Excerpts and Articles on James Oschman's Model of the Intelligent Body.
Website: http://www.energyresearch.bizland.com/index.html

Contents:

SECTION ONE:

Oschman, J. (2003) Energy Medicine in Therapeutics and Human Performance, Butterworth Heinemann

= item, excerpt, or selection number.

#1. From the back cover:

Are there limits to the human body's potential for healing and physical performance?

The body employs regulatory circuitry to maintain a high level of functioning for healing or obtaining optimal performance. Diseases and injuries compromise the regulatory circuitry. In this groundbreaking text, Oschman describes a high-speed communication system in the human body that senses and responds to the energetic environment. This communication system is the substrate for *systemic cooperation* Learning how to achieve more as a therapist, performer or team involves increasing the cooperative interactions within the network that reaches all parts of the body and affects all systems.

Energy Medicine in Therapeutics and Human Performance explores the human body's potential by drawing on an extraordinary range of sources from physiology and biophysics, to examples from the realms of spontaneous healing, cutting-edge athletic and artistic performance, the martial arts, and various contemplative and spiritual practices. Reading like a detective novel, the text presents clues that make no sense by themselves, but reveal a logical pattern when taken together. With new perspectives and theoretical models, the book offers ways to apply these concepts directly,

practically and clinically. Applications include treating traumas of all kinds as well as movement disorders, including paralysis. The concepts open up new maps of the unconscious, intuition, and insight -- subjects previously considered too difficult or imprecise for scientific exploration.

Offering exciting, illuminating and practical insights, Energy Medicine in Therapeutics and Human Performance*:*

- Provides an understanding of the nature of energy medicine by exploring science and common experience.
- Explains complex scientific concepts in ways that are both vivid and easy to grasp.
- Connects abstract theories with practical applications.
- Addresses technical detail in a manner that allows readers from different backgrounds and with different depths of experience to choose their own level of access.
- Includes detailed references to cutting-edge research and time-tested studies for the most well rounded perspective on the subject.

Written by a well-known and highly respected author in this complex and emerging field of study, Energy Medicine in Therapeutics and Human Performance is ideal for anyone interested in hands-on therapeutics, and performance at the cutting edge and beyond.

#2. Book reviewed by Maurie Pressman, M.D. Bridges: ISSSEEM Magazine, v. 15, #2, 2004 Summer (Actual date 2004 Oct.) pp. 14, 20

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We are in an age of remarkable revolution in our thinking, realizations, view of earth and heaven and of how the body works. And all of this is summarized, or at least implied, in a remarkable book by researcher and bio-physicist, James Oschman, Ph.D. The name of the book is Energy Medicine in Therapeutics and Human Performance. He chooses this title because of the relationship of the new physics (the discovery of quantum physics, the breakdown of the atom into smaller components) to therapeutics, which is rendered by a knowledge of the energies within the body, around the body and provided for the body, by a practitioner. It is relevant, also, to exceptional human performance, where the exceptional part of it is related to finding a full flow of smooth and coherent energy. This is the well-known phenomenon of "getting in the zone.

I have written about Oschman in a previous article, speaking about our two nervous systems (The Monthly Aspectarian, December, 2001). But this present book expands upon his previous publication (Energy Medicine: The Scientific Basis). Oschman has gathered an enormous, truly impressive array of references. Firstly these were gathered from the 1990's, a period in which biological, or more specifically, biophysical research, has grown exponentially. "Bio-physical" means a combination of the two great categories of biology and physics-and biology takes on a new aspect and a new meaning now that physics has viewed, studied and gotten to know the smallest components of the atom, which become waves rather than particles.

Oschman points out that there is a system within the body, actually the largest system, called the connective tissue. This is what we look upon ordinarily as "gristle," tendons and fascia. Every organ in the body, indeed every cell in the body is encased in connective tissue. What has been discovered recently is truly remarkable. That is that this connective tissue continues within the cell plasma, and this continuation is in the form of a kind of bony structure called the "cytoskeleton" (cell skeleton). And furthermore, the continuation continues by going within the nucleus. What are the implications? Mostly that there is indeed a continuum within the body, a wholism, which has been neglected by our scientific and medical researchers. One part of the body not only knows what every other part of the body knows (every cell, every interior of the cell) but also is reactive to it.

What is equally important is that each cell within the body, each cell within the continuum of connective tissue, lines up, migrates, forms, vibrates with electro-magnetic energy and forms a second nervous system! This does not neglect the well-known nervous system that begins with the brain and extends to the spinal cord and the peripheral nerves. Indeed it does not; but it does define a second nervous system which also affords a basis for acupuncture, and which operates at the same time as the central nervous system. This second system, mediated by the connective tissue, is part of an ancient nervous (awareness) sensorial complex. This is seen in the reactivity of the most primitive organisms, such as bacteria and protozoa. These little beings are able to sense the environment, react to the environment to protect themselves, and explore the environment to find food and sustenance. This ancient communication system operates underneath and ahead of the central and peripheral nervous system.

The implications of all of this is that there is a wholism within the body, a wholism in which each part connects with the other-instantaneously and ongoingly. Each part adjusts, and the best result in terms of health and performance arrives when there is the greatest coherence or flowing together or acting together.

Furthermore, it has been discovered that whereas our approach (to healing and understanding body function) has been through chemistry, trying to find the right chemical reaction and the right pill to set things aright, the ongoing reactions are truly electro-magnetic. There is a flow within this connective tissue that is twenty times faster than that which runs through the central nervous system. There is an instant reactivity. This was noticed when Oschman described a fly flying onto an eyelash. The blinking of the eye is so fast as to be far beyond that which is mediated by the central nervous system.

There is within the body such a thing as a piezoelectric response. As soon as any tissue is bent or stretched, there is an outpouring of electricity in turn creating a magnetic field. It is the circuitry through which these flows take place that is the basis for the acupuncture meridians. These meridians support the flows of energy from the piezoelectric effect, but they also support many other kinds of regulatory flow, including those involved in emotional expression. This flow of electromagnetic energy is also the basis of transmission of information and even the evocation of the chemical reactions within the body.

