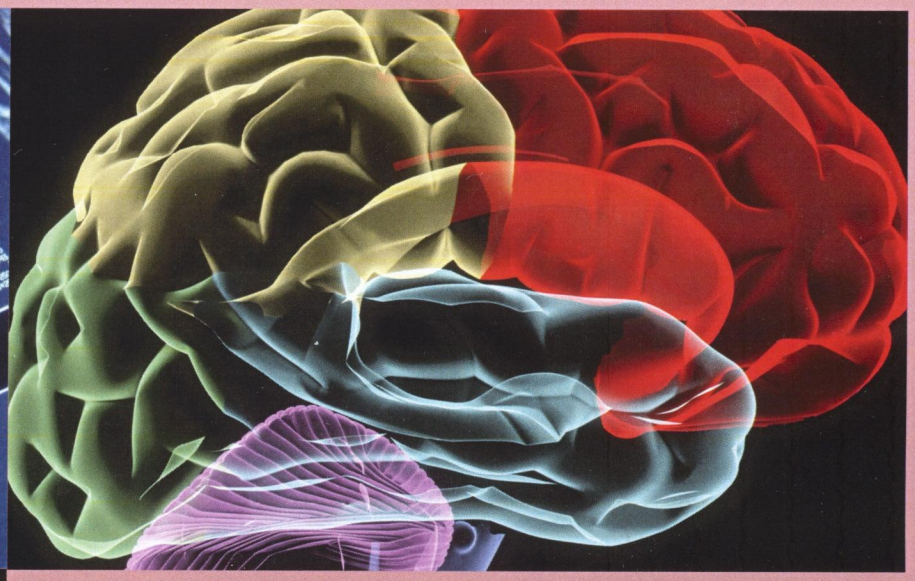

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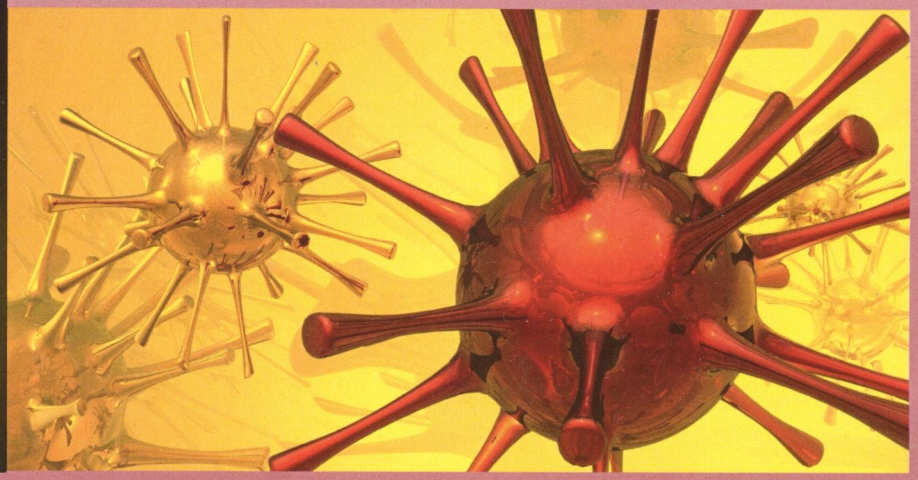

Editors:

Dr. Ronald Klatz

Dr. Robert Goldman

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Chapter 33

Mitochondria and Cellular Aging

James L. Oschman, Ph.D.[1]
President, Nature's Own Research Association

ABSTRACT

Physics defines "energy" as the ability to do work. This definition can be used to follow the flows of energy through the human body. For example, a single photon of light has enough energy to do the work of changing the structure of a pigment molecule in the retina so we can detect light, leading to a nerve impulse to the visual cortex. Gravity does the work of damaging tissues when we fall down. Sound causes hair cells in the inner ear to vibrate so we can hear. The chemical energy from adenosine triphosphate (ATP) does the work that enables nerves to conduct messages and that powers the migrations of white blood cells to a site of injury. In terms of anti-aging medicine, we are interested in the factors that can restore and maintain adequate energy supplies and the circulation of energy within our bodies so that vital processes can continue to function optimally throughout our lives. This article considers the biochemical and biophysical aspects of energy production and utilization in the human body, the ways energetic "deficiencies" arise, and how they can be corrected. One focus is on providing metabolic energy to all parts of the immune system to maintain and even amplify the body's natural defense and repair processes. A second topic is the possible role of protons and electrons in energizing cellular processes. Finally, we consider the possible role of electrons in resolving chronic inflammation and maintaining the "inflammatory preparedness" of the organism.

Keywords: longevity, energy metabolism, mitochondria, inflammation, living matrix, physiological balance, electron transport

INTRODUCTION

Physicists define "energy" as the ability to do work. We all know what it is like to simply feel like we don't have any energy to do what we wish to do, just like the woman shown in Figure 1. A variety of factors can go into creating this feeling. It can be a consequence of over-exertion, inadequate nutrition, a lack of exercise, insufficient rest and recovery, emotional upset, depression, illness, injury, imbalanced structure (posture), and so on. In this article we take a deeper look into biological energetics in order to examine the factors that can compromise our physiology and accelerate the aging process. We will also look at preventive steps that can be taken to maintain our energetic integrity and thereby maintain our natural state of longevity.

