge. In addition, they found that the computational spectral signature was 271 nm, which matched the experimental spectral signature of EZ water, which is 270 nm. This ultra-violet spectral signature is the peak absorption wavelength measured in most of the EZ experiments by Pollack [11, 71, 79-82]. These computational findings contradict critics claiming that EZ zones would create charge displacement based on a colloid dispersion theory (DLVO theory) that uses zeta potential to explain colloid interactions [25].

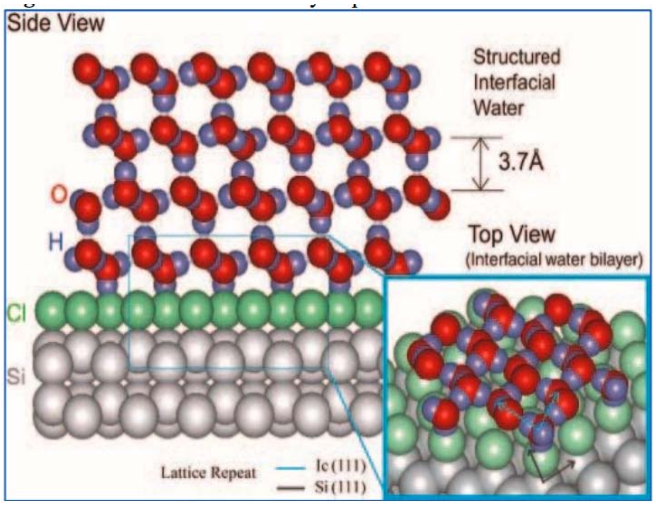

Figure 3: Structured water on a hydrophilic interface.

The chlorine termination on a Si(111) substrate forms a hydrophilic layer that orients the water bilayer. The closest packing distance (4.43 Å) between oxygen atoms in the bottom layer of water is similar to thelength (4.50 Å) between the on-top and interstitial sites of the chlorine layer, resulting in specific bilayer orientations (_30°) with respect to the silicon substrate. This ordered stacking persists for three to four bilayers (_1nm) before disorientation takes place and results in crystallite islands, forming the layered structure. The size of atoms is not to scale for the van der Waals radii.

Liquid crystalline water has an orientational order in each 2D sheet consisting of hexagonal-ringed water molecules that are H-bonded to the adjacent rings. Liquid crystals have birefringence properties that can be measured with a polarized light microscope. Crystalline structures can be detected with polarized light using bire fringent methods that can measure different indices of light refraction [102-104]. The liquid crystalline property of BSW interfacial water can be evaluated using polarized light microscopes to test the birefringence of the BSW water zone. In a paper by Ho *et al*. [102], they state a linear relationship between

birefringence and molecular alignment order parameters for nematic liquid crystals, which is an excellent first approximation to biological polymers. Three studies tested EZ water and found that it exhibited birefringence properties, indicating that their water samples had liquid crystalline properties [102-104]. Several researchers have noted that Nafion and metal surfaces also show birefringent properties. Thus, differential light refraction is not an accurate method for testing liquid crystalline properties.

The validity of SW and BSW water structures should be judged from the findings of studies that used a wide variety of methods to determine the degree of structure in the water, including IR spectroscopy, NMR, birefringent, pH, electrical conductivity, and viscosity. The Exclusion Zone theory postulated by Dr. Pollack states that even ions are excluded from the EZ zone [11].The EZ zone on cell membranes has a negative charge due to the negative charge of the membrane. Also, the negative charge of the EZ liquid crystalline lattice excludes protons, which immediately react with water molecules to form hydronium ions (H_3O+). The hydronium ions form an interfacial water zone outside and adjacent to the EZ water zone and have a very low pH due to excess protons. A study by Pollack [11] tested the pH gradient across an EZ zone on a Nafion surface. They found that the pH dropped from about6.5 to 3 within 20 s when measured 1 mm from the Nafion surface and then returned to about 5.5 after 60s. Also, the pH dropped from 6.5 to 4 after 30 s of the water touching the Nafion surface and returned to 5.5 after 60 s. Since the pH is on a logarithmic scale, a 3-unit drop in pH is equivalent to a thousand-fold increase in proton concentration within 1 mm of the Nafion surface [11]. This narrow zone of hydronium ions interfaces with the EZ zone that interfaces with the cell membrane. These findings confirm the Exclusion Zone theory of exclusion of even hydronium ions (H_3O+) from the negatively charged EZ zone. The two negative and positive charged water zones next to cell membranes act as a chemical battery that stores electrical energy that could be used as a supplemental energy source for cell energy needs [11].

Structured water in CD spheres or rods in liquid water has different density and viscosity properties than BSW interfacial water that covers membrane surfaces. The density of SW water with a CD sphere is lower than liquid water, but the BSW interfacial water density is higher than liquid water [8]. Interfacial water within the EZ water zone is a dense lattice of thousands of sheets of H-bonded water rings. Also, the viscosity of the BSW interfacial water is a challenge to measure with non-invasive methods. A review by Kunzek*et al*. [105] states that the viscosity of a glassy state, or tightly bound water, in plant tissue can reach 1,013,000 mPa s.Sun [106] estimated the viscosity of tightly bound water in red oak (*Quercus rubra*) seeds. He estimated the viscosity of the tightly bound water to be 600 mPa·s, or about 600x the viscosity of liquid water, which is 0.89 mPa·s. A living cell viscosity study by Berret [107] used microwire rotation inside cells to test for viscosity inside HeLa cells. He found that the intercell viscosity reached 32,000 to 78,000 mPa·s, which is substantially higher than the viscosity of tightly bound water determined by Sun [106].One possible explanation for the differences in BSW water viscosity between the two experiments is that the Berret study used magnets known to increase water structure and thereby increase cell viscosity levels. Another possible explanation is that the red oak seeds were dormant, where cells were not actively respiring or growing, while the HeLa cells were actively respiring. These findings indicate that bound or interfacial water has a much higher viscosity than liquid water. The higher viscosity in these studies is strong evidence that the BSW water in the interfacial, or bound water zone, has a liquid crystalline structure. This BSW interfacial water has heavy gel-like properties due to the stacked layers of H-bonded, hexagonal-ringed sheets. However, the methods used in these studies show that taking *in vivo* measurements of an extremely small zone of BSW interfacial water has been a significant challenge so far. The recent use of terahertz spectroscopy to conduct non-destructive and non-invasive measurements of BSW interfacial water shows promise. Still, it also has limitations in scanning water layers up to 300 μm in depth.

There is abundant food processing literature about tightly bound water in plant and animal tissue. However, water researchers are still searching for a theory explaining how water can adhere tightly to lipid membranes. Logically, water should not adhere to the membrane surfaces due to electrostatic repulsion forces between the negative surface charge of lipid membranes and the negative charge of BSW interfacial, or EZ water zone. The outward-facing heads of the lipid molecules are negatively charged “polar’ heads, which electrostatically repel the negative charges within the EZ water. Two unconventional theories have been proposed to address the electrostatic repulsion issue. Pollack has proposed that

a monolayer of protons (H+) is sandwiched between the lipid membrane and the EZ water zone. This monolayer of protons would be the "glue" that allows BSW interfacial or EZ water to adhere to the lipid membrane surface. The second and possibly more promising theory has been advanced by Del Giudice and Voeikov [108]. Based on the QED theory, they proposed the Resonance Attraction Theory based on mutual resonance between the BSW interfacial, or EZ water zone and the lipid membrane. They postulated that the electrostatic repulsion forces could be overcome if the oscillations of a nearby CD sphere become locked in phase with the resonant waves emitted by the membrane surface. Due to resonance attraction forces, the CD sphere adheres to the lipid surface and morphs into a flattened liquid crystalline structure, forming the EZ water zone that interfaces with the membrane [109]. This theory proposes that the coherent resonance between the lipid membrane and BSW water frequencies is the 'glue" that allows the interfacial water to adhere to the lipid surfaces. The in-phase resonance between the EZ interfacial water and lipid membrane weakens with distance but is quite strong at the membrane surface.

Adherence of BSW water to proteins and nucleic acids is assumed to follow the first principles of electrostatics, in which opposite charges attract each other. Several articles suggest that BSW water is critical in the self-assembly process of folding proteins into a precise 4D structure to function [110 - 114] properly. Although the correct minimal-energy folding information is coded in the physicochemical properties of their amino acid sequence, misfolded proteins can be a frequent occurrence if not correctly hydrated. Misfolded proteins are almost always non-functional and are water-insoluble, which accumulate in the cell. Misfolded proteins accumulate as amyloid deposits that may progress into numerous human diseases, *including many* neurological disorders such as dementia, Alzheimer's, Parkinson's disease, and diabetes. BSW water appears to hydrate microsites within the protein folds, thereby assisting with folding. In addition, the strong H-bonds within the BSW water-ringed structures ensure enough stability to maintain the integrity of the 4D protein structure. Evidence of the ability of BSW water to provide stability to proteins and DNA has a long research record [110-114].

The instability of the DNA spiral helical structure leads to breaks in the DNA, which increase in frequency as humans age [114-116]. The strength of the H-bonds in the hydration layer of DNA or proteins shows that the water molecules are highly bonded together [117-118]. A study by Jhon [8] found that 62% of the interfacial water next to DNA and proteins is hexagonal, ring-structured water. He also found that DNA hydration water, or BSW interfacial water on normal DNA that he labeled “B-DNA,” stabilized the helical structure of DNA. In his study, the abnormal DNA, or “Z-DNA,” was distorted and had fewer water molecules hydrating the DNA spiral grooves [8].The typical structure of DNA resembles the 4D structure of proteins, i.e., only when the chromosomes are dividing does DNA revert to the coil helical structure. The ability of BSW water to provide stability to the 4D structure of DNA may be as important or more important than the stability of the 3D helical structure of DNA as it initiates the transcription process for coding RNA.

6. BIOLOGICALLY STRUCTURED WATER AND BIOENERGETICS

As mentioned earlier, BSW water and bioenergetics are strongly linked together. The structure and functioning of BSW water are dependent on the energy sources, strength, resonance, and patterns present across all levels of life, from individual cells to entire organisms. It is possible that the dynamics of BSW water influence bioenergetics, as it is derived from the complex interplay of energy within living organisms. This section of Part 1 will argue that the overall dynamics of BSW water play a significant role in contributing to bioenergetics across all life scales.

The broad definition of bioenergetics includes all biological energy sources such as energized electrons, membrane potential, biomolecular vibrations/ oscillations, resonance, piezoelectric/mechanical, and bioluminescence. However, it is universally accepted that cell mitochondria are the only source of cell energy via ADP to ATP and NAD+ to NADH for the daily energy requirements for humans, based on kcal/day, are estimated solely on the consumption of O_2 that is used in the aerobic respiration pathway. Energy balance is defined as the balance of calories consumed through eating and drinking (energy in) compared to calories burned through physical activity (energy out). Energy balance assumes that aerobic respiration supplies the energy needs (energy in) at the cell level. Energy homeostasis can be broadly defined as the biological process that coordinates the homeostatic regulation of energy intake and energy expenditure. This broad definition of energy homeostasis allows other energy sources to contribute to the cumulative

energy input. Scientists with alternative bioenergetic theories have realized that a more realistic estimate of total energy requirements is needed to account for all the energy requirements to maintain healthy cells [10, 19, 41, 47-50, 79-81, 119-123].

A concept paper by Herreraet al. [119] estimated that mitochondria turnover rates for ATP were insufficient to meet the average energy requirements for humans. The Physiopedia website states that the average human recycles enough ATP daily to match their weight [120]. They also state that each ATP molecule should be recycled about 1,000 to 1,500 times to meet these daily energy requirements [120]. Sinclair [121] estimates that a 50 kg person would require approximately 50 kg of ATP daily. The molecular weight of ATP is 507.18 g/mol. Therefore, 50 kg of ATPis equivalent to 98.6 moles of ATP. In other words, a 50 kg human must recycle about 5.9 x 10^25 molecules of ATP daily to meet their daily energy requirement. If these ATP recycling estimates are approximate, then this is an enormous physiological burden to maintain energy homeostasis in humans.