This magnetic flow is best when everything is coherent, meaning flowing together. This is the "zone" of exceptional human performance, or the "zone" of exceptional human health. Furthermore this flow of electro-magnetic energy goes beyond the body, creating electro-magnetic waves that

we call the "aura." It extends so that we can feel (if we allow ourselves to be sensitive) a good environment or an unhealthy environment, a good person or one who may not be so good. This is an exchange with the environment. This is the opportunity to receive healing vibrations from the hands of a Reiki practitioner or a hands-on therapist-or even the intentions of a good physician as opposed to one who is overly-hard-pressed and in a hurry.

This new discovery has staggering implications for the further understanding of the human being and of the environment. It has promise for the health of the human being and the health of the environment. It has wonderful promise for the fulfillment of the balance between human and human, called society, for the balance of human and earth called the environmental exchange, for an even higher balance in that which is called "spirituality."

Selected excerpts from 2003 Energy Medicine in Therapeutics and Human Performance

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Appendix A. John McDearmon Moore, Jr. A ;country doctor

Appendix B. Magnetobiology and Electro-dynamic Fields in Therapeutics and Human Performance

Appendix C. Mechanism of Energy Transduction in Biological Systems: New York Academy of Sciences Conference

#5. p. xii *Round about the accredited and orderly facts of every science there ever floats a sort of dust-cloud of exceptional observations, of occurrences minute and irregular and seldom met with, which it always proves more easy to ignore than to attend too. . . . Anyone will renovate his science who will steadily look after the irregular phenomena, and when science is renewed, its new formulas often have more of the voice of the exceptions in them than of what were supposed to be the rules. WILLIAM JAMES*

#6. pp. 61-62 **The importance of connective tissue.** In terms of the goals of this book, there is no perspective that is more important than the systemic properties of the connective tissue and the relation of the connective tissue to the other systems in the body.

The connective tissue is the most abundant component of animal matter and forms the bulk of the animal body. The overall form of the body, as well as the architecture and mechanical and functional properties of all of its parts, are largely determined by the local configuration and properties of the connective tissue. All of the so-called great systems of the body -- the circulation, nervous system, musculoskeletal system, digestive tract, the various organs -- are ensheathed in and partitioned by connective tissue. The connective tissue forms a continuously interconnected systetm throughout the living body. All movements, of the body as a whole and of its smallest parts, are created by tensions carried through the connective tissue fabric. It is a liquid crystalline material and its components are semiconductors, properties that give rise to many remarkable properties. One of the semiconductor properties of connective tissue is *piezoelectricity*, from the Greek, meaning "pressure electricity." Because of piezoelectricity, every movement of the body, every pressure and every tension anywhere, generates a variety of oscillating bioelectric signals or micro currents and other kinds of signals that will be described later. These signals are precisely characteristic of those tensions, compressions, and movements. Because of the continuity and conductivity of connective tissue, these signals spread-throughout the tissues. Because of continuity with cell interiors, to be described next, these micro-currents are conducted into cells. If the parts of the organism are cooperative and coordinated in their functioning and every cell knows what every other cell is doing, it is due to the continuity and signaling properties of the connective tissue.

#7. p. 72 To summarize: The connective tissue and cytoskeletons together form a structural, functional, and energetic continuum extending into every nook and cranny of the body, even into the cell nucleus and the genetic material. All forms of energy are rapidly generated, conducted, interpreted, and converted from one to another in sophisticated ways within the living matrix. No part of the organism is separate from this matrix.

#8. p. 75 For the body to function as a whole, there must be a system that reaches to and into every cell. For the body to function at its absolute peak of performance, all parts and processes must be interconnected by a system that delivers energy and 7 information at the fastest possible means that nature has available. The living matrix is the system of systems that accomplishes these integrative activities.

#9. pp. 88-89 **Semiconductor crystals in living systems** The reason that Szent-Györgyi's suggestion applies to the subject of this book is as follows: The "great number of atoms … arranged with regularity in close proximity, as for example in a crystal lattice" is none other than the living matrix with all of its interconnected components extending throughout the body. The crystalline nature of the living matrix arises from the way the component connective tissue and cytoskeletal and nuclear molecules organize themselves into very regular parallel arrays…

#10. p.93 The phenomena of the living state are, Szent-Györgyi stated, too rapid and subtle to be explained by the slow fluxes of ions across nerve membranes or through inter-cellular spaces. Some other form of rapid communication must be taking place within the tissues. He proposed that this was none other than the migration of electrons, protons, and "holes" through the

semiconducting protein fabric of the body. (When a material gives up an electron, the vacancy left behind behaves like a mobile particle with a positive charge and a mass slightly larger than an electron. The cavity is called a *hole,* and it moves through a crystal much like a positive charge moves.) ..

#11. p. 99 The living matrix is a communication network, and the organized water molecules surrounding the physical fabric are an intimate part of that network, serving as a proton-conducting subsystem.

#12. p. 110 **A Hydrated Vibratory Continuum**. It now is realized that the entire dynamic living matrix is capable of creating, sustaining, propagating, and processing a variety of vibratory entities as messages and as energy. Here we use the word *energy* in the sense of physics: energy is the ability to do work.

#13. p. 134 Specifically, we suggest that the living matrix/acupuncture system may be a distributed communication and energetic network. The meridians may be channels for long-distance physiological communications, and the acupuncture points may represent nodes in the system that are responsible for local distribution of signals arriving from other parts of the body, for inserting local news into the global network, for maintaining the strength and clarity of signals, for processing signals into decisions, and for powering those decisions into certain kinds of actions. Hence we might find at the acupoints switches, amplifiers, couplers, filters, gates, and even memory elements. These are properties that could be looked for, so this is an explicit statement of an hypothesis to be tested or refuted.

#14. p. 141 The living matrix is a molecular system that simultaneously conducts energy and information throughout the body, and that regulates growth, form, and wound healing. Every part of the body is a part of this continuous living matrix. It is a system of systems. Memories are stored within this system, and the totality of its operations gives rise to what we refer to as consciousness … This system is accessed by acupuncture and other complementary medical approaches.

#15. pp. 152-53 **Properties of the living matrix in relation to acupuncture.** Now we briefly summarize the properties of the living matrix in relation to the acupuncture system. For more details, see Chapters 8 through 10.