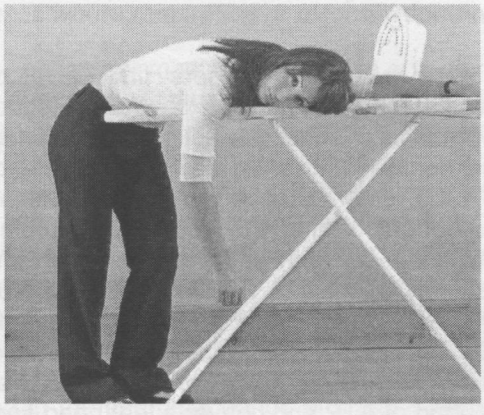

Figure 1. Physics defines energy as the ability to do work. We all know what it feels like to have no energy.

BIOCHEMICAL PATHWAYS

A major focus of modern biochemistry is to define the pathways that provide energy for the various processes that are essential to life. Some important questions:

- How do cells get the energy needed for protein synthesis?
- How do organs get the energy to carry out their functions, such as detoxification by the liver, the formation of the urine by the kidneys, digestion, and so on?
- How are muscles supplied with the energy for contractions that lead to movements of the body?

Muscle contraction is one of the most important of the energetic systems in the body, and has therefore been the subject of much research. A brief history of muscle energetics follows.

Albert Szent-Györgyi began fundamental research on muscle contraction in Szegred, Hungary in 1931. To learn how muscles change their shape and size, and the chemical substances involved, he extracted myosin from rabbit muscle, drew it into a hypodermic syringe, and then pressed it out into fine threads. When Szent-Györgyi added adenosine triphosphate (ATP) to his myosin preparation, the threads rapidly contracted to one-third their original size, just like a muscle fiber does when it is tensing. Previous work had shown that the mitochondria produce the ATP which is the immediate source of energy that powers cellular activities. Szent-Györgyi received the Nobel Prize in 1937 for his research that identified some of the chemical intermediates in energy metabolism. His early work on muscle represented the first time a fundamental physiological process, muscle contraction, was carried out using isolated molecules, *in vitro*. His discoveries paved the way for future research in the field of muscle biochemistry. Szent-Györgyi and his research team went on to discover that muscle tissue contained a second protein, actin, which combined with myosin to form interlocking fibers. We now know that both actin and myosin are found in virtually all cells, not just in muscles. In 1954, Szent-Györgyi received the Lasker Award for his contributions to understanding cardiovascular diseases through basic muscle research. Of his early observations on isolated muscle proteins, Szent-Györgyi said:

> *To see these little artificial muscles jump for the first time was, perhaps, the most exciting experience of my scientific life, and I felt sure that in a fortnight I would understand everything. Then I worked for twenty more years on muscle and learned not a thing. The more I knew, the less I understood; and I was afraid to finish my life with knowing everything and understanding nothing. Evidently something very basic was missing. I thought that in order to understand I had to go one level lower, to electrons, and – with graying hair – I began to muddle in quantum mechanics. So I finished up with electrons. But electrons are just electrons and have no life at all. Evidently on the way I lost life; it had run out between my fingers. I do not regret this wild goose chase – because it made me wiser and I know, now, that all levels of organization are equally important and we have to know something about all of them if we want to approach life.*[2]

On the basis of this early work, researchers first developed a "contracting filament hypothesis" in which the muscle filaments themselves contract. Electron microscope observations, however, did not support this hypothesis. Neither the actin nor the myosin filaments shortened when the muscle contracted. Only the degree of overlap between thick and thin filaments changed. In papers published in 1957 and 1959, Hugh Huxley proposed a Sliding Filament Model, in which contraction results as the cross-bridges linking the actin and myosin molecules tilt and pull the filaments past one another.[3, 4] This is the currently accepted model of muscle contraction.

In 1950 the noted British physiologist, A.V. Hill challenged biochemists to prove that ATP really is the source of energy for muscle contraction.[5] In 1962, Davies and colleagues responded with studies showing that ATP actually does break down during the contraction of muscle.[6, 7] Eventually it was established that the myosin cross bridges have the enzyme ATPase that releases the energy stored in the terminal phosphate bond of ATP and converts that bond energy into the tilt of the myosin head to power movements. The contraction of a muscle, then, arises from the sum of the movements of myosin cross bridges driven by the breakdown of ATP. Further research led to the view that all vital

Chapter 23

Counteracting Aging With Basic Physics

Wolf-Dieter Kessler, M.D., Ph.D. and James L. Oschman, Ph.D.

ABSTRACT

Very weak electromagnetic fields at the appropriate frequencies can be as effective, or even better, than other approaches for reducing inflammation, counteracting diseases, and enhancing longevity. The mechanism involves resonance, the process by which a field of a particular frequency or wavelength can transfer vibrational energy to an object. Clinical applications of electromagnetic resonance have the advantage that they can act at a distance using tiny fields that excite or energize natural processes taking place deep within the body. Resonance is based on simple and understandable biophysics that clearly explains why specific frequencies and not others are therapeutically effective. Two mechanisms are discussed here. The first involves the same theory that has been used in magnetic resonance imaging (MRI) since 1970 to explain how specific frequencies produce resonance in biological structures. The second involves radio antenna theory that is based on the wavelengths of molecules and molecular arrays. Resonance has such broad significance for medicine that there is a need for a summary of the mechanisms involved, which is the purpose of this report.