A concept paper by Ivanov [122] proposes five significant challenges to the current energy balance tenets. His first challenge is that all life forms appear to have much higher cell energy requirements that need to be accounted for by biological scientists. He listed several examples, including energy needs for protein synthesis in the human liver (52% of the liver's total energy budget). Also, the human brain consumes about 16 to 18% of the total energy budget for the average person. His second challenge is that all energy is funneled into a few energy biomolecules, such as ATP and NADH, creating a bottleneck for cell availability. Also, the energy efficiency of converting glucose into energized ATP bonds is about 38.3% [122].His critique is that efficiency rates should be included in all energy input models. His third observation includes the total environmental energy costs, such as human food, clothing, and shelter. His fourth critique circles back to the overall energy efficiency issues, with a high percentage of the energy inputs being converted into heat.This argument is a variation of his second challenge. However, more research must be devoted to possible mechanisms or biological methods of capturing, storing, and converting excess or waste cell energy into high-grade energy for reuse to meet cell energy needs. Possible avenues for capturing, storing, and converting unusable energy into useful energy through BSW water structure and functions will be explored in later sections of this review. His fifth challenge is why so many examples of life require little to no energy consumption. His examples include lungfish that survive ten years buried in mud or dormant seeds that can survive hundreds of years. The mysteries of animal hibernation, seed dormancy, and extreme plant desiccation are still being explored to understand better how life can be maintained with so little energy consumption. His overall argument is that our knowledge about total biological energy inputs and outputs, aka bioenergetics, needs to be revised, which is very evident by conducting the most basic literature search within this field of research.

The premise that biological energy requirements are higher than acknowledged appeared to have merit. Therefore, any research that could increase or enhance biological energy generation, capture, storage, and convert useless energy back into useful energy would be very valuable indeed. The literature on BSW water implicates several avenues of supplementing or enhancing energy generation, capture, storage, and energy upgrading by replenishing BSW water levels. The following section in Part 1 concisely reviews several BSW-linked pathways or functions that hold promise for supplementing or enhancing cell energy levels. In addition, Part 2 of this review will directly address how to replenish BSW water levels in humans, animals, and plants.

7. ALTERNATIVE ENERGY SOURCES

A review of BSW water functions associated with increasing bioenergetic levels should also include a section on how environmental stressors may harm or reduce BSW water levels in organisms. The first step is to understand better what chemicals may be harmful or have the potential to lower BSW water levels. Aging tends to reduce BSW water levels, but exposure to toxic chemicals or other stressors will accelerate the loss in BSW levels. Two approaches to reducing harm to human health are linked to the BSW interfacial water zone. The first approach is to reduce harmful chemicals and EMF fields that decrease water structure. The second approach is to replace/recycle senescent or zombie mitochondria with new cells that can maintain their BSW interfacial water zones at adequate membrane potentials.

Structure-making and structure-breaking properties of soluble ions and even organic molecules can increase or reduce water structure [8, 54].Multi-charged

cations such as Zn^{2+}, Ni^{2+}, Fe^{3+}, Ca^{2+}, Na^{2+}, Mn^{2+}, Li^{+}, and Cu^{2}+ have positive interaction energy and add structure to water. Large, positively charged ions hold water molecules more tightly, allowing less molecular movement and H-bonds to strengthen and add water structure [8].In addition, organic biomolecules such as taurine, proline, and glycine betaine also add structure to water. Structure-breaking ions include Al^{3+} and Mg^{2+} because they are much smaller cations than mentioned above. Other structure-breaking anionic ions include Cl^{-}, Fl^{-}, Br^{-}, and I^{-} also reduce water structure [8].Unfortunately, most municipal wastewater treatment plants add fluoride and chlorine to water to disinfect the bio-contaminants before being released for household use. Prolonged use of fluorinated and chlorinated drinking water may reduce BSW water structure unless the water is filtered before drinking. Aluminum has a high water-breaking ability in many household products, such as beverage cans, pots and pans, and foil. In addition, aluminum is in personal products, such as antacids, food additives, cosmetics, and antiperspirants, which places this Al^{3+} ion in immediate human contact or even human consumption.

A related medical issue with BSW interfacial water is the effect of general anesthesia on water structure. A local and general anesthesia study by Kundacina *et al*.[123] (also co-authored by Dr. Pollack) found that all three of the test anesthesia reduced the size of EZ water zones. Their findings are direct evidence that BSW interfacial water, super coherence, and pain signals are interrelated, which will be discussed in more detail in Part 3. Also, three studies by Ueda *et al*. [124-126] found that general anesthesia released non-freezable, or bound water, from membrane surfaces. These studies and others [127-131] indicate that BSW interfacial water plays a crucial role in pain signaling or consciousness of pain. These findings open more questions about the temporary dynamics of the release of bound/interfacial water and when the EZ zone starts to rebuild and return to its healthy status. These studies suggest that general anesthesia disrupts BSW interfacial water enough that an open-heart surgery patient will remain unconscious and pain-free during the hours-long operation. A complete understanding of the interplay between BSW water and loss of consciousness is still being determined and needs more research. However, the connection between anesthesia and unconsciousness begs the larger question about the overall effects of BSW water, super coherence, and consciousness that has caught the interest of other researchers [127-131].Is it possible to directly manipulate the coherence of BSW interfacial water and induce unconsciousness without relying on general anesthesia drugs that work well but have deleterious recovery issues? The links between BSW water, super coherence, and consciousness will be explored in Part 3.

In addition to soluble ions and anesthesia's ability to disrupt or reduce BSW interfacial water, other studies show that different EMF frequencies also exhibit "structure making" and "structure breaking" properties concerning water structure. As mentioned previously, good evidence exists that the fundamental Schuman frequency of 7.8 Hz increases water structure [27, 61-63]. Additional studies also studied the effects of ELF frequencies on water structure [132-134]. In general, the low end of extremely low frequencies (ELF) between 1 and 300 Hz appears to be able to resonate with water and increase its structural properties. However, water structure decreases as EMF frequencies increase into the gigahertz range. A water microwave study by Rao *et al*. [135] studied the effects of gigahertz frequencies (2.45 GHz) reduced water structure by altering bond vibrations in the O-H bonds in water molecules. Also, Yakunov *et al*. [136] found that microwave frequencies (2.45 GHz) reduced water structure. These studies investigated the microwave frequencies of older cell phones (2.4 GHz), which can potentially reduce EZ water zones in humans, depending on exposure dynamics. Newer 5G cell phones emit microwaves at 20 - 60 GHz frequencies, fast enough to disrupt covalent bonds in water molecules. A 5G microwave review paper by Seker and Simsek [137] states that 60 GHz frequencies can disrupt the molecular structure of water. A recent study by Kalantaryan*et al*. [138*]says that water exposed to51 GHz microwave frequencies disrupted the "hexagonal structure" of water. They also concluded that the resonance spectra of malignant breast tumors peaked at 51 GHz microwave frequencies. Several other studies have also indicated that microwave frequencies from 20 to 60 GHz disrupt H-bonding dynamics in water [139-142]. Together, the findings in these studies indicate that EMF wavelengths can have a profound effect on BSW water structure that also has implications for BSW water functions and health status.

Finally, recent research on aging shows that metabolic dysfunction leads to disruption of cytosolic NAD+/NADH ratios, production of reactive oxygen species, and accumulation of structure-making ions (Cu^{2+}, Fe^{3+}, Zn^{2+}) [1-2] in senescent or zombie cells

[143 - 146]. Senescent cells have high metabolic rates but lose their ability to divide and reproduce, thus increasing the rate of aging in organisms [143-146]. A study on aging and dehydration by Bonatto*et al*. [147] found that intracellular water volume increases. However, they also concluded that the low-density, structured water portion of the intracellular water decreased in volume, while the high-density, unstructured water increased in the intracellular water. Also, a red blood cell study by Minton [148] found that intracellular water loss due to aging and dehydration leads to protein aggregation and dysfunction. He proposes that aging and dehydration with commitment loss in intracellular water may result in cell senescence or zombie cells [148].Aging and dehydration literature suggests that BSW intracellular water decreases with overall dehydration levels. Unfortunately, senescent or zombie cells are resistant to autophagy and apoptosis pathways. It is unclear whether rehydration therapy will restore the senescent/zombie cells to health or whether fasting and exercise are preferred to activate autophagy and apoptosis and recycle senescent cells.

8. BIOENERGETICS, BSW WATER, CELL MEMBRANE POTENTIAL

There are numerous ways that BSW water can contribute as an alternative energy source for cell energy requirements. These energy sources include conducting piezoelectric currents, emitting biophotons, and free-floating CD spheres that may collect, store, and release EMF energy back into the cells. This review will not discuss these smaller energy sources but instead will focus on three areas in which BSW water may substantially contribute to the overall input of cell energy. These energy-related activities include electron and proton conduction, membrane potential, and water respiration.

The liquid crystalline properties of BSW interfacial water have been compared to the properties of solid crystals such as silicone quartz. Quartz crystals are known to collect and resonate with EMF frequencies in early radio receivers, thereby converting EMF energy into patterns of sonic energy. The process of generating, sending, receiving, and converting EMF radiation into intelligible patterns is also known as sending, storing, and receiving information. This review section will focus on generating, collecting, storing, and transmitting EMF radiation for cell energy needs and not for information or coherence needs, which will be discussed in Part 3.In other words, the ability of BSW water crystalline properties to interact with EMF frequencies will be discussed in later sections. However, the ability of BSW water crystalline properties to donate and accept electrons and protons in relationship to energy will be reviewed in this next section.

The ability of the liquid crystalline properties of SW water to conduct either electrons or protons has been well-researched. Electrical conductivity in SW water increases depending on the percentage of SW water in the water sample [41, 71, 149-151]. Soluble ions in the water will also increase conductivity; therefore, it is important to measure conductivity before and after any water treatment to add water structure so a baseline reading can be established. Taking the electrical conductivity reading after the treatment gives a crude estimate of the increased water structure due to the added water rings. For example, the baseline conductivity in aquifer mineral water was about 378 µS/cm. In comparison, the conductivity of the generated SW water using the mineral water ranged from 8,000 to 10,000 µS/cm, or a 20x to 25x increase in electrical conductivity.

Perhaps even more important than the ability of SW water to conduct electrons is its ability to conduct proton or proticity [19] The flow of protons across the inner mitochondrial membrane is crucial for recycling NADH back to NAD+ and releasing a proton to convert ADP to ATP However, BSW interfacial water also has the ability for "jump conduction" of protons across the crystalline sheets of H-bonded, hexagonal-ringed water [12, 19, 152-153] During proton jump conduction, protons flow in one direction while electrons flow in the opposite direction Proton conductivity is important in recycling energy molecules in the mitochondria but also in photosynthesis and in a myriad of other redox reactions [154-158] Proton conduction eventually led to the concept of a neural network for protons based on the ubiquitous presence of BSW interfacial water on all membrane surfaces The first mention of a proton-neural network was by Aiello et al. [159] in 1973 A book chapter by Oschman [19] proposed a biological communication network based on the liquid crystalline properties of BSW interfacial water A concept paper by Ho et al. [160] also proposed a proton-neural network based on a vast network of BSW interfacial water covering cell membranes The concept of a proton-neural network has been the subject of many concept papers [161-163] Water wires inserted in cell membranes also conduct protons from inside a cell or organelle to the outside [160] A study by Mikheenko

[164] revealed proton superconductivity in water-filled microtubules The ability of BSW interfacial water to act as a superconductor for protons at ambient temperatures has the potential for instant communication to all the cells in an organism [164] A proton-neural network may have a dual function to first supply protons for a vast array of redox reactions that are ever-present and never-ending in cells The second function is to provide a communication network to integrate and coordinate metabolic activities [165].A proton-neural network is based on proton transfer dynamics. In contrast, BSW super coherence is based on resonance or phase locking of EMF frequencies to communicate and coordinate activities and functions at the whole organism level.