All components of the living matrix are *semiconductors*. This means they are able to generate and conduct vibrational information. Where two or more components intersect (semiconductor junctions) there is a possibility of signal processing analogous to that taking place in transistors, integrated circuits, or microprocessors found in computers and other electronic devices. Semiconductor molecules convert energy from one form to another. One way this takes place through the *piezoelectric* effect. Many of the components are piezoelectric. This means that waves of mechanical vibration moving through the living matrix produce electric fields, and vice versa; that is, waves of electricity produce mechanical vibrations. Phonons are electromechanical waves in a piezoelectric medium. Piezoelectric properties arise because much of the semiconducting living matrix is highly ordered, or crystalline. Specifically, many of the molecules in the body are regularly arrayed in crystal-like lattices. This includes the lipids in cell membranes, the collagen molecules of connective tissue, the actin and myosin molecules in muscles and other cells, and

other components of the cytoskeleton, such as microtubules and micro filaments. The high degree of structural order (the matter field) gives rise to a highly ordered or coherent electromagnetic field. This electromagnetic field is composed of giant *coherent* or laser like oscillations that move rapidly throughout the living matrix and that also are radiated into the environment. These vibrations are called *Frohlich oscillations*. They occur at particular frequencies in the microwave and visible light portions of the electromagnetic spectrum. A number of scientists have detected these signals.

Water is a dynamic component of the living matrix. On average, each matrix protein has 15,000 water molecules associated with it. Because many of the proteins are highly ordered, as we have just seen, the associated water molecules also are highly ordered. Water molecules are electrically polarized (dipoles) and therefore tend to orient or rotate in a magnetic field. The living matrix organizes the dipolar water molecules in a way that constrains or restricts their ability to vibrate, rotate, or wiggle about in different spatial planes. Water molecules are only free to vibrate or spin in particular directions. The following statement summarizes some recent findings:

> *Water can act as a structural signal transmitter and stabilizer. The water-proton subsystem is imprinted by the appropriate biomolecules. An interplay takes place between geometry and dynamics. . . . [P]rotons behave as a (sub)system having its own properties and characteristics, determining the macroscopic properties of the system as a whole.* Aiello et al. (1973)

Continuity is a characteristic of the system we are describing. The properties just listed are not localized but are spread throughout the organism. Although we may distinguish individual organs, tissues, cells, and molecules, the living matrix is a continuous and unbroken whole. Each part can generate signals, conduct them, and respond to them.

Finally, components of the living matrix undergo reversible polymerization processes, or *gel-sol transitions*. Each time a microtubule or actin filament or other polymeric structure forms, information is encoded into its structure. Before cells divide, their cytoskeletons depolymerize or fall apart, and some of the subunits or fragments assemble into the mitotic apparatus that separates the chromosomes during mitosis. Depolymerization into monomeric units is comparable to erasing a tape recording.

#16. pp. 184 – 185 The current health crisis and the increasing contrast between the results with conventional and complementary approaches can lead us toward a more sane, realistic, and balanced view of ourselves in all of our relations. Like it or not, the future of mainstream medicine depends on its willingness to look at the deep meaning of complementary medical practices and the natural wisdoms of the body they reveal. Ultimately the public will judge the entire biomedical research enterprise by its ability to uncover methods that lead to improvements in curing, caring, and comfort of patients. Which innovations emerge from conventional versus unconventional sources, or from their integration, will be a matter of historical rather than practical importance.

#17. p. 187 **Interacting With Complexity** What brings vitality and aliveness to all of the matrix are not the linear sequences of chemical reactions, messages, or physiological events but the ways they are regulated and integrated We are dealing with .a vast network of processes -- proliferations, specializations, movements, differentiations, dedifferentiations, interactions, cross-linkages, feed-

forwards and feedbacks of startling complexity and diversity -- all directed at a goal of maintaining and restoring *the orderly pattern of the whole.*

Complementary medicine uses a variety of ways of interacting with this complexity. "Hands-on" and "hands-off" therapies focus on the physical and energetic matrix that supports essential communications and cell migrations instead of trying to deal with specific disorders. Systems and continuum thinking are ways of conceptualizing what is going on. Intuition and intention (which are systems and continuum properties) are keys to optimizing structure and function.

If there is one lesson to be learned from the broad spectrum of experiences of complementary practitioners, it is that detailed understandings of physiological and molecular processes, although of interest, are not essential for working at the level of the whole. There are simple reasons for this, articulated in a variety of ways by Weiss, von Bertalanffy, Szent-Györgyi, Capra, Rolf, and others. The whole is not the sum of the parts, and its behavior is not a synthesis of the behaviors of the parts. The whole is governed by certain natural processes, wisdoms, rules. or principles that are-practical and discernable. *Continuum* is one of these principles. As we stated earlier, continuum refers to the state of continuous organic wholeness fundamental to the structure and behavior of the natural world. It is the willingness to operate at this level, which is at the edge of present scientific mystery, that distinguishes the results of complementary therapies from those of conventional medicine.

#18. p. 190 Many of life's most remarkable experiences can begin to be understood by realizing that the body possesses a high-speed, solid-state, semi-conducting electronic communication network that reaches into every nook and cranny of the organism. Of course, most biologists were not prepared for … [Szent-Györgyi] radical idea that electrons and protons might have something to do with life. To this day, many scholarly and knowledgeable academics remain blissfully unaware of the progress that has been made by scientists studying electronic and submolecular biology; however, … [Szent-Györgyi] was convinced that life's activities are far too rapid and subtle to be accounted for solely by signaling in the nervous system and signal molecules randomly diffusing from tissue to tissue. The thesis of this book is that communications within the living matrix organize, integrate and energize the myriad of functions that occur within us every instant of our lives.

#19. p. 190 **Designing An Organism** One way of looking at this is from the perspective of the biologist. Ask the question: What would be the best way of designing an organism so it can respond to its environment in a way that gives it the best chance of survival? Then give the organism millions of years of evolutionary trial and error to test various designs, using all of the laws of physics that are available in nature. What will the outcome?

I believe that the logical outcome will be an organism in which every tissue, cell, molecule, and atom is organized in a highly specific and precise manner that allows all parts to communicate as rapidly as possible with all others. This will enable the organism to find nourishment, protect itself, and respond to a crisis in a way that will provide the highest probability of survival.