RESONANT THERAPIES FOR ANTI-AGING MEDICINE

Successful anti-aging medicine can be accomplished by the use of antioxidants and specific electromagnetic fields. Resonance is the mechanism by which a field of a particular frequency can transfer vibrational energy to an object. Clinical applications of electromagnetic resonance have the advantage that they can act at a distance using tiny fields that excite or energize natural processes taking place deep within the body.

One biophysical explanation for the effects of resonant interactions is that they energize the movements of electrons that can neutralize free radicals, preventing or stopping their destructive and aging effects. Techniques for neutralizing free radicals include the consumption of dietary supplements rich in antioxidants (e.g. green tea containing epigallocatechin-3-gallate[1]) and using pulsing electromagnetic fields to induce the movement of mobile or free electrons within the tissues. The electrons must be delivered to the places in the body where they are needed. This involves quantum wave processes including semiconduction and tunneling.

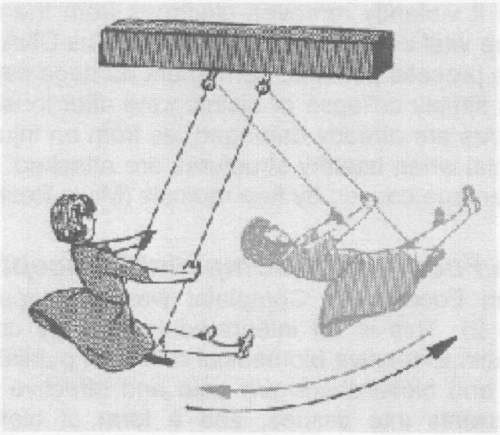

Figure 1. Resonance is demonstrated by pushing a child on a swing. When applied at the appropriate intervals, the pushes cause the child to swing higher and higher. Physicists refer to this arrangement as a pendulum.

In physics, resonance is defined as the tendency of any object to oscillate or vibrate at maximum amplitude at certain frequencies, known as the system's resonant or natural frequencies. At these frequencies, even a tiny rhythmic driving force can build up in the system to produce strong vibrations because the system accumulates each pulse of energy put into it. The familiar example is pushing a child

on a swing (Figure 1). When applied at the appropriate intervals, the pushes cause the child to swing higher and higher. Physicists refer to this arrangement as a pendulum, and the energy is stored alternately as kinetic energy of motion (at the base of the swing where the child is moving the fastest) and gravitational potential energy (at the top of the swing where the motion slows and then momentarily ceases). We will see below that this rhythmic shifting of energy from one form to another, technically known as transitions, is a key to resonance and its clinical applications.

Resonant phenomena occur with all types of matter and with all kinds of vibrations or waves: there is mechanical resonance, acoustic resonance, electromagnetic resonance, and resonance of quantum wave functions. Particles of all sizes can resonate, ranging from electrons to protons to atoms, molecules, molecular assemblies, and entire organisms such as bacteria and viruses. Resonant frequency therapy is a non-invasive treatment that has been reported to provide significant relief for a variety of ailments and medical conditions. The method has been used since the early 1900's, and has been improved upon since that time. We shall examine the physics of resonance from several perspectives to help explain the therapeutic effects.

Different Tissues Age at Different Rates

Some tissues and some organs age faster than others. This is due to differences in levels of infection, inflammation, trauma, or toxic accumulation in different parts of the body. The most rapidly aging area in the body is referred to as the *Main Focus*.[2] This terminology distinguishes from the *Main Complaint*, which is the painful or uncomfortable issue or medical diagnosis that brings the patient to see the doctor. The Main Focus is the area which perturbs all of the other tissues the most. Implicit in these designations is the fact that, for a variety of reasons, the main complaint does not always correspond to the source of the patient's problem. For example, the musculoskeletal system can compensate for an injured or painful condition by shifting loads to other parts of the body that eventually begin to break down as a result of the cumulative strain.

The Main Focus is a region that may be draining energy (ATP, nutrients, oxygen) from other organs and tissues; it may be releasing toxic metabolites; and it may be compromising regulatory communications, cell migrations, musculoskeletal movements, or other processes essential to health. The Main Focus may be the repair field created by a recent or old injury. Total vitality involves all of the organs and organ-systems working together. If one part is compromised, so is the whole. If one can locate the Main Focus and neutralize free radicals and energize or jump-start the healing process in the area, rapid changes can take place throughout the organism, resolving the Main Complaint.

A free radical is an atom, ion, or molecule with one or more unpaired electrons, and is destructive to cells and tissues because it violently removes electrons from them, causing structural damage and compromising functions. Some vital cellular components, such as DNA, can be repaired after free radical damage, but if the destructive process persists, permanent damage can take place, eventually leading to mutations. Cellular structures simply collapse or disintegrate after loosing electrons to free radicals. This is beneficial when the structures are already damaged, as from an injury, and need to be replaced. Free radical damage is not beneficial when healthy structures are attacked. A leading theory states that aging results from the cumulative damage caused by free radicals (Miwa Beckman and Muller 2008[3]).