As previously mentioned, Pollack's Exclusion Zone theory states that the EZ zone water has a charge potential [11, 71, 79-82, 166]. Liquid crystalline lattice has openings for the aquaporins in the membrane, allowing water flow in the aquapor in channels [167-168]. The movement of water from the outside to the inside of a cell has been measured, which indicates that there are channels in the liquid crystalline lattice as that water can freely move across the membrane. The current membrane pump theory states that cell membranes contain ion ports/channels that are voltage-gate controlled, which regulate soluble ion concentrations on both sides of the membrane. The membrane potential is the ion charge differential across the membrane [166]. In contrast, the QED and QFT theories predict that water structures form coherent domains due to resonance with EMF frequencies that result in a cold vortex of quasi-free electrons in the outer shell of the CD [42, 46-48, 116]. As a CD sphere approaches a surface membrane and starts to resonate with that membrane, the CD flattens out into a liquid crystalline lattice composed of sheets of H-bonded, hexagonal-ringed water molecules [42, 46-48, 112]. The liquid crystalline lattice, aka EZ water zone, aka BSW interfacial water, has a negative charge due to the presence of quasi-free electrons. Also, the liquid crystalline lattice, or EZ water zone, excludes all ions and biomolecules within the interfacial water zone. The EZ water zone has a vortex of quasi-free electrons that interface with hydronium ions, generating the overall charge potential within the EZ water zone [11, 42, 46-48, 116]. The differential ion potential theory for cell membrane potential is based on ionic charges. In contrast, the charged membrane potential is based on vortices of electrons and protons interfacing with one another in the EZ water zone. The two membrane potential theories are based on different charge origins, but they both agree that membranes have an electrical potential measured in mV.

Membrane potential serves two critical functions. The first function is a vast reservoir of quasi-free electrons and protons to meet an unquenchable demand for innumerable redox reactions. The second function is to serve as a "large storage battery" of the electrical potential that can supplement the energy requirements of each cell. The EZ water zone can reach an electrical potential of–100 mV to –200 mV, depending on the cell type and the health of the cell [11, 71]. Chai *et al*. [169] found that the EZ water zone on a Nafion surface increased to 600 μm deep after 10 min exposure to far-infrared wavelength (3,1000 nm). Numerous articles have stated that membrane potential should be over a threshold value to maintain the health status of cells [170-173]. Ho [174] states that the average "resting membrane potential" is about -50 mV. Pokorny *et al*. [173] state that healthy mitochondria should have anactual membrane potential of - 140 mV, and dysfunctional mitochondria have a potential of - 70 mV. A concept paper by Page [175] states that Dr. Wallace estimates that mitochondria membrane potential can reach a charge up to -180 mV. Wallace also estimates that human bodies have an average of 10^{17} mitochondria with the electrical potential of a lightning bolt stored in each human. These findings show a strong correlation between membrane potential and cell health and that membrane potential varies depending on the cell type. When the EZ zone is at its optimal size and depth, there is an abundant supply of electrons and protons, and the energy available from the membrane potential should be close to "fully charged."

Several studies have confirmed Pollack's assertion that red and infrared light increases the EZ zone on membranes, which increases membrane potential and redox potential [11, 169]. Passarella *et al*. [176] found that rat liver mitochondria had increased membrane potential and a 70% increase in ATP levels when the cells were exposed to red light (647 nm). Alexandratou et al.[177] showed a 30% increase in mitochondrial membrane potential with 15 s exposure to red light EMF (647 nm). A third study by Hu et al. [178] revealed a 34.5% increase in mitochondrial membrane potential when exposed to red light (633 nm). These independent studies validate Pollack's premise that red and infrared light increases the EZ water zone [11, 179]. As the EZ zone increases in depth, there is also a

substantial increase in membrane potential with a concomitant redox ability to recycle ADP, NAD+, and NADP at flux rates needed to sustain cell energy balances in healthy cells [16, 18-19].

In addition to recycling ADP, NAD+, and NADP,EZ water's negative and positive charged zones act as the stored electrochemical potential to supply energy for cell metabolic needs [11, 82].The existence of a BSW interfacial water zone with a high electronic charge potential was predicted by Szent-Gyorgyi in the early 1960s [180]. As it turns out, Szent-Gyorgyi was about 50 years ahead of his time, and his predictions about cell bioenergetics took a rather long and tedious journey to fruition and success. This scientific journey included discoveries of energized CD domains that led to energized BSW interfacial water with quasi-free electrons that eventually led to the discovery of an EZ water zone with a non-biological electrical potential up to -180 mV of energy, which was briefly summarized in the first section of this review. In short, the BSW interfacial water, aka EZ water zone, has a stored energy "potential" that allows energized water to decompose back to protons, electrons, and molecular oxygen (O_2) [47-51, 84, 116, 181].

The journey of bioenergetics is sometimes laborious, and it is difficult to piece together research findings into a cohesive, rational understanding of BSW water and cell energy. However, as disparate research and concept paper findings are joined over time, the pieces of the bioenergetics puzzle are slowly falling into place. This puzzle comes into focus with the realization that the BSW interfacial water zone can be energized with minimal energy inputs [45-51, 84, 118, 181] to the point of ionization, leading to the generation of O_2, protons, and electrons from the energized water molecules. The complete picture of this puzzle set will be discussed in more detail in the following section on water respiration. Water-based bioenergetics has two phases, with phase one converting energized water into O2, protons, and electrons. The second phase recycles the activated O_2 by receiving four electrons and four protons through a series of redox reactions back into H_2O and O_2.

The first phase of water-based energy generation, or water respiration (WR), was conceptualized by Preparata, Del Giudice, and their colleagues [84, 45-51]. In their first papers, they focused on coherent domains in water. They used the QED theory to calculate that CD water domains could be energized at 12.06 eV, which was just 0.54 mV from the ionization threshold of water molecules (12.6 eV). In addition, the trapped EMF radiation inside the CD had an equivalent of 0.26 eV [45-51]. In their later papers, they proposed that the energized CD domains in liquid water were readily converted into EZ water zones as they approached biological membrane surfaces. The cold vortices of quasi-free electrons in the outer shell of the CD sphere were converted into quasi-free electrons within the EZ zone that interfaced with the membrane surface. The negative and positive "redox layers" in the interfacial water zone converted the energy of the CD spheres into stored membrane potential based on the redox properties of the two water zones [41-51].

BSW water can receive, capture, and store heat generated from the mitochondria in the red and infrared wavelengths to reach the 12.06 eV energized level predicted by Del Giudice [45-51]. Red light alone (~680 nm) has enough energy (1.8 eV) to ionize energized BSW water. When water molecules reach their ionization threshold of 12.6 eV, the following reaction [1, 9] occurs:

$$2\ H_2O + hv \rightarrow 2\ H_2 + O2\ or H_2O\ 2\ H^+ + 2\ e^- + O \qquad (1)$$

This water-splitting equation is the first half of the Water Respiration (WR) cycle that occurs under biological conditions. This half of the energy generation cycle splits energized water into hydrogen and oxygen.

The second half of the energy generation WR cycle involves a redox cascade of one electron reduction reaction that reduces O_2 back to H_2O again. As the introduction mentions, BSW water continuously interacts with energy generated in vivo, affecting redox reactions and BSW water properties. Most studies ignore or overlook the interactions between BSW water and biological-sourced energy when analyzing redox reactions within cells. Molecular hydrogen and oxygen can be “activated” under normal physiological conditions. Molecular oxygen (O_2) exists in a triplet state, where it is most stable and is generally biologically un reactive. However, triplet state O_2 can be converted to singlet oxygen ($^1O_2$), where all the electrons are spin-paired [182 - 184]. Singlet oxygen ($^1O_2$), also known as “activated oxygen,” is much more reactive than triplet oxygen and can initiate a myriad of redox reactions. Molecular O_2 can be converted into activated oxygen ($^1O_2$) when exposed to red and infrared radiation in mitochondria and other biological sites [185 - 188]. Mitochondria research shows that the temperature of human mitochondria averages about 53-54 C [189-190]. Temperature converts to energy in

the infrared spectrum, i.e., a temperature of 53-54 C is equivalent to a long wavelength infrared spectrum (8,000 to 15,000 nm) with a temperature range of 89 to 80 C [191]. In addition, when organisms are exposed to sunlight, they are also exposed to the full range of infrared spectrum. In short, a narrow range of infrared wavelengths is generated internally by mitochondria, and sunlight is an external source for a full range of infrared wavelengths. These findings suggest that human mitochondria generate enough heat, or mid-infrared radiation, in addition to exposure to sunlight, to convert triplet oxygen to singlet oxygen in vivo. Exposure to infrared wavelengths activates molecular oxygen into singlet oxygen and initiates the redox cascade back to water and molecular oxygen.

The WR cycle depends entirely on the liquid crystalline properties of the interfacial water attached to cell membranes to capture and store biologically sourced energy, generally in the form of heat, to activate the BSW water. The WR cycle is initiated with energized water, and the cycle is completed and returns to its beginning of splitting a water molecule at the top of the energy generation pathway. The second half of the WR cycle is also called water respiration by Voeikov [1, 192 - 195]. The redox equations [196] for water respiration are:

$$^3O_2 + hv \rightarrow {}^1O_2 \quad (2)$$

$$^1O_2 + H\bullet \rightarrow HO_2\bullet \quad (3)$$

$$O_2- + H+ \rightarrow HO_2\bullet \quad (4)$$

$$HO_2\bullet + HO_2\bullet \rightarrow H_2O_2 + {}^1O_2. \quad (5)$$

$$\bullet OH + \bullet OH \rightarrow H_2O_2 \quad (6)$$

$$2H_2O_2 + hv \rightarrow {}^1O_2 + 2H_2O \quad (7)$$

$$H_2O_2 + O_2- \rightarrow \bullet OH + -OH + {}^1O_2 \quad (8)$$

The first reaction of the WR cycle occurs as molecular oxygen exposed to light energy transfers from the triplet ground state $^3O_2$ to the first excited singlet state $^1O_2$ (total electron spin is zero) with an energy of 0.98 eV. The other reactive oxygen species (ROS) include the electronically excited radical anion O2−, electronically excited hydroperoxide radical $HO_2\bullet$, electronically excited hydroxyl radical HO•, and hydrogen peroxide H_2O_2. If the intermediate redox steps are ignored, the entire set of reactions can be summarized as follows [192 - 195]:

$$4O_2 + 4e^- + 4H^+ 2H_2O = 3O_2$$

The reduction of O_2 involves forming several Radical Oxygen Species (ROS), eventually leading to the final products of water and molecular oxygen.The conversion of four oxygen molecules (O_2) into two water molecules (H_20) releases approximately 180 KJ of energy per mole of O_2.

The ability of singlet oxygen to form ROS species has caused untold anxiety and consternation among biological and medical scientists over the past 50 years. Research on aging has extensively reported the dangers of ROS on cell integrity and is a primary cause of age-related diseases. The WR energy theory is based on a cascade of redox reactions, including ROS. Water respiration has a long history but was vehemently ignored as nobody wanted to champion a theory based on harmful and deleterious ROS reactions. However, the water respiration theory may be revived with recent quantum biology discoveries that propose that BSW water has superconductivity properties at room temperatures. Numerous articles have posited that BSW water has superconductivity properties [9, 41, 130, 175]. Quantum biology includes mind-numbing concepts such as superconductivity, superposition, and entanglement, which have biological relevance with ultra-fast or simultaneous positioning or occurrence of protons and electrons [197-202]. A cursory literature search reveals dozens of research findings on water or proton wires that allow proton tunneling at ultra-fast, superconductive speeds [203-207]. The accumulated evidence shows that quantum proton tunneling is valid, and protons and electrons always move together but in opposite directions [205-207]. Quantum biology has become widely accepted, and many quantum properties have been associated with BSW interfacial water, such as delocalization, vortex quantum behavior, wave packets, coherence, and tunneling [202]. Quantum biology indicates that in vivo redox reactions could occur at ultra-fast or superconductive speeds. Therefore, redox reactions within the WBEG pathway probably occur at quantum speeds without causing detectable ROS injury or damage to membranes or biomolecules [1, 197-202].