#20. p. 191 **Introducing The Problems Of Energy And Information.** A fundamental problem in biology is how energy and information move about within living systems. There is a standard

textbook view implying that these are solved problems. Energy is conducted in the form of molecules, such as sugar or adenosin triphosphate (ATP), which have chemical bonds that can break and release their energy to power life's activities. Information is conducted by action potentials in the nervous system and by hormones and other factors circulating in the blood and other body fluids.

#21. p. 195 Coherent vibrations recognize no boundaries, at the surface of a molecule, cell, or organism. They are collective properties of the whole, and they radiate their messages into the environment in various ways.

#22. pp. 220-221 **Neurons, Glia, And Their Systemic Interactions**

> *For decades, scientists thought that all of the missing secrets of brain function resided in neurons. However, a wave of new findings indicates that glial cells, formerly considered mere supports and subordinate to neurons, participate actively in synaptic integration and processing of information in the brain.* Vesce, Bezzi, and Volterra (2001)
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> *The past decade of studies has changed our view of the integrative capacities and roles of glia. A picture is emerging in which neurons and astrocytes, a subtype of glial cell, are in a continuous regulatory dialogue. . . . It is likely that the results of these recent studies will signal a new way of thinking about the nervous system, in which the glial cell comes to the forefront of our attention.* Mazzanti, Sul, and Haydon (2001)
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> *Glial cells are active partners of neurons in processing information and synaptic integration. The active properties of glia, including long-range signaling and regulated transmitter release, are beginning to be elucidated. Recent insights suggest that the active brain should no longer be regarded as a circuitry of neuronal contacts, but as an integrated network of interactive neurons and glia*. Bezzi & Volterra (2001)
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> *Glial cells are emerging from the background to become more prominent in our thinking about integration in the nervous system. Given that glial cells associated with synapses integrate neuronal inputs and can release transmitters that modulate synaptic activity, it is time to rethink our understanding of the wiring diagram of the nervous system. It is no longer appropriate to consider solely neuron-neuron connections; we also need to develop a view of the intricate web of active connections among glial cells, and between glia and neurons. Without such a view, it might be impossible to decode the language of the brain*. Haydon (2001)

#23. p. 226 Perhaps Valerie Hunt's observations on the dancers imply that the evolutionarily ancient sensory/movement systems found in lower organisms, even bacteria, still exist in the human body and can be accessed under appropriate conditions. Perhaps this is the same system Albert Szent-Györgyi was describing in his research on electronic biology.

#24. p. 229 The main point we are approaching is that there is a theoretical basis for sensory energy inputs at any receptor being conveyed rapidly and without loss into the living matrix system and then throughout the body.

#25. p 230 Sensory systems can respond to one or a few energetic quanta. Because it is an excitable medium, the living matrix can amplify an incoming stimulus to produce a large or even a huge response. The classic example is the carelessly discarded cigarette or match that starts a raging forest fire.

One place this energy could be directed is into the contractile system in muscles. Hence sensory information could bypass or be conveyed parallel to neuronal signals. This would provide for a very rapid response to the environment. It could initiate motor responses prior to perception by the normal neuronal cognitive processes.

#26. pp. 270-271 **Continuum Communication** In terms of both manual therapeutics and biomedicine, the most exciting property of the tensegrous living matrix is the ability of the entire network to generate and conduct vibrations. The vibrations occur as mechanical waves or sounds, called *phonons*, electrical signals, magnetic fields, electromagnetic fields, heat, light. and solitons. In contrast to chemical messengers, energy fields propagate extreme1y rapidly and do not require complex enzymatic systems to break down the messages so the activated process can be turned back off again. For the most part, these forms of energy obey established laws of physics that describe fields from any source. Signals are produced and distributed throughout the body because of properties that are common to all of the components of the living matrix. To summarize:

1. *Semiconduction*: All of the components are semiconductors. This means they can both conduct and process vibrational information, much like an integrated circuit or microprocessor in a computer. They also convert energy from one form to another.

2. *Piezoelectricity*: All of the components are piezoelectric. This means that waves of mechanical vibration moving through the living matrix produce electrical fields and vice versa, that is, waves of electricity moving through the lattice produce mechanical vibrations.

3. *Crystallinity*: Much of the living matrix consists of molecules that are regularly arrayed in crystal like lattices. This includes lipids in cell membranes, collagen molecules of connective tissue, actin and myosin molecules of muscle, and components of the cytoskeleton.

4. *Coherency*: The highly regular structures just mentioned produce giant coherent or laser-like oscillations that move rapidly throughout the living matrix and that also are radiated into the environment. These vibrations are called *Frohlich oscillations*. They occur at particular frequencies in the microwave and visible light portions of the electromagnetic spectrum. A number of scientists have detected these signals (Popp, Li & Gu 1982; Popp et al. 1981).

5. *Hydration*: Water is a dynamic component of the living matrix. On average, each matrix protein has 15,000 water molecules associated with it. Because many of the proteins are highly ordered, as we have just seen, the associated water molecules also are highly ordered. Water molecules are polarized (dipoles). The living matrix organizes the dipolar water molecules in a way that constrains or restricts their ability to vibrate, rotate, or wiggle

about in different spatial planes. Water molecules are only free to vibrate or spin in particular directions.

6. *Continuity*: As we have seen, the properties just listed are not localized but are spread throughout the organism. Although we may distinguish individual organs, tissues, cells, and molecules, the living matrix is a continuous and unbroken whole.

A consequence of continuum communication is that every process taking place anywhere in the organism produces a characteristic pattern of vibrations that travels thru out the living matrix and that undoubtedly distributes regulatory information. In terms of electronics, the signals are FM (frequency modulated) rather than AM (amplitude modulated). The frequency changes every time a cell moves or alters its shape, an organ shifts its functional state, a muscle contracts, a gland secretes, a nerve conducts an impulse, or a cell metastasizes. (Pienta & Coffey 1991). Transmission of vibratory signals through the living matrix imparts unity of function to the organism.

According to the continuum communication model, the living matrix creates a veritable symphony of vibratory messages that travel to and fro, alerting every part of the organism about the activities taking place in each other part. What we refer to as *consciousness* is the totality of these vibrations. Disease, disorder, and pain arise within portions of the vibratory continuum where information and energy flows are restricted. Restrictions occur locally because infections, physical injury, and emotional trauma alter cellular and extracellular properties of the fabric.