Application of the Main Focus-Main Complaint Concept

The concept of Main Focus-Main Complaint was developed to facilitate application of the ONDAMED® system (Figure 2). This is an integrated technology combining Pulsing Electromagnetic Fields (PEMF) and biofeedback. Extensive biomedical research published in the peer reviewed literature has shown that both PEMF and biofeedback are safe and effective for a wide range of conditions.[4,5] PEMF induces tiny microcurrents into tissues, and a form of biofeedback known as the vascular autonomic signal or VAS, detected at the radial arterial pulse (Figure 3), is used to select the appropriate frequencies, intensities, and anatomical locations for stimulation. ONDAMED® is unique because it helps locate the anatomical site of the Main Focus and because it adjusts treatments to the individual patient and the processes taking place in the area of the Main Focus. Moreover, the induced currents are well below the levels that cause nerves to depolarize. Hence the patient rarely senses the stimulation, except for the faint sounds emitted by the coils. These sounds and the selected positions of the hand-held applicator provide biofeedback to the patient on the true source of their Main Complaint.

The diagnostic procedure begins with placing a magnetic applicator around the patient's neck to introduce frequencies into their body. The operator then scans through a range of PEMF frequencies from 0.5 to 32,000 Hz by turning the wheel on the regulator (Figure 2). When a physiologically significant frequency is induced into the body via the neck applicator, there is a subtle but palpable change in the radial artery pulse (Figure 3). This is the vascular autonomic signal or VAS. The method was originally developed by the French neurologist, Paul Nogier[6] and is now in widespread use. Specifically, noninvasive measurements of the VAS have become important in clinical medicine and technologies have been developed to provide continuous monitoring of the parameter. The accuracy of the method has been established[7] and several devices have received 510(k) approval from the Food and Drug Administration. Extensive research has shown that the VAS responds to virtually any physiological perturbation affecting any system in the body. The response is a change in the vascular smooth muscles in the arterial walls mediated by the autonomic nervous system.[8] Changes in the tone of the vascular smooth muscles lead to simultaneous changes in a variety of cardiovascular parameters: the initial upstroke of the pressure wave, the pulse pressure, the peak-to-peak interval of systolic pressure, the diastolic level, the flow speed of the radial artery, and the counter pressure of peripheral arteries.[9] When applied in cardiovascular medicine, the method is known as arterial tonometry. It is increasingly used to monitor cardiovascular health and other important physiological parameters.[10]

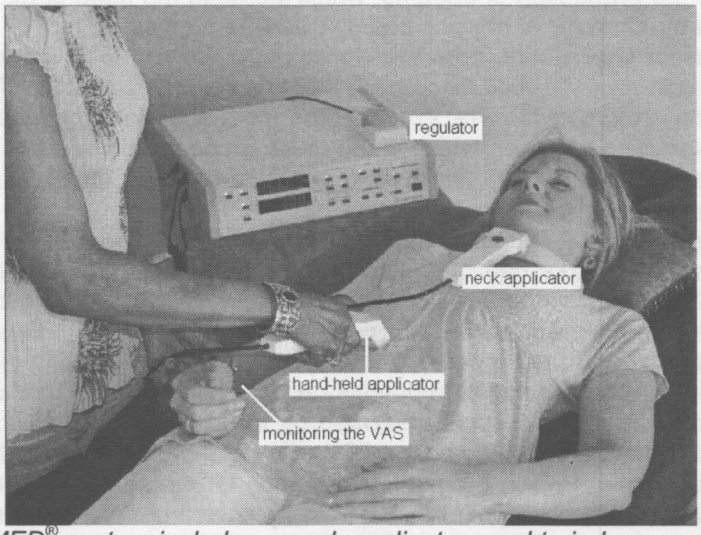

Figure 2. The ONDAMED® system includes a neck applicator used to induce specific frequencies in the range of 0.5 to 32,000 Hz into the body. The operator monitors the radial artery pulse and depresses a button on the regulator when a vascular autonomic signal (VAS) is detected. In a second part of the process, the operator scans with the hand-held applicator to find the anatomical site or sites of the Main Focus.

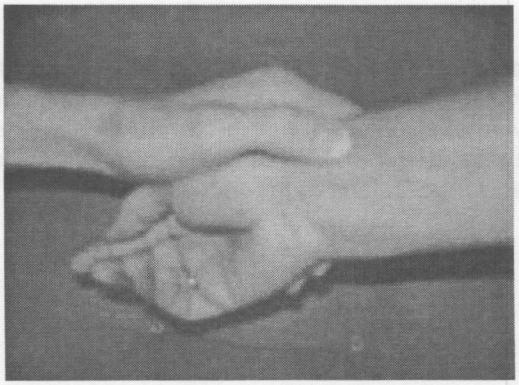

Figure 3. Monitoring the radial artery pulse. When a physiologically significant frequency is induced into the body via the neck applicator, there is a subtle but palpable change in the radial artery pulse. This is the vascular autonomic signal or VAS.

When a VAS response is detected at the radial artery pulse, the operator depresses a button on the regulator and the ONDAMED® stores the frequency in its memory (Figure 2). When the full range of frequencies, 0.5 to 32,000 Hz, has been scanned, the ONDAMED® is shifted to a second mode that enables the operator to determine the anatomical location of the Main Complaint and apply to the area the frequencies detected in the first mode. Localization is done by scanning the body with a hand held applicator that sequentially emits the same frequencies the body responded to during the frequency scan (Figure 2). For each frequency, the appropriate anatomical position of the applicator and the optimal distance from the body are determined, again guided by the radial artery pulse. In this way one or more Main Focus regions are brought into resonance. Various other applicators are available to treat large areas such as the spine or the abdomen.

The next section describes the physical and biophysical mechanisms that explain how resonant electromagnetic fields influence living systems.