According to Voeikov, cells need a four-fold excess of oxygen to prevent ROS radical accumulation during water respiration and prevent ROS injury to the cells [1]. Sustainable levels of O_2 within cells are possible if cells are exposed to specific EMF wavelengths, such as infrared radiation, to energize BSW interfacial water so that it progresses through the first stage of the

WBEG pathway. In other words, infrared energy or other energy sources are continually used to energize BSW water, so the WR energy cycle has a four-fold excess of O2 to start the redox cascade chain with minimal ROS generation and ROS injury [1, 192-195]. Blood pH is a biomarker for available oxygen for cell metabolism. Blood with a pH of 7.45 contains 65% more excess oxygen than blood with a pH of 7.35, and 7.35 to 7.45 is the physiological pH range in humans [208-209]. Generally, structured drinking water products are more alkaline, and studies show that drinking alkaline water raises pH blood levels [210-211]. The effects of sodium bicarbonate on blood pH levels are well known, as well as the impact on health and physical performance [212-215].

Respiration can be glucose-based within the mitochondria or water-based in the WBEG cycle. Glucose respiration can be inhibited with rapamycin, which inhibits mTOR, which regulates glucose's aerobic respiration. In other words, as the mitochondria reduce oxygen consumption through reduced glycolysis rates, mitochondria generate less ROS, and there is less oxidative stress in cells [216-218]. Rapamycin inhibits mTOR, which regulates many cell functions, including glycolysis in the mitochondria. Inhibition of mTOR is associated with reduced aging and improved health [219-225]. Although these findings show indirect evidence, they suggest that reducing glycolysis levels, thereby reducing O2 consumption in cells, has a twofold effect. Reduced O2 consumption within the mitochondria also reduces ROS generation from dysfunctional mitochondria and reduces membrane potential [216-218]. As membrane potential and glycolysis are reduced, and mTOR is inhibited, the cell increases its rate of autophagy and apoptosis [219-225]. As senescent cells are replaced due to autophagy and apoptosis, they shift back to a balanced contribution of mitochondrial and WR energy generation, improving health and longevity. In summary, the rapamycin studies offer indirect evidence that oxygen consumption by aging and dysfunctional mitochondria lead to ROS and oxidative stress. However, suppose senescent cells can be activated to signal autophagy and apoptosis. In that case, the regenerated cells can regain healthy cell membrane potential, activating the WR cycle as a cell energy source.

Szent-Gorgy coined bioenergetics and stated that biological water at membrane interfaces was the key to life. He also proposed that interfacial " energized " water required less energy to split than water in the ground state [9]. Another prophetic premise of Szent-Gorgy was how organized the "aqua-biomolecular" cells were in converting energized electrons into high-grade energy useful for cellular energy needs instead of allowing the low-grade energy to be wasted or lost [1]. Ironically, his fantastical bioenergetic theories were widely discredited and denounced when he was alive but are now being validated and recognized as far ahead of his time. Energized electrons and protons in the form of cold vortex rings that are delocalized and swarm each hexagonal ring of water are the very essence of quantum and redox properties of BSW water. These quantum and redox properties of BSW water are absolutely essential for life and well-being as the research findings add more and more detail and insight into the overall harmony and coherence at all biological scales in organisms.

9. TRANSMUTATION OF PLANT ELEMENTS

Quantum biology and structured water may also play a role in the bio-transmutation of elements in a cell environment. Louis Kervran discovered biological transmutation in the 1960s. His work was so radical that he was given a "parody" award called the Ig Noble Prize in 1993 for being an "ardent admirer in alchemy" [226]. Since his discovery, many scientists have proven that bio-transmutation does occur in microbes and plants [227-230]. Later in the 1990's Ukrainian scientist Vladimir Vysotskii studied bio-transmutation in bacteria. He was able to coax Bacillus subtilis, Escherichia coli, and a yeast species (Saccharomyces cerevisiae) to transmute manganese into iron [231]. In 1978, Solomon Goldfein attempted to validate Kervran's claims for bio-transmutation. He found that mitochondria appeared to act like a microscopicparticle accelerator, resulting in protons moving at quantum speeds, thereby allowing bio-transmutation [232]. In 2015, a Japanese researcher, Hideo Kozima, postulated that neutrons could be “trapped” in transition metal’s nuclei, resulting in the elements' bio-transmutation [233-235].

A very recent study by Sugihara and Maiwa [236] studied the transmutation of radioactive elements from contaminated soil from the Fukushima reactor disaster that occurred in 2011. They pressurized seawater at 147 Mpa to break the hydrogen bonds in the water molecules, which generated a type of water called SIGN water. Their SIGN water contained info tons, which are intermediate particles between a proton and an electron <H+ ~ e->. They postulated that the

hydrogen bonds in water molecules dissociate to generate info tons, which can then react with any nucleus, obtaining energy from radioactive isotopes of an element. They state that the info tons could convert Na to Mg and several other radioactive elements back into non-radioactive elements [236]. They also state that any plant may convert Na to Mg when absorbing water through aquaporin proteins against gravity through their roots (the calculated pressure is approx. 0.8MPa, which is not enough to dissociate hydrogen bonds of water) [236]. This study broke the H-bonds of two water molecules using high pressure to create a new particle (info tons) and, thus, transmute several radioactive elements into non-radioactive elements and Na into Mg. Their findings are intriguing if further validated due to their implications of structured water, quasi-free protons, and energy generation.

The quantum dynamics of protons derived from SW and BSW water appear to hold much promise and much consternation among researchers [237-240]. As quantum mysteries unfold, the weirdness of superconductivity, particle tunneling, dark matter, entanglement, and element transmutation will push science to the edge of logic and understanding. If we are up for the challenge to gain more insights about BSW water and biology, researchers must be willing to jump “Down the Quantum Rabbit Hole” and follow wherever nature leads.

REFERENCES

[1] Voeikov VL Biological oxidation: over a century of hardship for the concept of active oxygen. Cell Mol Biol 2005; 51: 663-75.

[2] Nuday C. Water Codes The science of health, consciousness, and enlightenment 2014 Water Ink, CA.

[3] Henniker JC The depth of the surface zone of a liquid. Reviews of Modern Physics 1949; 21(2): 322. https://doi.org/10.1103/RevModPhys.21.322

[4] Lippincott ER, Stromberg RR, Grant WH, Cessac GS. Science 1969; 164: 1482. https://doi.org/10.1126/science.164.3887.1482

[5] Schiff M. The Memory of Water Thorsens 1995.

[6] Ling G. A Physical Theory of the Living State: the Association-Induction Hypothesis. 1962 Blaisdell Publishing Company, A Division of Random House, Inc., London.

[7] Ling G. History of the Membrane (Pump) Theory of the Living Cell from Its Beginning in Mid-19th Century to Its Disproof 45 Years Ago — though Still Taught Worldwide Today as Established Truth. Physiological Chemistry and Physics and Medical NMR 2007; 39(1): 46-49.

[8] Jhon MS. The water puzzle and the hexagonal key Amerika, Uplifting 2004.

[9] Ho MW Illuminating water and life: Emilio Del Giudice Electromagnetic biology and medicine 2015; 34(2): 113-22. https://doi.org/10.3109/15368378.2015.1036079

[10] Voeikov VLKey role of stable nonequilibrium state of aqueous systems in bioenergetics. Russian J Gen Chem 2011; 81(1): 209-19. https://doi.org/10.1134/S1070363211010385

[11] Pollack GH The fourth phase of water Ebner and Sons Publishers: Seattle, WA, USA 2013.

[12] Ho MW Living rainbow H2O World Scientific; 2012.

[13] The legacy of Dr. Marcel Vogel 1996 https://ia802800.us.archive.org/5/items/lifestreamsampler/Lifestream%20Sampler.pdf

[14] MarcelVolgellegacywebsite. https://marcelvogellegacy.com/about-marcel-vogel.

[15] Crystal Visions website http://crystalvisions-film.com/marcel-vogel-crystals/

[16] https://medium.com/broaderinsights/who-was-marcel-vogel-a9430f8c11e3

[17] Tompkins P, Bird C The secret life of plants England: Penguin books; 1974.

[18] Montagnier L, Del Giudice E, Aïssa J, Lavallee C, Motschwiller S, Capolupo A, Polcari A, Romano P, Tedeschi A, Vitiello G. Transduction of DNA information through water and electromagnetic waves. Electromagnetic Biology and Medicine 2015; 34(2): 106-12. https://doi.org/10.3109/15368378.2015.1036072

[19] Oschman JL. Energy medicine-e-book: The scientific basis Elsevier Health Sciences 2015.

[20] Rubik B, Muehsam D, Hammerschlag R, Jain S. Biofield science and healing: history, terminology, and concepts. Global Advances in Health and Medicine 2015; 4. https://doi.org/10.7453/gahmj.2015.038.suppl

[21] Gallo P, Amann-Winkel K, Angell CA, Anisimov MA, Caupin F, Chakravarty C, Lascaris E, Loerting T, Panagiotopoulos AZ, Russo J, Sellberg JA. Water: A tale of two liquids. Chemical Reviews 2016; 116(13): 7463-500. https://doi.org/10.1021/acs.chemrev.5b00750

[22] Taschin A, Bartolini P, Eramo R, Righini R, Torre R. Evidence of two distinct local structures of water from ambient to supercooled conditions. Nature Communications 2013; 4(1): 2401. https://doi.org/10.1038/ncomms3401

[23] Shi R, Tanaka H. Direct evidence in the scattering function for the coexistence of two types of local structures in liquid water. Journal of the American Chemical Society 2020; 142(6): 2868-75. https://doi.org/10.1021/jacs.9b11211

[24] Camisasca G, Schlesinger D, Zhovtobriukh I, Pitsevich G, Pettersson LG. A proposal for the structure of high-and low-density fluctuations in liquid water. The Journal of Chemical Physics 2019; 151(3). https://doi.org/10.1063/1.5100875

[25] Kontogeorgis GM, Holster A, Kottaki N, Tsochantaris E, Topsøe F, Poulsen J, Bache M, Liang X, Blom NS, Kronholm J. Water structure, properties and some applications-A review. Chemical Thermodynamics and Thermal Analysis 2022; 6: 100053. https://doi.org/10.1016/j.ctta.2022.100053

[26] Nilsson A, Pettersson LG. The structural origin of anomalous properties of liquid water. Nature Communications 2015; 6(1): 8998. https://doi.org/10.1038/ncomms9998

[27] Ryzhkina IS, Murtazina LI, Kiseleva YV, Konovalov AI. Properties of supramolecular nanoassociates formed in aqueous solutions of biologically active compounds in low or ultra-low concentrations InDoklady Physical Chemistry 2009 Oct (Vol. 428, pp. 196-200). SP MAIK Nauka/Interperiodica. https://doi.org/10.1134/S0012501609100029

[28] Chaplin MF. Water's hydrogen bond strength Water and Life: The unique properties of H2O 2007; 69-86. https://doi.org/10.1201/EBK1439803561-c5

[29] Tao Y, Zou W, Jia J, Li W, Cremer D. Different ways of

hydrogen bonding in waterdoes warm water freeze faster than cold water? Journal of Chemical Theory and Computation 2017; 13(1): 55-76. https://doi.org/10.1021/acs.jctc.6b00735

[30] Chen B, Ivanov I, Klein ML, Parrinello M. Hydrogen bonding in water. Physical Review Letters 2003; 91(21): 215503. https://doi.org/10.1103/PhysRevLett.91.215503

[31] Brini E, Fennell CJ, Fernandez-Serra M, Hribar-Lee B, Luksic M, Dill KA. How water's properties are encoded in its molecular structure and energies. Chemical Reviews 2017; 117(19): 12385-414. https://doi.org/10.1021/acs.chemrev.7b00259

[32] Cai R, Yang H, He J, Zhu W. The effects of magnetic fields on water molecular hydrogen bonds. Journal of Molecular Structure 2009; 938(1-3): 15-9. https://doi.org/10.1016/j.molstruc.2009.08.037