The living matrix retains a record or memory of the influences that have been exerted upon it. When vibrations pass through tissues they are altered by the signatures of the stored information. In this way, our consciousness and our choices are influenced by memories stored in the soft tissues.

#27. p. 302 Water is intimately associated with all protein molecules. This "living" water has unique properties as a consequence of its association with the molecules in the living matrix. The study of the water aligned with proteins is a topic that could engage a team of scientists, using the most sophisticated equipment available, for a very long time before even a superficial knowledge of the subject would emerge. Such a study would be extremely worthwhile, however, because it would disclose many keys to understanding health and disease and human functioning.

Fortunately a series of studies using the latest theories in quantum electrodynamics has given us an indication of the nature of the protein-water interactions that come under the heading of "quantum coherence" The major researchers involved in this work include Ho, del Guidice, Doglia, Milani, Vitiello, Frohlich, Preparata, Smith, Popp, and Warnke.

Water has a specific and dynamic structure by virtue of its relationship with proteins, ions, and the other molecules that make up the living matrix and the fluids within it.

#28. p. 303 Proteins in the body and the water around them are essentially inseparable. The water has a structure that mirrors the protein structure, and the protein structure is dependent on the water to shape it and hold it together. If anything happens in or on the protein, things will happen to the surrounding water structure. If anything happens to the water system, it will alter the architecture of the protein.

#29. Pp. 309-310 An "interview" with Mae-Wan Ho based on several of her classic publications: 1997, “Quantum coherence and conscious experience;” 1996, “The biology of free will;” 1996, “Bioenergetics and Biocommunication;” and 1999, “Coherent energy, liquid crystallinity and acupuncture.”

Question: Which part of the body is in control?
Mae-Wan: Nothing is in control, yet everything is in control. Each part is as much in control as it is sensitive and responsive. Choreographer and dancer are one and the same. Global and local, whole and part, are indistinguishable. The living matrix network is a molecular democracy of distributed control. More important than control is the source of the integration that gives rise to large-scale actions that are coordinated in a continuum from the macroscopic to the molecular.

Question: Does consciousness control matter or vice versa?
Mae-Wan: An organic sentient whole is an entangled whole. In the ideal, the self and the environment are domains of coherent activities. This is a pure state that permeates the whole of the being with no definite localizations or boundaries. The coherent self couples coherently to the environment so that one becomes as much in control of the environment as one is responsive.

Question: Where in the brain are consciousness and memory located?
Mae-Wan: Consciousness and memory will not be found at some definite location in the brain. Instead, both are distributed and delocalized throughout the system.

Question: Is there a regular pattern of neural activity related to consciousness?
Mae-Wan: In spite of decades of searching for repeatable patterns in brain activity, none have been found. Every perception is influenced by all that have gone before.

Question: Where do we find the evidence for this organicist perception of a unified theory of consciousness and systemic regulation?
Mae-Wan: The new organicism recognizes no boundaries between disciplines. It arises in the space between all disciplines. It is an un-fragmented knowledge system by which one lives. It is a non-dualist and holistic participatory knowledge system resembling those of traditional indigenous cultures all over the world.

Question: What about the laws of physics and genetics?
Mae-Wan: The laws of physics are not laid down once and for all. They especially do not dictate what we can or cannot think. The sentient coherent being is free of the laws of physics and is free to explore and create its possible futures. For example, living systems are not subject to the laws of thermodynamics. The genetic landscape has been found to be far more flexible and fluid than we thought 10 years ago [circa 1986]. The epigenetic landscape has a fluid topography that includes multiple developmental pathways. The genetic paradigm was fatally undermined at least 10 years ago, when a plethora of "fluid genome" processes were first discovered, and many more have come to light since.

Question: How does quantum coherence relate to bioenergetics?
Mae-Wan: Quantum coherence is far more dynamic than the biochemical models of energy flow. Quantum coherence explains how we can have energy at will, whenever and wherever it is needed. Quantum coherence recognizes a wide variety of possible methods or modes of energy flow and energy storage. Energy can be de-localized over all modes (lifting an object is a mode of energy utilization, as are thinking, running, and breathing) or concentrated into a single mode (such as a defensive, offensive, or protective movement). Energy is always available within the system and can be mobilized with maximum efficiency over all modes. Energy can be transferred directly and immediately to a place where it is needed, without heat loss or dissipation.

Question: Just exactly what is quantum coherence?
Mae-Wan: Organisms are made up of strongly dipolar molecules packed tightly together in regular, almost crystalline arrays. Large voltages are present. Electric and elastic forces cause the molecules in these arrays to vibrate. Because the structures are geometrically coherent, large collective modes or coherent excitations will develop. These are described as phonons or photons. When the coherence builds to a certain level, a large-scale Frohlich wave is produced. In essence, the organism behaves as a single crystal. The antero-posterior axis is the optical axis for the whole organism. There is something very special about organic wholeness that is only describable in terms of quantum coherence.

Question: Is there a good metaphor for quantum coherence?
Mae-Wan: The laser is a good metaphor. Energy is pumped into a cavity containing atoms capable of emitting light. At low levels of pumping, the atoms emit randomly, as in an ordinary lamp. As the pumping energy is increased, a threshold is reached where all the atoms oscillate together in phase and send out a giant light track that is a million times stronger than that emitted by individual atoms. Energy pumping and dynamic order are intimately linked.

SECTION TWO:

16.7. ENERGY MEDICINE MODEL of Oschman 2000, Energy Medicine: The Scientific Basis (an extract Section 16.7. from Part 1: REB Philosophy, Theory and Research Background)

When I finished reading Oschman's brilliant synthesis (2000, Energy Medicine: The Scientific Basis) I came away with the belief that no therapy (cognitive, hypnotic, energetic, or what have you) would be complete without some form of body work or movement treatment. At least I think that all therapists, of whatever persuasion, must seriously consider including movement, stretching, etc. as an adjunct to their regular therapy. The REB^{sm} uses squeezing, blinking, rocking, head and eye movements, postures. While doing the various movement and stimulus activities, clients are tuned into the sensations experienced, maintaining a witness orientation and when there is a change in the felt sense (an indication of energy shifting and thus of progress) they are instructed to send a positive emotional feeling sense to their system (especially the heart) for making this change.