Electron and Proton Resonance

Resonance can be explained on the basis of the ways electromagnetic fields interact with the electrons and protons making up the atoms of a structure. To understand resonance we must look at the charge and spin properties of both electrons and protons. We shall see that resonant electromagnetic fields can also lead to the production of photons, which increase the state of excitation within the tissues. Here we are using the terminology of physics and also quantum physics.

In 1989 Professor Cyril Smith, from the University of Salford in England, published his research on "The Electromagnetic Man."[11] He discussed the magnetic resonance of the hydrogen nucleus, otherwise known as the proton, or H^+. The proton is the most abundant magnetic dipole in the body as it arises from the disassociation of water, which is the most abundant molecule in the body. Hartmut Müller has pointed out that the proton is 1800 times more massive than the electron, and that this implies that proton resonance dominates resonant interactions.[12]

Smith also described the dualism between chemical toxins and their resonant frequencies. In other words, a particular molecule can have a biological effect, such as triggering an allergic reaction. Smith discovered that the electromagnetic emission spectrum of the molecule can also trigger the same allergic reaction and that other frequencies can neutralize the reaction.[13,14] This important discovery has been valuable in explaining and treating a wide variety of conditions involving electromagnetic sensitivity, a serious medical condition that is familiar to practitioners of environmental medicine.

Nuclear magnetic resonance has been used by the medical community since 1970. It provides the basis for magnetic resonance imaging or MRI. Could the same principle be used in anti-aging medicine? The answer is yes. Proton magnetic resonance is one source of the frequency specificity of electromagnetic fields. The physics behind this specificity is well understood, and resides in the intrinsic quantum property known as spin. Certain atomic nuclei have non-zero spin and therefore have magnetic moments. This is true of $_2H$, $_3He$, $_{23}Na$, and $_{31}P$. Electrons and protons are both fermions, with half-integer spin or spin ½, which means that they obey the Pauli Exclusion Principle,[15] i.e. a pair of them can exist in a particular region (orbital) only if they have opposite spins. Physicists often refer to the spin states as "spin up" and "spin down."

Precession

In spectroscopy, resonance takes place when the frequency of an electromagnetic field matches the transition frequency of a material. Transitions, in turn, refer to shifts from one energy state to another, as in the transition from gravitational potential energy to the kinetic energy of motion in the "child on a swing" example mentioned above (Figure 1). In the case of electrons and protons, the transitions take place in relation to the spins and precessions of the particles.

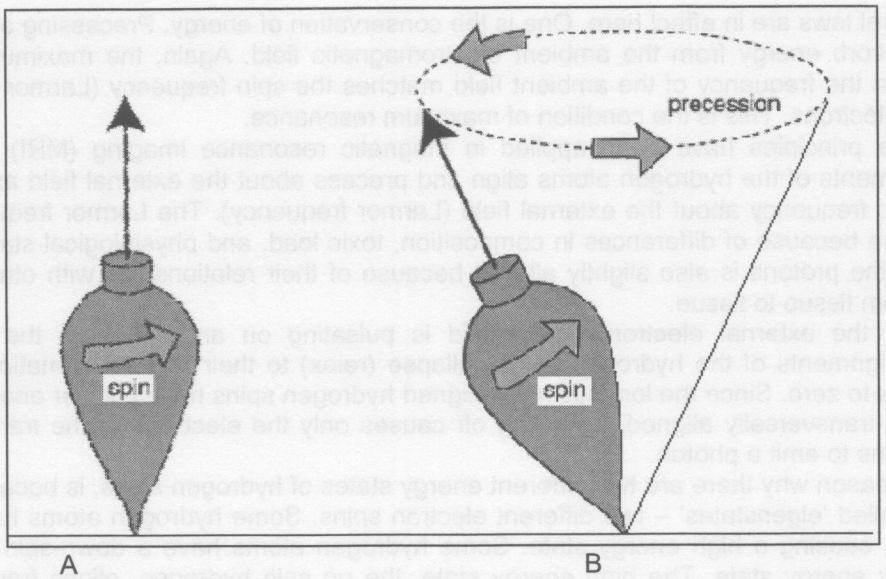

Figure 4. Using a spinning top to visualize precession. A perfectly balanced spinning top (A) will have a certain spin axis, whereas an imbalance will cause precession. This means that the spin axis gyrates so that it traces out a conical surface (B).

The transitions involved in proton magnetic resonance involve precessing of the spin axis. To visualize the meaning of precession, refer to the spinning top, Figure 4. A perfectly balanced spinning top will have its spin axis oriented vertically (Figure 4A), whereas an imbalance will cause the top to precess. This means that the spin axis will gyrate in such a way that it traces out a conical surface (Figure 4B).

There are two kinds of precession, torque-free and torque-induced. Returning to the child on the swing analogy of Figure 1, if someone disturbs the swinging process by pushing in a direction perpendicular to the direction of the swing, a torque will be introduced that causes the swing (pendulum) to precess. This is a torque-induced precession. Alternatively, if the two ropes holding the seat of the swing are made at slightly different lengths, the pendulum will again precess, but in this case the precession is not torque-induced.

Each electron and each proton spins about an axis. These spins give rise to magnetic fields surrounding atoms. When we think of magnetic fields we usually think of iron magnets. Much of living matter does not contain iron, but still has magnetic properties known as diamagnetism and paramagnetism. Diamagnetic materials become weakly magnetic when a magnetic field is applied to them. Water and most organic compounds are diamagnetic. Paramagnetic materials can also be weakly magnetized by an externally applied magnetic field, but the magnetization drops to zero immediately when the external field is removed.