[33] Chang KT, Weng CI. The effect of an external magnetic field on the structure of liquid water using molecular dynamics simulation. Journal of Applied Physics 2006; 100(4): 043917. https://doi.org/10.1063/1.2335971

[34] Alkorta I, Rozas I, Elguero J. Non-conventional hydrogen bonds. Chemical Society Reviews 1998; 27(2): 163-70. https://doi.org/10.1039/a827163z

[35] Szcześ A, Chibowski E, Hołysz L, Rafalski P. Effects of static magnetic field on water at kinetic condition. Chemical Engineering and Processing: Process Intensification 2011; 50(1): 124-7. https://doi.org/10.1016/j.cep.2010.12.005

[36] Li XZ, Walker B, Michaelides A. Quantum nature of the hydrogen bond. Proceedings of the National Academy of Sciences 2011; 108(16): 6369-73. https://doi.org/10.1073/pnas.1016653108

[37] Pugliano N, Saykally RJ. Measurement of quantum tunneling between chiral isomers of the cyclic water trimer. Science 1992; 257(5078): 1937-40. https://doi.org/10.1126/science.1411509

[38] Kolesnikov AI, Reiter GF, Choudhury N, Prisk TR, Mamontov E, Podlesnyak A, Ehlers G, Seel AG, Wesolowski DJ, Anovitz LM. Quantum tunneling of water in beryl: a new state of the water molecule. Physical Review Letters 2016; 116(16): 167802. https://doi.org/10.1103/PhysRevLett.116.167802

[39] Richardson JO, Pérez C, Lobsiger S, Reid AA, Temelso B, Shields GC, Kisiel Z, Wales DJ, Pate BH, Althorpe SC. Concerted hydrogen-bond breaking by quantum tunneling in the water hexamer prism. Science 2016; 351(6279): 1310-3. https://doi.org/10.1126/science.aae0012

[40] Martin Chaplin. https://water.lsbu.ac.uk/water/water_sitemap.html.

[41] Messori C, Prinzera SV, di Bardone FB. Deep into the Water: Exploring the Hydro-Electromagnetic and Quantum-Electrodynamic Properties of Interfacial Water in Living Systems. Open Access Library Journal 2019a; 6(05): 1. https://doi.org/10.4236/oalib.1105435

[42] Messori C, Prinzera SV, di Bardone FB. The super-coherent state of biological water. Open Access Library Journal 2019b; 6(02): 1. https://doi.org/10.4236/oalib.1105236

[43] Jerman I. The origin of life from quantum vacuum, water and polar molecules. American Journal of Modern Physics 2016; 5(4-1): 34-43.

[44] Scirè AA. mesoscopic model for the collective dynamics of water coherence domainsarXiv preprint arXiv: 2004.07545 2020.

[45] Geesink HJ, Jerman I, Meijer DK. Water, the cradle of life via its coherent quantum frequencies. Water 2020; 11: 78-108.

[46] Marchettini N, Del Giudice E, Voeikov V, Tiezzi E. Water: A medium where dissipative structures are produced by a coherent dynamics. Journal of Theoretical Biology 2010; 265(4): 511-6. https://doi.org/10.1016/j.jtbi.2010.05.021

[47] Del Giudice E, Voeikov V, Tedeschi A, Vitiello G. The origin and the special role of coherent water in living systems. Fields of the Cell 2015; 95-111.

[48] Del Giudice E, Tedeschi A, Vitiello G, Voeikov V. Coherent structures in liquid water close to hydrophilic surfaces. Journal of Physics: Conference Series 2013; 442(1): 012028) IOP Publishing. https://doi.org/10.1088/1742-6596/442/1/012028

[49] Giudice ED, Spinetti PR, Tedeschi A. Water dynamics at the root of metamorphosis in living organisms. Water 2010; 2(3): 566-86. https://doi.org/10.3390/w2030566

[50] Giudice ED, Tedeschi A. Water and autocatalysis in living matter. Electromagnetic Biology and Medicine 2009; 28(1): 46-52. https://doi.org/10.1080/15368370802708728

[51] Bono I, Del Giudice E, Gamberale L, Henry M. Emergence of the coherent structure of liquid water. Water 2012; 4(3): 510-32. https://doi.org/10.3390/w4030510

[52] Czerlinski G, Ryba R. Trevor Coherence domains in living systems. J Vortex Sci Technol 2015; 2: 110. https://doi.org/10.4172/2090-8369.1000110

[53] Liboff AR, Poggi C, Pratesi P. Weak low-frequency electromagnetic oscillations in water. Electromagnetic Biology and Medicine 2017; 36(2): 154-7. https://doi.org/10.1080/15368378.2016.1227332

[54] Davidson RM, Lauritzen A, Seneff S. Biological water dynamics and entropy: a biophysical origin of cancer and other diseases. Entropy 2013; 15(9): 3822-76. https://doi.org/10.3390/e15093822

[55] Ball P. Water is an active matrix of life for cell and molecular biology. Proceedings of the National Academy of Sciences 2017; 114(51): 13327-35. https://doi.org/10.1073/pnas.1703781114

[56] Fathi AA, Alsslam AE, Ahmed HS. Schumann resonances and their potential applications: a review Article. Инженерныетехнологии и системы 2017; 27(4): 476-89. https://doi.org/10.15507/0236-2910.027.201704.476-489

[57] Miller I 2003 http://www.globaldialoguefoundation.org/files/THESEDONAEFFECT.pdf

[58] English t 2021 https://interestingengineering.com/science/what-is-the-schumann-resonance.

[59] Micunovic I 2023 https://www.meer.com/en/72411-schumann-resonance

[60] Burns S 2023 https://www.youtube.com/watch?v=9Zw_QUT4XFI

[61] Mohri K, Fukushima M. Milligauss magnetic field triggering reliable self-organization of water with long-range ordered proton transport through cyclotron resonance. IEEE Transactions on Magnetics 2003; 39(5): 3328-30. https://doi.org/10.1109/TMAG.2003.816766

[62] D'Emilia E, Giuliani L, Lisi A, Ledda M, Grimaldi S, Montagnier L, Liboff AR. Lorentz force in water: Evidence that hydronium cyclotron resonance enhances polymorphism. Electromagnetic Biology and Medicine 2015; 34(4): 370-5. https://doi.org/10.3109/15368378.2014.937873

[63] D'Emilia E, Ledda M, Foletti A, Lisi A, Giuliani L, Grimaldi S, Liboff AR. Weak-field H3O+ ion cyclotron resonance alters water refractive index. Electromagnetic Biology and Medicine 2017; 36(1): 55-62. https://doi.org/10.1080/15368378.2016.1181082

[64] Liguori A, Brizhik L, Liguori S, Silli L, Bangrazi S, Petti F, Pinti

M, Pistelli MI, Giuliani L. Effects of Ion Cyclotron Frequencies on Human Resistance and Reactance in 31 Healthy Subjects Radiation 2022; 2(4): 357-75. https://doi.org/10.3390/radiation2040027

[65] Ho MW. Large supramolecular water clusters caught on camera-a review. Water 2014; 6: 1-2.

[66] Gerrard N, Mistry K, Darling GR, Hodgson A. Water dissociation and hydroxyl formation on Ni (110). The Journal of Physical Chemistry C 2020; 124(43): 23815-22. https://doi.org/10.1021/acs.jpcc.0c08708

[67] Merte LR, Bechstein R, Peng G, Rieboldt F, Farberow CA, Zeuthen H, Knudsen J, Lægsgaard E, Wendt S, Mavrikakis M, Besenbacher F. Water clustering on nanostructured iron oxide films. Nature Communications 2014; 5(1): 4193. https://doi.org/10.1038/ncomms5193

[68] Shiotari A, Sugimoto Y. Ultrahigh-resolution imaging of water networks by atomic force micros copy. Nature Communications 2017; 8(1): 1-7. https://doi.org/10.1038/ncomms14313

[69] Ma R, Cao D, Zhu C, Tian Y, Peng J, Guo J, Chen J, Li XZ, Francisco JS, Zeng XC, Xu LM. Atomic imaging of the edge structure and growth of a two-dimensional hexagonal ice. Nature 2020; 577(7788): 60-3. https://doi.org/10.1038/s41586-019-1853-4

[70] Madl P, Del Giudice E, Voeikov VL, Tedeschi A, Kolarž P, Gaisberger M, Hartl A. Evidence of coherent dynamics in water droplets of waterfalls. Water 2013; 5: 57-68.

[71] Pollack GH The fourth phase of water Ebner and Sons Publishers: Seattle, WA, USA 2013.

[72] Yablonskaya O, Voeikov V, Buravleva E, Trofimov A, Novikov K. Physicochemical effects of humid air treated with infrared radiation on aqueous solutions. Water 2021; 13(10): 1370. https://doi.org/10.3390/w13101370

[73] Dombrovsky LA, Fedorets AA, Medvedev DN. The use of infrared irradiation to stabilize levitating clusters of water droplets. Infrared Physics & Technology 2016; 75: 124-32. https://doi.org/10.1016/j.infrared.2015.12.020

[74] Dombrovsky LA, Fedorets AA, Levashov VY, Kryukov AP, Bormashenko E, Nosonovsky M. Stable cluster of identical water droplets formed under the infrared irradiation: Experimental study and theoretical modeling. International Journal of Heat and Mass Transfer 2020; 161: 120255. https://doi.org/10.1016/j.ijheatmasstransfer.2020.120255

[75] Rosenfeld D, Woodley WL. Deep convective clouds with sustained supercooled liquid water down to-37.5 C. Nature 2000; 405(6785): 440-2. https://doi.org/10.1038/35013030

[76] Sholl DS, Steckel JA. Density functional theory: a practical introduction John Wiley & Sons; 2022.

[77] Gould T, Kooi DP, Gori-Giorgi P, Pittalis S. Electronic excited states in extreme limits via ensemble density functionals. Physical Review Letters 2023; 130(10): 106401. https://doi.org/10.1103/PhysRevLett.130.106401

[78] Zhang Z, Li D, Jiang W, Wang Z. The electron density delocalization of hydrogen bond systems. Advances in Physics: X 2018; 3(1): 1428915. https://doi.org/10.1080/23746149.2018.1428915

[79] Pollack GH. Cell electrical properties: reconsidering the origin of the electrical potential. Cell Biol Int 2015; 39(3): 237-342. https://doi.org/10.1002/cbin.10382

[80] Pollack GH, Figueroa X, Zhao Q. Molecules, water, and radiant energy: new clues for the origin of life. International Journal of Molecular Sciences 2009; 10(4): 1419-1429. https://doi.org/10.3390/ijms10041419

[81] Pollack GH. Water, energy and life: fresh views from the water's edge. International Journal of Design & Nature and Ecodynamics: a Transdisciplinary Journal Relating to Nature, Science and the Humanities 2010; 5(1): 27. https://doi.org/10.2495/DNE-V5-N1-27-29

[82] Hwang SG, Hong JK, Sharma A, Pollack GH, Bahng G. Exclusion zone and heterogeneous water structure at ambient temperature. PLoS One 2018; 13(4). https://doi.org/10.1371/journal.pone.0195057

[83] Ho MW. Water is the means, medium, and message of life. Intern J Design & Nat and Ecodynamics 2014; 9(1): 1-2. https://doi.org/10.2495/DNE-V9-N1-1-12

[84] Ho MW. 10 Life is Water Electric Bioelectromagnetic and Subtle Energy Medicine 2014; 93.

[85] Barbosa-Cánovas GV, Fontana Jr AJ, Schmidt SJ, Labuza TP, editors. Water activity in foods: fundamentals and applications John Wiley & Sons; 2020. https://doi.org/10.1002/9781118765982

[86] Joardder MU, Mourshed M, Masud MH. State of bound water: measurement and significance in food processing. Springer International Publishing; 2019. https://doi.org/10.1007/978-3-319-99888-6

[87] Kuroki S, Tsenkova R, Moyankova D, Muncan J, Morita H, Atanassova S, Djilianov D. Water molecular structure underpins extreme desiccation tolerance of the resurrection plant Haberlea rhodopensis. Scientific Reports 2019; 9(1): 3049. https://doi.org/10.1038/s41598-019-39443-4

[88] Muncan J, Kuroki S, Moyankova D, Morita H, Atanassova S, Djilianov D, Tsenkova R. Protocol for aquaphotomics monitoring of water molecular structure in leaves of resurrection plants during desiccation and recovery.