The following are some of the more relevant quotes taken from his extensive and detailed examination. (following pages refer to Oschman, 2000)

CELL STRUCTURE AND THE "LIVING MATRIX"

This topic deals with the structure and energetics of the material substrate of the body.

CELL STRUCTURE AND THE "LIVING MATRIX"

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16.7.1. THE CELL IS NOT A BAG

"...[T]he cell is...filled with filaments and tubes and fibers and trabeculae--collectively called the cytoplasmic matrix or cytoskeleton." (p. 45)

16.7.2. CONTINUUM

[T]he cellular matrix is connected, across the cell surface, with the connective tissue system or extracellular matrix... [There is a] whole class of 'trans-membrane' linking molecules, or 'integrins.'.. The boundaries between the cell environment, the cell interior, and the genetic material are not as sharp or impermeable as we once thought... The entire interconnected system has been called the connective tissue cytoskeleton, the tissue-tensegrity matrix. or simply, *the living matrix* ... 'the web that has no weaver. The living matrix is a continuous and dynamic 'supramolecular' webwork extending into every nook and cranny of the body; a nuclear matrix within a cellular matrix within a connective tissue matrix. In essence, when you touch a human body, you are touching a continuously interconnected system, composed of virtually all of the molecules in the body linked together in an intricate webwork. The living matrix has no fundamental unit or central aspect, no part that is primary or most basic. The properties of the whole net depend on the integrated activities of all the components. Effects on one part of the system can, and do spread to others... [T]he various parts and systems of the body... can be regarded as a local domain or subdivision of a continuous web." (pp. 45-48)

16.7.3. INFORMATION FLOWS

"[I]n order to survive, complex living systems require an intricate web of informational processes. Each component must be able to quickly and appropriately adjust its activities in relation to what the other parts are doing... The biology of wholeness is the study of the body as an integrated, coordinated, successful system. No parts or properties are uncorrelated, all are demonstrably interlinked... [C]ommunications in living systems involve two main languages: the chemical and energetic. Chemical regulations are carried out by hormones, various 'factors'..., and the various 'second messengers' within cells... [E]nergetic interactions are of two kinds, electrical and electronic. The electrical activities of nerves and muscles [are one kind], but there are many other kinds of energetic signaling systems... The entire living matrix is simultaneously a mechanical, vibrational or oscillatory, energetic, electronic, and informational network... Hence the entire composite of physiological and regulatory processes we refer to as 'the living state' take place within the context of a continuous living matrix... [E]very cell receives information on the activities taking place in every other part of the body... Physiological integration is possible because every cell and every molecule fine-tunes its activities appropriately... [T]he living matrix itself is a high-speed communication network linking every part with every other." (pp. 49-51)

16.7.4. BIO-ELECTRO-MANETIC FIELDS OF THE HUMAN BODY

The schematic of the various electromagnetic fields of the body are given in Figures 16.2. to 16.5.

To quote from Oschman (p.77., Figure 6.2) "The overall biomagnetic field of the human body as visualized IN POLARITY THERAPY. Each organ and each tissue contributes to this pattern, which varies from moment to moment in relation to functional activities. The overall shape of the field results mainly from currents set up in the body by the heart, which produces the strongest biomagnetic field. The field is comparable in shape to that developed by … [a] coil is centered around the body axis because of the helical flow of heart electricity through variety of tissues. The main flows are through the circulatory system, which is a good conductor because it is filled with saline solution, plasma. As with the coil …, blood flow up and down through the aorta and major arteries is helical. Muscles are also good conductors of electricity, particularly along their longitudinal axes. There is resistance to current flow across the belly of a muscle. The musculature of the heart and arteries all the way down to the pre=capillaries is helically oriented … As the vascular system begins at the heart and extends into every nook and cranny of the body, it is ideally suited to distribute heart electricity to all of the tissues. (There are about 50,000 miles of blood vessels in the body). In addition, currents set up by the heart flow through the vertically-oriented muscles associated with the vertebral column and backs of the legs – the erectors and hamstring system. … [Figure 16.3.] … shows a representation of the field around the head in an etching drawn by Edwin D. Babbitt (1896), and is abased on the patterns of light he observed around the body after spending some weeks in the dark, which greatly increased his visual sensitivity. … The pattern drawn by Babbitt corresponds primarily to the biomagnetic field expected from movements of nerve impulses through the corpus callosum connecting the two hemispheres of the brain."

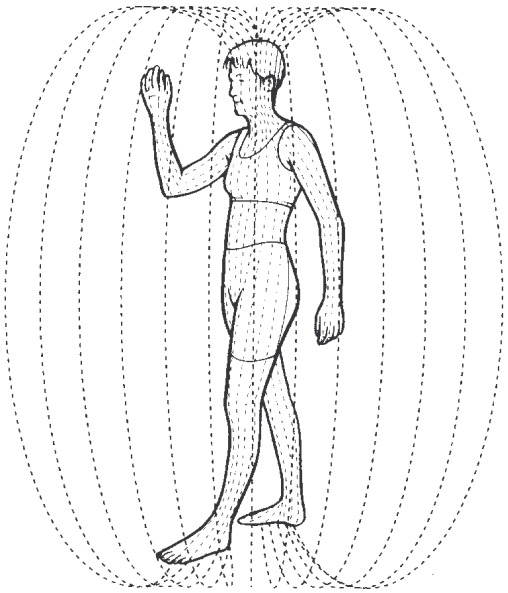

Figure 16.2. The bio-electro-magnetic field of the whole body.

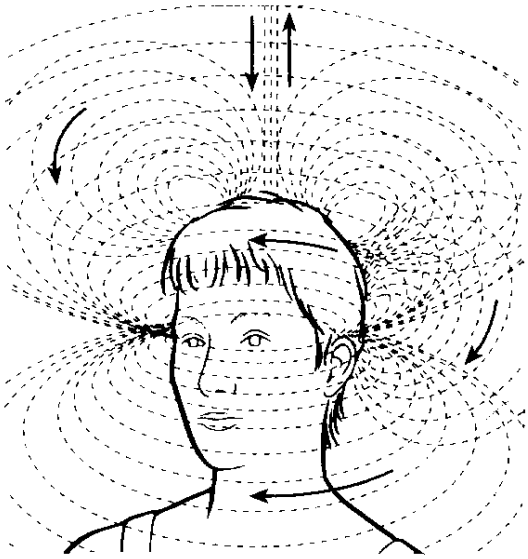

Figure 16.3. The bio-electro-magnetic field of the head.