We mentioned that both protons and electrons have the property known as spin. The situation can be compared to the spinning top (Figure 4). In the absence of an external field, there will be a certain spin axis (Figure 4A). If an external field is applied, the spin axis will tilt and will precess – the spin axis of the particle will sweep out a conical surface as shown in Figure 4B. When the electric or magnetic field changes in intensity and/or direction, the tilt of the axis will change accordingly, and the precession frequency will change as well. The frequency of the precession is known as the Larmor frequency, named after Sir Joseph Larmor (1857-1942), an Irish physicist and mathematician.

An oscillating electromagnetic field will increase in intensity and then drop back to zero. Hence precession of the spin axis will increase in intensity and then relax back to the original axis. Because the field is oscillating, there are two transitions. One is a shift to maximum precession as the field reaches maximum strength, and the other is the relaxation back to the original spin state. This is the basic mechanism by which an electromagnetic field of the appropriate frequency will be absorbed by the motions of electrons and protons. In other words, at the appropriate frequency (the Larmor frequency) there will be a strong absorption and rapid transfer of energy from the field to the material. This is the basis for electron spin resonance and nuclear or proton magnetic resonance.

Several laws are in effect here. One is the conservation of energy. Precessing allows the charged particle to absorb energy from the ambient electromagnetic field. Again, the maximum energy uptake happens when the frequency of the ambient field matches the spin frequency (Larmor frequency) of the protons and electrons. This is the condition of maximum resonance.

These principles have been applied in magnetic resonance imaging (MRI) since 1970. The magnetic moments of the hydrogen atoms align and precess about the external field axis. They precess with a specific frequency about the external field (Larmor frequency). The Larmor frequency varies from tissue to tissue because of differences in composition, toxic load, and physiological status. The spinning frequency of the protons is also slightly altered because of their relationships with other nearby atoms, which vary from tissue to tissue.

Since the external electromagnetic field is pulsating on and off, both the longitudinal and transversal alignments of the hydrogen spins collapse (relax) to their original formation, when the field strength drops to zero. Since the longitudinally aligned hydrogen spins have a lower energy state than the ones that are transversally aligned, switching off causes only the electrons of the *transversally* aligned hydrogen atoms to emit a photon.

The reason why there are two different energy states of hydrogen spins, is because the hydrogen has two so-called 'eigenstates' – two different electron spins. Some hydrogen atoms have an up-spin of their electron, causing a high energy state. Some hydrogen atoms have a down-spin of their electron, causing a low energy state. The high energy state, the up spin hydrogen, aligns transversally and its electron emits a photon when the resonant frequency of the external electromagnetic field drops to zero. Photons are absorbed by nearby electrons, which then momentarily jump to a higher energy state. These energized and mobile electrons are then capable of neutralizing free radicals in the repair field of the Main Focus.

Energetic Effects of Resonance

When an imposed electromagnetic field resonates with the protons and electrons in a tissue, an excitation is produced – the overall energy in the tissue increases. Stagnant metabolism converts into dynamic metabolism. Just exactly what does this mean? When we say the energy state is lower or higher in a particular region we must specify precisely what we are talking about. This is important because the term "energy" has been used very loosely in the complementary, alternative, and integrative medicine communities, and this loose language fosters skepticism on the part of physicians and biomedical researchers who look for precise scientific definitions.

One obvious and well known biochemical manifestation of "low energy" in a tissue or organ can be explained on the basis of lowered production of adenosine triphosphate (ATP), which can have a number of causes. For example, it is well known that some areas may have reduced circulation due to tissue damage, compromised blood vessels, tumors, scarring, or hypertoned or hypotoned muscles. Reduced circulation means ischemia and consequent reduction in oxygen and nutrients, and buildup of metabolic wastes. All of these conditions reduce mitochondrial oxidative phosphorylation, and there will be a reduction in the amount of ATP available for all anabolic and catabolic activities. The energy-consuming migrations of lymphocytes and macrophages to and within the repair field will be compromised, and the manufacture and secretion of proteins and other essential tissue components will be slowed.

The role of the living matrix in the movements of protons and electrons is discussed by Oschman elsewhere in this volume.[16]

Prototype: Osteoporosis

Extensive clinical experience has documented that specific electromagnetic frequencies give dramatic pain relief in patients with severe osteoporosis (Kessler *et al*, 2006).[2] After a few sessions using the ONDAMED® technology, patients who were unable to move on their own become mobile again. There is also evidence for increases in bone density. Case studies done by others have confirmed definite improvements in otherwise helpless patients. These results are not mysterious – they are based on the physics of electronic and magnetic resonance and charge density. The clinical observations also fit with the dominant theory of aging: aging results from the accumulation of free radical damage to cells and tissues.[3] Specifically, it is thought that aging results from free radicals removing electrons from otherwise

healthy cells. This electron loss has a wide range of disruptive and destructive consequences to health and longevity.

In 1995, Sisken and Walker listed some of the healing frequencies being tested in medical research laboratories and clinics, and the types of tissues affected.[17] Specifically, 2 Hz is effective for nerve regeneration and neurite outgrowth from cultured ganglia; 7 Hz stimulates bone growth; 10 Hz is effective for ligament healing, 15 and 20 Hz decreases skin necrosis and stimulates capillary growth; and 25 and 50 Hz stimulate fibroblast proliferation and have synergistic effects with nerve growth factor. In the period since that seminal report, countless additional studies have revealed a wide range of frequency-specific tissue responses that are increasingly being applied in clinical medicine.