[89] Ignatov I, Huether F, Neshev N, Kiselova-Kaneva Y, Popova TP, Bankova R, Valcheva N, Ignatov AI, Angelcheva M, Angushev I, Baiti S. Research of water molecules cluster structuring during Haberlea rhodopensis Friv. hydration. Plants 2022; 11(19): 2655. https://doi.org/10.3390/plants11192655

[90] IL C, Haskin CL, Fullerton GD. Multiple Unfrozen Water Fractions in Biological Tissues: Freezing Point and Size.

[91] Pal S, Chattopadhyay A. Hydration dynamics in biological membranes: Emerging applications of terahertz spectroscopy. The Journal of Physical Chemistry Letters 2021; 12(39): 9697-709. https://doi.org/10.1021/acs.jpclett.1c02576

[92] Mitra RK, Palit DK. Probing biological water using terahertz absorption spectroscopy. Terahertz Technology 2021; IntechOpen.

[93] Nakagawa H, Yamamoto N. Incoherent Neutron Scattering and Terahertz Time-Domain Spectroscopy on Protein and Hydration Water. Life 2023; 13(2): 318. https://doi.org/10.3390/life13020318

[94] Kerch G. Role of changes in state of bound water and tissue stiffness in development of age-related diseases. Polymers 2020; 12(6): 1362. https://doi.org/10.3390/polym12061362

[95] Nilsson A, Pettersson LG. The structural origin of anomalous properties of liquid water. Nature Communications 2015; 6(1): 8998. https://doi.org/10.1038/ncomms9998

[96] Malkin TL, Murray BJ, Brukhno AV, Anwar J, Salzmann CG. Structure of ice crystallized from supercooled water. Proceedings of the National Academy of Sciences 2012; 109(4): 1041-5. https://doi.org/10.1073/pnas.1113059109

[97] Zheng JM, Pollack GH. Long-range forces extending from polymer-gel surfaces. Physical Review E 2003; 68(3): 031408. https://doi.org/10.1103/PhysRevE.68.031408

[98] Sharma A, Pollack GH. Healthy fats and exclusion-zone size.

Food Chemistry 2020; 316: 126305.
https://doi.org/10.1016/j.foodchem.2020.126305

[99] Britannica. https://www.britannica.com/science/hexagonal-system.

[100] Yang DS, Zewail AH. Ordered water structure at hydrophobic graphite interfaces observed by 4D, ultrafast electron crystallography. Proceedings of the National Academy of Sciences 2009; 106(11): 4122-6.
https://doi.org/10.1073/pnas.0812409106

[101] Segarra-Martí J, Roca-Sanjuán D, Merchán M. Can the hexagonal ice-likemodel renderthe spectroscopic fingerprints of structured water; Feedback from quantum-chemical computations. Entropy 2014; 16(7): 4101-20.
https://doi.org/10.3390/e16074101

[102] Ho MW, Yu-Ming Z, Haffegee J, Watton A, Musumeci F, Privitera G, Scordino A, Triglia A. The liquid crystalline organism and biological water. Water and the Cell 2006; 219-34.
https://doi.org/10.1007/1-4020-4927-7_10

[103] Fukuyama H, Le Bihan D, editors. Water: the forgotten biological molecule. Pan Stanford Publishing 2010.

[104] Bunkin NF, Kozlov VA, Ignatiev PS, Suyazov NV, Shkirin AV, Atakhodzhaev IA. Refraction coefficient of water and aqueous solutions in the optical frequency range in the vicinity of Nafion. Biophysics 2012; 57: 733-49.
https://doi.org/10.1134/S0006350912060048

[105] Kunzek H, Müller S, Vetter S, Godeck R. The significance of physico chemical properties of plant cell wall materials for the development of innovative food products. European Food Research and Technology 2002; 214: 361-76.
https://doi.org/10.1007/s00217-002-0487-0

[106] Sun WQ. Dielectric relaxation of water and water-plasticized biomolecules in relation to cellular water organization, cytoplasmic viscosity, and desiccation tolerance in recalcitrant seed tissues. Plant Physiology 2000; 124(3): 1203-16.
https://doi.org/10.1104/pp.124.3.1203

[107] Berret JF. Local viscoelasticity of living cells measured by rotational magnetic spectroscopy. Nature Communications 2016; 7(1): 10134.
https://doi.org/10.1038/ncomms10134

[108] Voeikov VL, Del Giudice E. On the relationship between exclusion zones and coherence domains in water. Abstract retrieved from http://www.watercon.org/Abstracts_2012/Voeikov_DelGiudice_%20Abstract%20WC2012edit.pdf 2012.

[109] Del Giudice E, Voeikov V, Tedeschi A, Vitiello G. The origin and the special role of coherent water in living systems. Fields of the Cell 2015; 95-111.

[110] Bellissent-Funel MC, Hassanali A, Havenith M, Henchman R, Pohl P, Sterpone F, Van Der Spoel D, Xu Y, Garcia AE. Water determines the structure and dynamics of proteins. Chemical Reviews 2016; 116(13): 7673-97.
https://doi.org/10.1021/acs.chemrev.5b00664

[111] Fogarty AC Duboué-Dijon E, Sterpone F, Hynes JT, Laage D. Biomolecular hydration dynamics: a jump model perspective. Chemical Society Reviews 2013; 42(13): 5672-83.
https://doi.org/10.1039/c3cs60091b

[112] Mondal S, Bagchi B. From structure and dynamics to biomolecular functions: The ubiquitous role of solvent in biology. Current Opinion in Structural Biology 2022; 77: 102462.
https://doi.org/10.1016/j.sbi.2022.102462

[113] Helms V. Protein dynamics tightly connected to the dynamics of surrounding and internal water molecules. Chem Phys Chem 2007; 8(1): 23-33.
https://doi.org/10.1002/cphc.200600298

[114] Kanfi Y, Naiman S, Amir G, Peshti V, Zinman G, Nahum L, Bar-Joseph Z, Cohen HYThesirtuin SIRT6 regulates lifespan in male mice. Nature 2012; 483(7388): 218-21.
https://doi.org/10.1038/nature10815

[115] Gensler HL, Bernstein H. DNA damage as the primary cause of aging. The Quarterly Review of Biology 1981; 56(3): 279-303.
https://doi.org/10.1086/412317

[116] Wilson 3rd DM, Bohr VA, McKinnon PJ DNA damage, DNA repair, aging and age-related disease. Mechanisms of Aging and Development 2008; 129(7-8): 349-52.
https://doi.org/10.1016/j.mad.2008.02.013

[117] Khesbak H, Savchuk O, Tsushima S, Fahmy K. The role of water H-bond imbalances in B-DNA substate transitions and peptide recognition revealed by time-resolved FTIR spectroscopy. Journal of the American Chemical Society 2011; 133(15): 5834-42.
https://doi.org/10.1021/ja108863v

[118] Yokomizo T, Nakasako M, Yamazaki T, Shindo H, Higo J. Hydrogen-bond patterns in the hydration structure of a protein. Chemical Physics Letters 2005; 401(4-6): 332-6.
https://doi.org/10.2174/1871524915666150203093656

[119] Herrera A, del CA Esparza M, Md Ashraf G, A Zamyatnin A, Aliev G. Beyond mitochondria, what would be the energy source of the cell? Central Nervous System Agents in Medicinal Chemistry (Formerly Current Medicinal Chemistry-Central Nervous System Agents) 2015; 15(1): 32-41.

[120] Physiopedia website https://www.physio-pedia.com/Adenosine_triphosphate_(ATP).

[121] Sinclair 2017 https://www.quora.com/How-many-molecules-of-ATP-does-the-human-body-make-and-use-per-day

[122] Ivanov KP. Modern medical problems of energy exchange in humans. Annals of the Russian Academy of Medical Sciences 2013; 68(6): 56-9.
https://doi.org/10.15690/vramn.v68i6.674

[123] Kundacina N, Shi M, Pollack GH. Effect of local and general anesthetics on interfacial water. PLoS One 2016; 11(4): e0152127.
https://doi.org/10.1371/journal.pone.0152127

[124] Ueda I, Tseng HS, Kaminoh Y, Ma SM, Kamaya H, Lin SH. Anesthetics release unfreezable and bound water in partially hydrated phospholipid lamellar systems and elevate phase transition temperature. Molecular Pharmacology 1986; 29(6): 582-8
https://doi.org/10.1016/0166-6622(89)80141-6

[125] Ueda I. Anesthesia: an interfacial phenomenon. Colloids and Surfaces. 1989; 38(1): 37-48.
https://doi.org/10.1213/00000539-199404000-00018

[126] Ueda I, Tatara T, Chiou JS, Krishna PR, Kamaya H. Structure-selective anesthetic action of steroids: anesthetic potency and effects on lipid and protein. Anesthesia & Analgesia 1994; 78(4): 718-25.

[127] Riveros-Perez E, Riveros R. Water in the human body: An anesthesiologist's perspective on the connection between physicochemical properties of water and physiologic relevance. Annals of Medicine and Surgery 2018; 26: 1-8.
https://doi.org/10.1016/j.amsu.2017.12.007

[128] Hameroff SR. Anesthetic action and "quantum consciousness" a match made in olive oil. Anesthesiology 2018; 129(2): 228-31.
https://doi.org/10.1097/ALN.0000000000002273

[129] Meijer DK, Jerman I, Melkikh AV, Sbitnev VI. Biophysics of consciousness: A scale-invariant acoustic information code of a superfluid quantum space guides the mental attribute of the universe. Rhythmic Oscillations in Proteins to Human Cognition 2021; 213-361.
https://doi.org/10.1007/978-981-15-7253-1_8

[130] Sbitnev VI. Quantum consciousness in warm, wet and noisy brain. Modern Physics Letters B 2016; 30(28): 1650329. https://doi.org/10.1142/S0217984916503292

[131] Meijer DK, Jerman I, Melkikh AV, Sbitnev VI. Consciousness in the Universe is Tuned by a Musical Master Code, Part 3: A Hydrodynamic Superfluid Quantum Space Guides a Conformal Mental Attribute of Reality. Quantum 2020; 11(1): 72-107.

[132] Shen X. Increased dielectric constant in the water treated by extremely low frequency electromagnetic field and its possible biological implication. Journal of Physics: Conference Series 2011; 329(1): 012019). IOP Publishing. https://doi.org/10.1088/1742-6596/329/1/012019

[133] Vallée P. Action of pulsed low frequency electromagnetic fields on physicochemical properties of water: Incidence on its biological activity. European Journal of Water Quality 2006; 37(2): 221-32. https://doi.org/10.1051/wqual/2006006

[134] Rad I, Stahlberg R, Kung K, Pollack GH. Low frequency weak electric fields can induce structural changes in water. Plosone 2021; 16(12): e0260967. https://doi.org/10.1371/journal.pone.0260967

[135] Rao ML, Sedlmayr SR, Roy R, Kanzius J. Polarized microwave and RF radiation effects on the structure and stability of liquid water. Curr Sci 2010; 98(11): 1500-4.

[136] Yakunov AV, Biliy MM, Naumenko AP. Long-Term Structural Modification of Water under Microwave Irradiation: Low-Frequency Raman Spectroscopic Measurements. Advances in Optical Technologies 2017. https://doi.org/10.1155/2017/5260912

[137] Seker SS, Simsek O. Brief Review of Biological Effects of Electromagnetic Pollution (RF and 5G Waves) on Humans, Animals, and Vegetation.