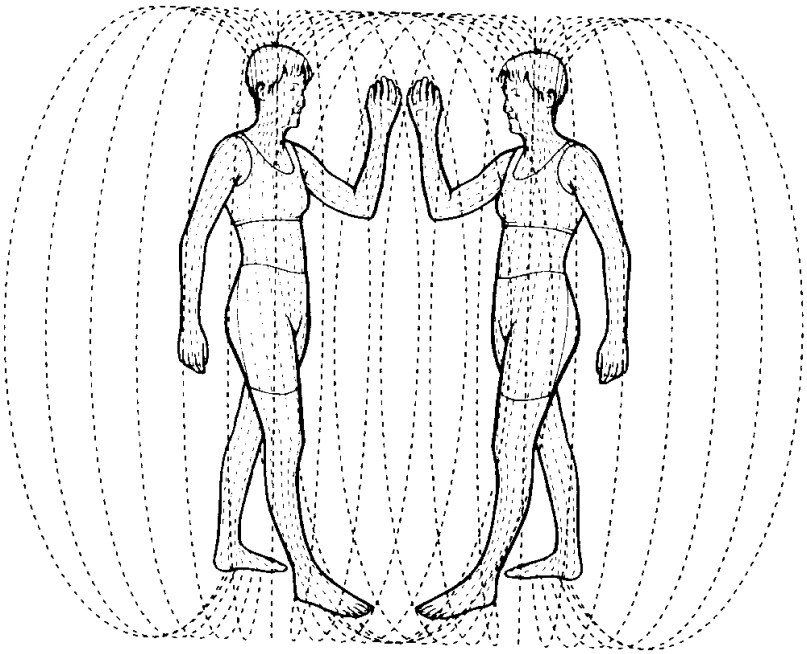

Figure 16.4. The bio-electro-magnetic field of two nearby people.

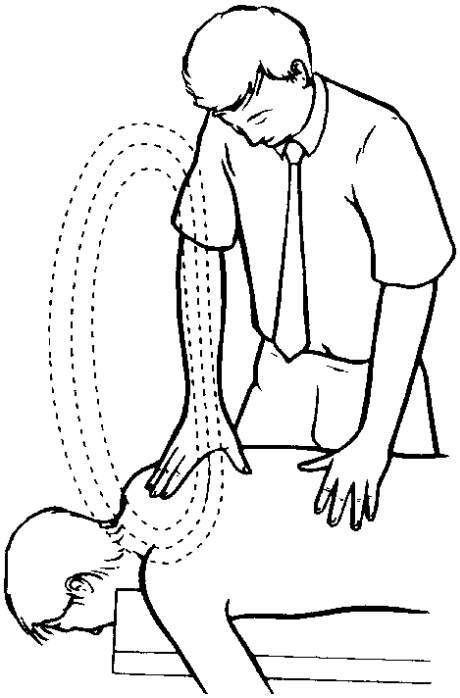

Figure 16.5. The bio-electro-magnetic field of “hands on bodywork”. “Superimposed on a diagram of a soft tissue manipulation (thumb technique) is the pattern of biomagnetic emanations from the practitioners hands.”

16.7.5. PROPERTIES OF THE LIVING MATRIX

"The living matrix continuum includes all of the connective tissues and cytoskeletons of all of the cells, throughout the body. We can summarize its properties as follows:"

"All of the great systems of the body -- the circulation, the nervous system, the musculoskeletal system, the digestive tract, the various organs and glands -- are everywhere covered with material that is but a part of a continuous connective tissue fabric [this is called the peri- systems or collectively the 'surrounding tissues.']... The connective tissues form a mechanical continuum extending throughout the... body, even into the innermost parts of each cell... The connective tissues determine the overall shape of the organism as well as the detailed architecture of its parts... All movement, of the body as a whole or of its smallest parts, is created by tensions carried through the connective tissue fabric... Each tension, each compression, each movement causes the crystalline lattice of the connective tissues to generate bioelectronic signals that are precisely characteristic of those tensions, compressions, and movements... The connective tissue fabric is a semiconducting communication network that can carry the bioelectronic signals between every part of the body and every other part." (p. 55)

16.7.6. COHERENCE

"[N]earby molecules interact with each other via electromagnetic fields... [C]rystalline molecular arrays should vibrate strongly and coherently... [E]normous electrical fields developed across cell

membranes, with the inside negative relative to the outside. Electrical fields are also generated in the collagen arrays to connective tissues (tendons, ligaments, bones, cartilage, fascia) during movements. Activities such as nerve conduction, muscle contraction, and glandular secretion also produce electrical fields. Each activity in the body creates a characteristic field pattern. Moreover, the whole body is polarized, with the head-end negative and the tail- or foot-end positive. Research on electrically polarized molecular arrays reveals that interactions... repeated by the millions of molecules within a cell membrane, tendon, muscle, bone, nerve cell, or other structure, give rise to huge coherent or laser-like vibrations. The vibrations are collective or cooperative phenomena, in which all of the weakly vibrating parts, in the presence of an electric field, become coupled. The result is a strong, orderly, and stable vibration that is far more than the sum of individual vibrations... [T]wo 'new qualities' arise [from these oscillations]. The first is that the crystalline molecular arrays found throughout the body are exceedingly sensitive to energy fields in the environment... The second...is that strong oscillations can travel about within the crystalline network of the body and they can be radiated into the environment... Crystalline components of the living matrix act as coherent molecular 'antennas,' radiating and receiving signals... [T]he water in the spaces between parts of the highly ordered systems is also highly organized. Vibrations of the water molecules can couple to the coherent energy patterns within the protein array. The resulting coherent water system has laser-like properties, and is likely to retain and release electromagnetic information, i.e., have a form of memory." (pp. 130-131)

16.7.7. CELLULAR OSCILLATIONS AND SYSTEMIC REGULATIONS

"[I]nformation is exchanged with the living matrix continuum. This is the continuous network composed of connective tissues, cytoskeletons, and nuclear matrices, and the continuous layers of water adhering to them. Since the living matrix extends into every nook and cranny of the body, it forms a systemic energetic continuum. The overall field of the body, and fields in the environment, affect all of the steps in the regulatory loop. Hence the electromagnetic 'environment' of a hormone-receptor interaction influences and is modified by the interaction... While pathology may manifest as chemical imbalances, the underlying problem is electromagnetic. Hence balance can often be restored by providing the correct or 'healthy' frequency, and entraining the oscillations back to coherence." (p. 135) This is why the REB^{sm} continually asks the clients to replace the negative with the positive.