Resonance can also have epigenetic effects through direct interactions with DNA and protein synthesis.[18,19]

Resonance and Antenna Theory

In radio science, the length of an antenna determines the wavelengths of incoming signals that are matched to or resonate with that antenna. Radio antenna theory states that optimal resonance takes place when the length of an object corresponds to the wavelength of the incoming signal. When the signal and antenna have identical wavelengths, the antenna is said to be a full-wave antenna. When the length of the antenna is an even fraction or multiple of the wavelength of the signal, the antenna is said to be a half-wave or a quarter-wave antenna or a multi-wave antenna. Such shorter or longer antennas will also resonate with an incoming signal. The strength of the resonance depends on having exact fractions or multiples or the resonant wavelength.

Similar relationships exist for molecules or assemblies of molecules in living systems. Dimensions of molecules are widely available from the literature of molecular biology and can be used to calculate biological resonances. Boehm explains the factors involved, including a process for calculating the resonant frequencies of specific types of genomic and protein materials, such as DNA, RNA, genes, sections of genes, enzymes, immune factors, oncogenes, oncogenic growth factors, and proteins of interest. The method includes the following steps: (1) determining the velocity of electromagnetic propagation through the medium surrounding the molecule or molecular assembly in question; (2) determining the length of the material; (3) determining the natural resonant frequency of the material by dividing the velocity of the electromagnetic radiation through the surrounding medium by the length of the material; (4) dividing or multiplying the resonant frequency by a factor of a power of two to obtain a resonant frequency that can be provided by a signal generator; (5) programming the signal generator to emit one or more resonant frequencies in the range selected in step 4; and (6) selectively influencing the target with one or more resonant frequencies.[20]

Signal generators are available for certain parts of the electromagnetic spectrum. When the resonant frequency of a molecule or other important structure falls outside of the range of conventional signal generators, Boehm explains that these devices can be programmed to emit one or more of the subharmonic or higher harmonic frequencies. The calculated resonant frequency is divided or multiplied by the number 2, as many times as necessary, until a frequency in the range of one's device is found. In music, a similar adjustment would be termed moving to a higher or lower octave. Moving to a higher octave cuts the wavelength in half, while moving to a lower octave doubles the wavelength. The lower or higher octaves of a therapeutic resonant frequency will resonate with the primary therapeutic resonant frequency, just as the tones in musical instruments resonate with and amplify each other, provided the octave shifts are exact. Signal generators can also be adjusted to produce electromagnetic fields with additional important characteristics such as power level, wave shape, multiple harmonic content, pulsation frequency, modulation and other factors.

Boehm's method takes into consideration the different media through which a signal is transferred, i.e. from air outside of the body to a fluid medium inside the body. This involves calculations of the refractive index of the media involved in order to allow for appropriate impedance matching as the signal moves from one medium to another.

As an example of applying the method, one could determine the length of the genomic material of an organism, or of a selected part of the genome, by multiplying the number of base pairs by the average spacing between them. The natural electromagnetic resonant frequencies for genomes generally fall in the infrared region of the electromagnetic spectrum. The natural resonant frequencies for genes and smaller portions of DNA or RNA appear in the near infrared, visible, and near ultraviolet regions of the spectrum.

Boehm provides an illustration with considerable biomedical significance: the pathogenic microorganism, *Borrelia burgdorferi* strain B31 – the species of spirochete that is the agent of Lyme disease, and has also been linked to non-Hodgkin lymphoma.[21] Its genome was the third microbial genome ever sequenced, and contains 910,725 base pairs and 853 genes.[22] To determine its length, 910,724 base pairs times the base pair spacing of 3.403846 e^{-10} meters = 3.09996 e^{-4} meters for the total length of the genome. The *in vivo* therapeutic resonant frequency of *Borrelia burgdorferi* DNA genome = 3.415,150,16 e^{+11} Hz, which appears in the infrared range of the electromagnetic spectrum. For practical purposes, a multi-octave shift to the audio range can be obtained by dividing the primary therapeutic resonant frequency by 2^{29}, which gives a therapeutic resonant frequency of 636.12 Hz. In musical terms, as described above, frequencies that are related by a factor of 2, or a power thereof, are known as octaves. The appropriate frequencies for *Borrelia burgdorferi* strain B31 in the audio range are 636.12 Hz, 1272.24 Hz, 2544.5 Hz, 5088.9 Hz, etc. Boehm reports that the 636 Hz frequency is very close to a frequency (640 Hz) that has been useful in treating Lyme disease. These are known as octave-shifted therapeutic resonant frequencies.[20]

There are many other examples of applying sound, radio or electromagnetic signals to disable harmful microorganisms, with each pathogen responding only to a particular frequency. For example, Cominole used frequencies in the short wave part of the electromagnetic spectrum to treat chronic *Staphylococcus* infections, acute inflammatory middle ear, chronic ulcerative colitis, bronchitis, rheumatoid arthritis, gout, flu, and thrombophlebitis, among others.[23] Soviet research beginning in 1974 began to identify which parts and processes in the pathogens are affected by these electromagnetic fields.[24]

Another example provided by Boehm is the precursor gene for *Borrelia burgdorferi* outer surface protein A (ospA), which has a therapeutic resonant frequency of 344.13 Hz. A previously known frequency currently used for therapy related to Lyme disease is 344 Hz, nearly an exact match.