[138] Kalantaryan V, Martirosyan R, Babayan Y, Petrosyan V. Violation of molecular structure of intracellular water as a possible cause of carcinogenesis and its suppression by microwave radiation (hypothesis). Computational and Structural Biotechnology Journal 2023. https://doi.org/10.1016/j.csbj.2023.06.013

[139] Kalantaryan VP, Hakobyan SN, Vardevanyan PO. Effect of weak electromagnetic waves on thermal properties of biomacromolecule water solutions. Journal of Contemporary Physics (Armenian Academy of Sciences) 2018; 53: 175-8. https://doi.org/10.3103/S106833721802010X

[140] Ramundo-Orlando A. Effects of millimeter waves radiation on cell membrane-a brief review. Journal of Infrared, Millimeter, and Terahertz Waves 2010; 31: 1400-11. https://doi.org/10.1007/s10762-010-9731-z

[141] Debouzy JC, Minier L, Veccio D, Pierre V, Jaoui R, Crouzier D. Are pulsed millimetre waves for biological/therapeutic use suitable to avoid thermal effects and magnify specific electromagnetic effects?

[142] Kalantaryan VP, Martirosyan R, Babayan Y, Khazaryan R. On the possibility of using non-ionizing electromagnetic radiation. (Millimeter waves) in Oncology Progress In Electromagnetics Research Letters 2020; 91: 49-57. https://doi.org/10.2528/PIERL20020301

[143] Wiley CD, Campisi J. The metabolic roots of senescence: mechanisms and opportunities for intervention. Nature Metabolism 2021; 3(10): 1290-301. https://doi.org/10.1038/s42255-021-00483-8

[144] https://komonews.com/news/healthworks/zombie-cells-buildup-in-your-body-may-play-role-in-aging-05-14-2019

[145] https://blog.daveasprey.com/senescence-longevity-supplements/#:~:text=These%20death%2Dresistant%20cells%2C%20called,improve%20your%20overall%20cellular%20function.

[146] https://www.longevity.technology/pathway-to-longevity-get-rid-of-zombie-cells/

[147] Bonatto D, Feltes BC, de Faria Poloni J. Aging as a consequence of intracellular water volume and density. Medical Hypotheses 2011; 77(6): 982-4. https://doi.org/10.1016/j.mehy.2011.08.025

[148] Minton AP. Water loss in aging erythrocytes provides a clue to a general mechanism of cellular senescence. Biophysical Journal 2020; 119(10): 2039-44. https://doi.org/10.1016/j.bpj.2020.10.004

[149] Demchuk O. Features of the use of structured water. The Scientific Heritage 2020; (47-5): 11-4.

[150] Ramsey CL. Application of a structured water generator for crop irrigation: Structured water, drought tolerance, and alteration of plant defense mechanisms to abiotic stressors. J Basic Appl Sci 2021; 17: 127-52 Abstract: A greenhouse study was conducted to enhance drought tolerance in velvet bean plants. https://doi.org/10.29169/1927-5129.2021.17.14

[151] Ramsey C, Freebury PC, Newman DH, Schweigkofler W, Cseke LJ, Newman SE. Use of Foliar Chemical Treatments to Induce Disease Resistance in Rhododendrons Inoculated with Phytophthora ramorum.

[152] Artemov VG, Uykur E, Kapralov PO, Kiselev A, Stevenson K, Ouerdane H, Dressel M. Anomalously high proton conduction of interfacial water. The Journal of Physical Chemistry Letters 2020; 11(9): 3623-8. https://doi.org/10.1021/acs.jpclett.0c00910

[153] Ho MW, Yu-Ming Z, Haffegee J, Watton A, Musumeci F, Privitera G, Scordino A, Triglia A. The liquid crystalline organism and biological water. Water and the Cell 2006; 219-34. https://doi.org/10.1007/1-4020-4927-7_10

[154] Sies H. Oxidative eustress: On constant alert for redox homeostasis. Redox Biology 2021; 101867. https://doi.org/10.1016/j.redox.2021.101867

[155] Go YM, Jones DP. Redox theory of aging: implications for health and disease. Clinical Science 2017; 131(14): 1669-88. https://doi.org/10.1042/CS20160897

[156] Flohe L. Looking back at the early times of redox biology. https://doi.org/10.20944/preprints202010.0511.v1

[157] Manoj KM, Tamagawa H. A critical appraisal on cellular homeostasis, transduction of environmental stimuli and the elicitation of electrophysiological responses OSF Preprints 2020.

[158] Ying W. NAD+ and NADH in cellular functions and cell death. Front Biosci 2006; 11(1): 3129-48. https://doi.org/10.2741/2038

[159] Aiello G, Micciancio-Giammarinaro MS, Palma-Vittorelli MB, Palma MU. Behaviour of Interacting Protons: The Average-Mass Approach to its Study and its Possible Biological Relevance Cooperative Phenomena 1973; 395-403. https://doi.org/10.1007/978-3-642-86003-4_35

[160] Ho MW, Yu-Ming Z, Haffegee J, Watton A, Musumeci F, Privitera G, Scordino A, Triglia A. The liquid crystalline organism and biological water. Water and the Cell 2006: 219-34. https://doi.org/10.1007/1-4020-4927-7_10

[161] Rouleau N, Persinger M. Cerebral networks of interfacial water: analogues of the neural correlates of consciousness in a synthetic three-shell realistic head model. Journal of Signal and Information Processing 2014; 5(04): 143. https://doi.org/10.4236/jsip.2014.54017

[162] Otto HH. Could Pure Water Helices in a Supporting Helical Tube Scaffold Become Superconducting at Ambient Conditions of Temperature and Pressure.

[163] Raković D. Brainwaves, neural networks, and ionic structures: Biophysical model for altered states of

consciousness. Consciousness: Scientific challenge of the 21st century 1995; 293-318.

[164] Mikheenko P. Superconductivity in self-assembled microtubules. Research Gate. Structure and to Consciousness. Journal of Applied Mathematics and Physics 2023; 11: 377-86. https://doi.org/10.4236/jamp.2023.112021

[165] Wilberforce T, Olabi AG. Proton exchange membrane fuel cell performance prediction using artificial neural network. International Journal of Hydrogen Energy 2021; 46(8): 6037-50. https://doi.org/10.1016/j.ijhydene.2020.07.263

[166] Wikipedia https://en.wikipedia.org/wiki/Membrane_potential.

[167] Kozumi T, Kitagawa Y. Water structure changes induced by ceramics can be detected by increased permeability through aquaporin. Biochemistry and Biophysics Reports 2016; 5: 353-8. https://doi.org/10.1016/j.bbrep.2016.01.002

[168] Ali AF, Cosemi E, Kamel S, Mohammed S, Elhefnawy M, Farid L, Shaker S. Miracle of Zamzam water: the effect on human endometrial aquaporin. IWTC 2009; 13: 1515-20.

[169] Chai B, Yoo H, Pollack GH.Effect of radiant energy on near-surface water. The Journal of Physical Chemistry B 2009; 113(42): 13953-8. https://doi.org/10.1021/jp908163w

[170] Pokorný J, Pokorný J, Foletti A, Kobilková J, Vrba J, Vrba JrJ. Mitochondrial dysfunction and disturbed coherence: gate to cancer. Pharmaceuticals 2015; 8(4): 675-95. https://doi.org/10.3390/ph8040675

[171] Pokorný J, Pokorný J, Borodavka F. Warburg effect—damping of electromagnetic oscillations. Electromagnetic Biology and Medicine 2017; 36(3): 270-8. https://doi.org/10.1080/15368378.2017.1326933

[172] Yang M, Brackenbury WJ. Membrane potential and cancer progression. Frontiers in Physiology 2013; 4: 185. https://doi.org/10.3389/fphys.2013.00185

[173] Pokorný J, Pokorný J, Kobilková J, Jandová A, Holaj R. Cancer development and damped electromagnetic activity. Applied Sciences 2020; 10(5): 1826. https://doi.org/10.3390/app10051826

[174] Ho.https://www.i-sis.org.uk/Membrane_potential_rules.php.

[175] Page M. The New Biophysics: A Deep Dive into the Quantum Rabbit Hole of Esoteric Physiology. https://12160.info/forum/topics/the-new-biophysics-a-deep-dive-into-the-quantum-rabbit-hole-of?page=1&commentId=2649739%3AComment%3A2013049&x=1#2649739Comment2013049.

[176] Passarella S, Casamassima E, Molinari S, Pastore D, Quagliariello E, Catalano IM, Cingolani A. Increase of proton electrochemical potential and ATP synthesis in rat liver mitochondria irradiated in vitro by helium-neon laser. FEBS Letters 1984; 175(1): 95-9. https://doi.org/10.1016/0014-5793(84)80577-3

[177] Alexandratou E, Yova D, Handris P, Kletsas D, Loukas S. Human fibroblast alterations induced by low power laser irradiation at the single cell level using confocal microscopy. Photochemical & Photobiological Sciences 2002; 1: 547-52. https://doi.org/10.1039/b110213n

[178] Hu WP, Wang JJ, Yu CL, Lan CC, Chen GS, Yu HS. Helium-neon laser irradiation stimulates cell proliferation through photostimulatory effects in mitochondria. Journal of Investigative Dermatology 2007; 127(8): 2048-57. https://doi.org/10.1038/sj.jid.5700826

[179] Karu TI. Mitochondrial signaling in mammalian cells activated by red and near IR radiation. Photochemistry and Photobiology 2008; 84(5): 1091-9. https://doi.org/10.1111/j.1751-1097.2008.00394.x

[180] Szent-Györgyi A. Bioelectronics: A Study in cellular regulations, Defense, and Cancer Academic Press; 2014.

[181] Caligiuri LM. QED coherence in matter, syntropy and the coherent domains as storing "devices". Journal of Physics: Conference Series 2022; 2197(1): 012004) IOP Publishing. https://doi.org/10.1088/1742-6596/2197/1/012004

[182] Wikipedia link. https://en.wikipedia.org/wiki/Singlet_oxygen#:~:text=The%20singlet%20has%20only%20one,corresponding%20to%20three%20degenerate%20states.

[183] Wikidoc link. https://www.wikidoc.org/index.php/Singlet_oxygen

[184] Chem.libre link. https://chem.libretexts.org/Bookshelves/General_Chemistry/Book%3A_Structure_and_Reactivity_in_Organic_Biological_and_Inorganic_Chemistry_(Schaller)/V%3A__Reactivity_in_Organic_Biological_and_Inorganic_Chemistry_3/04%3A_Oxygen_Binding_and_Reduction/4.01%3A_Introduction

[185] Semyachkina-Glushkovskaya OV, Sokolovski SG, Goltsov A, Gekaluyk AS, Saranceva EI, Bragina OA, Tuchin VV, Rafailov EU. Laser-induced generation of singlet oxygen and its role in the cerebrovascular physiology. Progress in Quantum Electronics 2017; 55: 112-28. https://doi.org/10.1016/j.pquantelec.2017.05.001

[186] Amaroli A, Pasquale C, Zekiy A, Utyuzh A, Benedicenti S, Signore A, Ravera S. Photobiomodulation and oxidative stress: 980 nm diode laser light regulates mitochondrial activity and reactive oxygen species production. Oxidative Medicine and Cellular Longevity 2021; 2021: 1-1. https://doi.org/10.1155/2021/6626286

[187] Zhou X, Wang Y, Si J, Zhou R, Gan L, Di C, Xie Y, Zhang H. Laser controlled singlet oxygen generation in mitochondria to promote mitochondrial DNA replication *in vitro*. Scientific Reports 2015; 5(1): 16925. https://doi.org/10.1038/srep16925

[188] Maharjan PS, Bhattarai HK. Singlet oxygen, photodynamic therapy, and mechanisms of cancer cell death. Journal of Oncology 2022; 2022. https://doi.org/10.1155/2022/7211485

[189] Chrétien D, Bénit P, Ha HH, Keipert S, El-Khoury R, Chang YT, Jastroch M, Jacobs HT, Rustin P, Rak M. Mitochondria are physiologically maintained at close to 50 C. PLoS Biology 2018; 16(1): 2003992. https://doi.org/10.1371/journal.pbio.2003992

[190] Terzioglu M, Veeroja K, Montonen T, Ihalainen TO, Salminen TS, Bénit P, Rustin P, Chang YT, Takeharu N, Jacobs HT. Mitochondrial temperature homeostasis resists external metabolic stresses. bioRxiv 2023; 2023-05. https://doi.org/10.7554/eLife.89232.1

[191] Wikipedia Infrared spectrum. https://en.wikipedia.org/wiki/Infrared.