CONCLUDING REMARKS

Free radicals have a paradoxical status in biology: they are constantly produced by living systems and are essential to life, but they can compromise health and speed the aging process under some conditions. Today, free radicals are being implicated in virtually all of the diseases of aging and in the aging process itself. Because the free radical has one or more unpaired electrons, it has charge and magnetic properties that make it highly reactive and very unstable. Many free radicals are so unstable that they can exist for only a fleeting moment – a microsecond or less. Free radicals steal electrons from other molecules. If these molecules belong to cell structures such as membranes or proteins or DNA, repeated free radical damage will cause cell structures and functions to collapse. Loss of electrons and loss of energy lead to degeneration and aging. Electrons are the antidote for free radicals.

Restoration of optimal health involves eliminating areas in the body where there are excess free radicals (e.g. sites of chronic inflammation, necrosis, or ischemia). Once this has been achieved, health and longevity are maintained by keeping a balance between the production and breakdown of free radicals wherever they may be formed in the body for whatever reasons: oxidative metabolism, toxic build-up, or injury. The successful anti-aging clinic first helps the patient restore total health, and then teaches ways of reducing oxidative stress in the future.

The theories described here provide a physical basis for methods that can be used to locate the parts of the body that are aging more rapidly because of low intrinsic energy or low electronic excitation. In particular, unhealthy tissue will have chaotic resonances due to trauma or to different accumulated particles such as heavy metals, viruses, bacteria, fungi, inflammatory debris, etc. The key to convert destructive interference into healthy functioning is resonance. Aging foci resonate to specific frequencies of electromagnetic fields. When this resonance occurs, the therapist can detect it using the simple pulse reaction or VAS. Application of fields at the appropriate frequencies (Larmor frequencies) and/or octave-shifted therapeutic frequencies induces changes in the spins of electrons and protons, and the emission of photons. These photons can excite electrons to migrate and to have a higher energy state. These electrons can actually be attracted to sites of inflammation by semiconduction or electron tunneling (a mechanism described in quantum wave mechanics). The reason for the attraction is that free radicals are electrophiles – they attract electrons because of their net positive charge. The living matrix, which extends throughout the organism, can deliver antioxidant electrons to any point they are needed, provided the matrix is functioning properly.[4,5,16]

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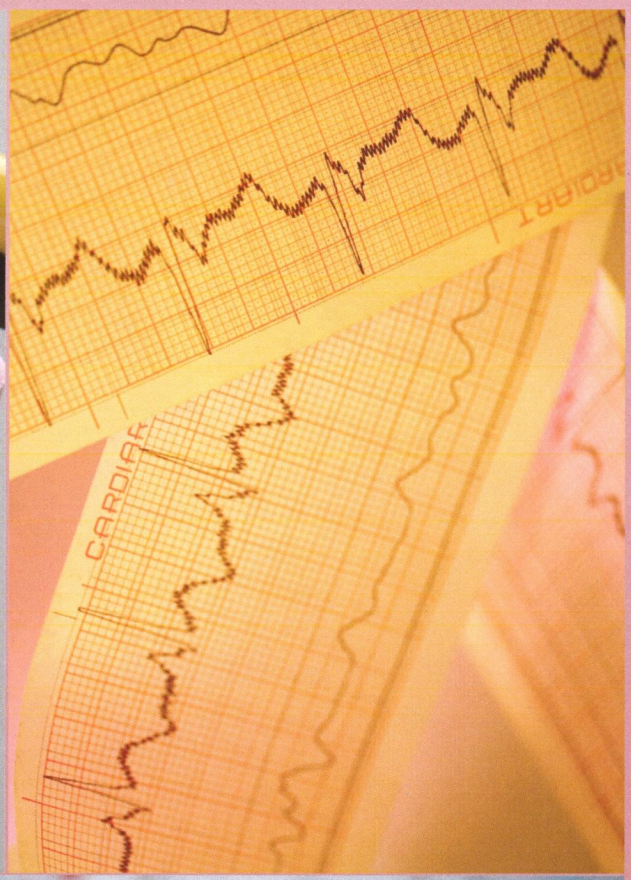
ABOUT THE AUTHORS

Dr. Wolf-Dieter Kessler has been a physican for 34 years. His clinic in Northern Germany is a leading institute for treating acute and chronic diseases. He was part of the lung transplant team at Montefiore Hospital in New York performing mainly electron-microscopical research on both human and canine transplanted lungs. He was confronted with a health problem 35 years ago after contracting a chronic infection (Lamliasis and Coxsackie B4) in India and became highly allergic to almost everything. The lack of satisfactory help in conventional medicine led him to study the latest advances in both conventional and complementary treatments.

Dr. James L. Oschman is a cell biologist and biophysicist. He has published about 90 papers in both leading scientific journals and in complementary medicine journals. He has also written two books on energy medicine, and lectures internationally on the subject. His investigations of the living connective tissue matrix provide the basis for powerful applications of energetics to anti-aging medicine.



American Academy of Anti-Aging Medicine
1510 West Montana Street
Chicago, IL 60614 USA
TEL: (773) 528-4333
FAX: (773) 528-5390
E-MAIL: a4m@worldhealth.net
INTERNET WEBSITES: www.worldhealth.net and www.a4minfo.net

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