[192] Voeikov VL. Reactive oxygen species—(ROS) pathogens or sources of vital energy Part 1 ROS in normal and pathologic physiology of living systems. Journal of Alternative & Complementary Medicine 2006; 12(2): 111-8. https://doi.org/10.1089/acm.2006.12.111

[193] Voeikov VL. Reactive oxygen species (ROS): pathogens or sources of vital energy Part 2 Bioenergetic and bioinformational functions of ROS. Journal of Alternative & Complementary Medicine 2006; 12(3): 265-70. https://doi.org/10.1089/acm.2006.12.265

[194] Voeikov VL. Fundamental role of water in bioenergetics In Biophotonics and Coherent Systems in Biology 2007; (pp. 89-104). Springer, Boston, MA. https://www.researchgate.net/publication/227058174_Fundamental_Role_of_Water_in_Bioenergetics. https://doi.org/10.1007/978-0-387-28417-0_7

[195] Voeikov V. Reactive oxygen species, water, photons, and life. In Biology Forum/Rivista di Biologia 2010; (103): Voeikov VL, Del Giudice E. On the relationship between exclusion

zones and coherencedomainsin water https://waterjournal.org/uploads/vol5/supplement/Voeikov%20and%20DelGiudice.pdf.

[196] Gudkov SV, Astashev ME, Bruskov VI, Kozlov VA, Zakharov SD, Bunkin NF. Self-oscillating water chemiluminescence modes and reactive oxygen species generation induced by laser irradiation; effect of the exclusion zone created by Nafion. Entropy 2014; 16(11): 6166-85. https://doi.org/10.3390/e16116166

[197] Tuszynski JA. From quantum chemistry to quantum biology: A path toward consciousness. Journal of Integrative Neuroscience 2020; 19(4): 687-700. https://doi.org/10.31083/j.jin.2020.04.393

[198] Li T, Tang H, Zhu J, Zhang JH The finer scale of consciousness: quantum theory. Annals of Translational Medicine 2019; 7(20). https://doi.org/10.21037/atm.2019.09.09

[199] Fields C, Friston K, Glazebrook JF, Levin M. A free energy principle for generic quantum systems. Progress in Biophysics and Molecular Biology 2022; 173: 36-59. https://doi.org/10.1016/j.pbiomolbio.2022.05.006

[200] Marais A, Adams B, Ringsmuth AK, Ferretti M, Gruber JM, Hendrikx R, Schuld M, Smith SL, Sinayskiy I, Krüger TP, Petruccione F. The future of quantum biology. Journal of the Royal Society Interface 2018; 15(148): 20180640. https://doi.org/10.1098/rsif.2018.0640

[201] Atkinson R, Baulch DL, Cox RA, Crowley JN, Hampson Jr RF, Kerr JA, Rossi MJ, Troe J. Summary of evaluated kinetic and photochemical data for atmospheric chemistry IUPAC Subcommittee on gas kinetic data evaluation for atmospheric chemistry 2001; 20. https://doi.org/10.1002/chin.198920332

[202] Kim Y, Bertagna F, D'souza EM, Heyes DJ, Johannissen LO, Nery ET, Pantelias A, Sanchez-Pedreño Jimenez A, Slocombe L, Spencer MG, Al-Khalili J. Quantum biology: An update and perspective. Quantum Reports 2021; 3(1): 80-126. https://doi.org/10.3390/quantum3010006

[203] Cui Q, Karplus M. Is a "proton wire" concerted or stepwise A model study of proton transfer in carbonic anhydrase. The Journal of Physical Chemistry B 2003; 107(4): 1071-8. https://doi.org/10.1021/jp021931v

[204] Salna B, Benabbas A, Sage JT, van Thor J, Champion PM. Wide-dynamic-range kinetic investigations of deep proton tunneling in proteins. Nature Chemistry 2016; 8(9): 874-80. https://doi.org/10.1038/nchem.2527

[205] Odella E, Secor M, Reyes Cruz EA, Guerra WD, Urrutia MN, Liddell PA, Moore TA, Moore GF, Hammes-Schiffer S, Moore AL. Managing the redox potential of PCET in grotthuss-type proton wires. Journal of the American Chemical Society 2022; 144(34): 15672-9. https://doi.org/10.1021/jacs.2c05820

[206] Odella E, Mora SJ, Wadsworth BL, Goings JJ, Gervaldo MA, Sereno LE, Groy TL, Gust D, Moore TA, Moore GF, Hammes-Schiffer S. Proton-coupled electron transfer across benzimidazole bridges in bioinspired proton wires. Chemical Science 2020; 11(15): 3820-8 https://doi.org/10.1039/C9SC06010C

[207] Goings JJ, Hammes-Schiffer S. Nonequilibrium dynamics of proton-coupled electron transfer in proton wires: concerted but asynchronous mechanisms. ACS Central Science 2020; 6(9): 1594-601. https://doi.org/10.1021/acscentsci.0c00756

[208] Whang SY Reverse aging Jsp Publishing; 1991.

[209] Carpenter D. https://www.scribd.com/document/366165197/Change-Your-Water-Change-Your-Life-pdf#.

[210] Ostojic SM, Stojanovic MD. Hydrogen-rich water affected blood alkalinity in physically active men. Research in Sports Medicine 2014 22(1): 49-60. https://doi.org/10.1080/15438627.2013.852092

[211] Chycki J, Kurylas A, Maszczyk A, Golas A, Zajac A. Alkaline water improves exercise-induced metabolic acidosis and enhances anaerobic exercise performance in combat sport athletes. PloS One 2018; 13(11): https://doi.org/10.1371/journal.pone.0205708

[212] Price MJ, Singh M. Time course of blood bicarbonate and pH three hours after sodium bicarbonate ingestion. International Journal of Sports Physiology and Performance 2008; 3(2): 240-2. https://doi.org/10.1123/ijspp.3.2.240

[213] Mueller SM, Gehrig SM, Frese S, Wagner CA, Boutellier U, Toigo M. Multiday acute sodium bicarbonate intake improves endurance capacity and reduces acidosis in men Journal of the International Society of Sports Nutrition 2013 Mar 26; 10(1): 16. https://doi.org/10.1186/1550-2783-10-16

[214] Durkalec-Michalski K, Zawieja EE, Podgórski T, Zawieja BE, Michałowska P, Łoniewski I, Jeszka J. The effect of a new sodium bicarbonate loading regimen on anaerobic capacity and wrestling performance. Nutrients 2018; 10(6): 697. https://doi.org/10.3390/nu10060697

[215] Delextrat A, Mackessy S, Arceo-Rendon L, Scanlan A, Ramsbottom R, Calleja-Gonzalez J. Effects of three-day serial sodium bicarbonate loading on performance and physiological parameters during a simulated basketball test in female university players. International Journal of Sport Nutrition and Exercise Metabolism 2018; 28(5): 547-52. https://doi.org/10.1123/ijsnem.2017-0353

[216] Singh AK, Singh S, Garg G, Rizvi SI. Rapamycin alleviates oxidative stress-induced damage in rat erythrocytes. Biochemistry and Cell Biology 2016; 94(5): 471-9. https://doi.org/10.1139/bcb-2016-0048

[217] Singh AK, Singh S, Garg G, Rizvi SI. Rapamycin mitigates erythrocyte membrane transport functions and oxidative stress during aging in rats. Archives of Physiology and Biochemistry 2018; 124(1): 45-53. https://doi.org/10.1080/13813455.2017.1359629

[218] Szlachcic E, Czarnoleski M. Thermal and oxygen flight sensitivity in aging Drosophila melanogaster flies: links to rapamycin-induced cell size changes. Biology 2021; 10(9): 861. https://doi.org/10.3390/biology10090861

[219] Garratt M, Nakagawa S, Simons MJ. Comparative idiosyncrasies in life extension by reduced mTOR signaling and its distinctiveness from dietary restriction. Aging Cell 2016; 15(4): 737-43. https://doi.org/10.1111/acel.12489

[220] Bjedov I, Rallis C. The target of the rapamycin signalling pathway in aging and lifespan regulation. Genes 2020; 11(9): 1043. https://doi.org/10.3390/genes11091043

[221] Stallone G, Infante B, Prisciandaro C, Grandaliano G. mTOR and aging: an old fashioned dress. International Journal of Molecular Sciences 2019; 20(11): 2774. https://doi.org/10.3390/ijms20112774

[222] Weichhart T. mTOR as a regulator of lifespan, aging, and cellular senescence: a mini-review. Gerontology 2018; 64(2): 127-34. https://doi.org/10.1159/000484629

[223] Chrienova Z, Nepovimova E, Kuca K. The role of mTOR in age-related diseases. Journal of Enzyme Inhibition and Medicinal Chemistry 2021; 36(1): 1678-92. https://doi.org/10.1080/14756366.2021.1955873

[224] Guertin DA, Sabatini DM. An expanding role for mTOR in cancer. Trends in Molecular Medicine 2005; 11(8): 353-61. https://doi.org/10.1016/j.molmed.2005.06.007

[225] Mota-Martorell N, Jové M, Pamplona R. mTOR complex 1 content and regulation is adapted to animal longevity.

International Journal of Molecular Sciences 2022; 23(15): 8747.
https://doi.org/10.3390/ijms23158747

[226] Wikipedia for Luis Kervran. https://en.wikipedia.org/wiki/Corentin_Louis_Kervran.

[227] Bockris JO, Mallove EF. The occurrence of cold nuclear reactions widespread throughout Nature. Infinite Energy 1999; 27: 29-38.

[228] Kozima H. Biotransmutation as a cold fusion phenomenon. Proc JCF16 2016; 16(18): 216-39.

[229] Meessen A. Explanation of Cold Nuclear Fusion and Biotransmutations. Journal of Modern Physics 2023; 14(7): 1087-116.
https://doi.org/10.4236/jmp.2023.147060

[230] Kervran CL, Abehsera M. Biological Transmutations, and Their Applications in Chemistry, Physics, Biology, Ecology, Medicine, Nutrition, Agriculture, Geology. 1972. Swan House Publishing, Brooklyn, New York, USA.

[231] Kornilova AA, Vysotskii VI, Gaydamaka SN, Gladchenko MA. Nuclear Reactions in Living Nature: The Possibility of Biological Processing and Deactivation of Liquid Radioactive Waste 2019.Physical and Mathematical Modeling of Earth and Environment Processes (2018) 4th International Scientific School for Young Scientists, Ishlinskii Institute for Problems in Mechanics of Russian Academy of Sciences (pp. 213-230) Cham: Springer International Publishing.
https://doi.org/10.1007/978-3-030-11533-3_21

[232] Goldfein S. Energy development from elemental transmutations in biological systems US Army Mobility Equipment Research and Development Command; 1978.

[233] Kozima H, Kaki K The Cold Fusion Phenomenon and Neutrons in Solids Proc JCF16 2016; 16(14): 158-98.

[234] Kozima H. Biotransmutation as a cold fusion phenomenon. Proc JCF16 2016; 16(18): 216-39.

[235] Kozima H. The Cold Fusion Phenomenon-What is It? Proc JCF14 2014; 14(16): 203-30.

[236] Sugihara S, Maiwa H. How Element Changes Proceed with Nuclear Transmutation by Pairs of Electron and Proton in Hydrogen Atom of Water.

[237] Sbitnev VI. Quantum consciousness in warm, wet and noisy brain. Modern Physics Letters B 2016; 30(28): 1650329.
https://doi.org/10.1142/S0217984916503292

[238] Wynter C. End the Mind/Brain False Dichotomy.

[239] Steele EJ. Quantum Weirdness and Living Systems: A Personal Perspective Quantum 2017.

[240] Castañeda Cataña MA, Amato R, Sepulveda C, Carlucci MJ. Knowledge Evolution: Inert sciences to living science. Glob J Ecol 2022; 7(2): 082-9.
https://doi.org/10.17352/gje.000066