16.7.8. GRAVITY AND PHYSICAL AND EMOTIONAL STRUCTURE

According to Ida Rolf (structural integration) the following effects of trauma occur.

"Any trauma to the body is recorded as changes in internal structure... [E]ven slight displacements have cumulative and long-term effects, especially if there is a shift in the way weight is carried (a change in the relation to gravity).... [I]t is possible *all* traumas to the body alter the relation to gravity by causing deviations from the ideal pattern, the form we have inherited to enable us to cope with gravity."

"The way the body responds to physical trauma applies equally to the response to an emotional mishap or to a chronic psychological state. Psychological attitudes are always are represented in body structure. Fear, grief, and anger each have a characteristic pose and pattern of movements...'body language.' An emotional response immediately precipitates contraction of flexor

muscles and movement away from structural balance. Once this happens, gravity takes over and pulls the structure downward, making the body shorter... If an individual continues to dramatize an emotional situation, the physical body becomes set into a psychological pattern. Once these changes have taken place, the physical attitude becomes invariable, involuntary. Movements, including respiration, reveal the emotional turmoils. In a balanced body, inspiration involves lengthening of the entire spine, from the sacrum all the way up to the cranium. When movements are restricted, individuals can no longer feel an emotion as an emotion. No longer can they have a natural response to an immediate situation and then get on with their life. Instead, they live, move, and have their being in an attitude. No amount of discussion, thought, or mental suggestion can change the pattern. To escape... the physical tone of the muscles and the structure in relation to gravity must be changed."

"The imbalances resulting from physical or emotional trauma can lead to a whole realm of chronic problems... [G]ratvity is a part of the whole that has been given relatively little attention [in therapy]."

"A physical trauma... can influence the emotional state. A relatively simple accident which nevertheless leaves the body maligned and out of balance can affect the psychological sense of the individual. The kinesthetic body feels inadequate, and the physical structure projects and image of inadequacy." (pp. 160-161)

Body work and movement therapies can extend range and efficiency of motion, flexibility, resiliency, balance, timing, precision and **emotional integration**.

"Muscular balance is the outward and visible sign that vital communications and energy flows are functioning freely... the flow of body fluids, the flow of neural impulses and the flow of vibrations through the semiconducting tensegrous living matrix. These are the vibrations that convey the information needed for the support system to adapt itself to the way it is being used, and to repair injuries." (p. 166) Thus, to change a chronic emotion, change the way you move, sit, and be.

16.7.9. SOME CONCLUSIONS

"Body shape and patterns of movement simultaneously tell three stories, each relating to the way we experience gravity:"

1. "A evolutionary history, representing [how] our ancestors adapted to live in the gravity field of our planet."
2. "A shorter history of personal traumas and adaptations during our lifetime."
3. "The story of our present emotional state, including the effects of our most recent experiences."

"[A]ny therapy that brings the visible parts of the body into alignment, or that restores flexibility and mobility, will, at the same time, facilitate vital communications and thereby have beneficial effects upon the health of the fascial supporting systems. Once the body has been organized around the vertical, and dynamic movements have become optimized, 'gravity becomes the therapist'." (pp. 173-174)

"On the basis of what is now known about the roles of electrical, magnetic, elastic, acoustic, thermal, gravitational, and photonic energies in living systems, it appears that there is no single 'life force' or 'healing energy' in living systems. Instead, there are many energetic systems in the living body, and many ways of influencing those systems... [T]he 'living state' and../'health' are all of these systems both known and unknown, functioning collectively, cooperatively, synergistically... [This involves the study of] the interactions between biological energy fields, structures, and functions." (p. 219)

"Every system in the body has an accompanying 'peri-' system which we can call collectively the 'surrounding tissues.' You can distinguish between the primary function of a particular system and the functions of the connective tissue system that surrounds and maintains it. The nerves, blood vessels, bones, muscles etc. have this peri- system that helps the system function. These 'peri-' systems have an important role in regeneration and repair (healing) as well as a global communication function in the total system." (pp. 231-233)

"There is an emerging new definition of living matter which incorporates the 'new' physics and chemistry (solid state, semiconduction, quantum mechanics, liquid crystals, and biological coherence). [T]iny amounts of energy at the appropriate frequency can produce profound biological effects...[C]ells maintain their organized society by 'whispering together' in a faint and private language. The 'whispers' travel as both chemical and electromagnetic messages... In the past, we thought the words of the 'language of life' were nerve impulses and molecules, but we now see that there is a deeper layer of communication underlying these familiar processes. Beneath the relatively slow moving action potentials and billiard ball interactions of molecules lies a much faster and subtle realm of interactions. This dimension is subatomic, energetic, electromagnetic and wave-like in character. The chemical messenger ultimately transfers its information electromagnetically. Hence the electromagnetic code is actually primary. Nerve impulses and chemical messengers are contained within the individual whereas energy fields radiate indefinitely into space and therefore effect others who are nearby... The electromagnetic language has two aspects, frequency and intensity... [L]aboratory research is confirming [that] when it comes to triggering healing responses, 'small is powerful,' or 'less is more.' The search for an appropriate essence is in fact a search for compounds with the correct molecular emission spectrum to provide benefit for a particular ailment in a particular patient at a particular time..." (pp. 250-251)

SECTION THREE:

THE INTELLIGENT BODY[1]

James L. Oschman, Ph.D.[2]

Bridges Quarterly Magazine of the International Society for the Study of Subtle Energies and Energy Medicine, Spring 2005, v. 16, #1, pp. 3, 10-14

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1. Introduction

In spite of a century of neuroscience and a decade of the brain, we are still unclear about the nature of physiologic consciousness and its relations to learning, memory, intelligence, the subconscious, the unconscious, and intuition.

The matrices within and between cells in the human body, collectively called the *living matrix*, give rise to a primordial and evolutionarily ancient form of intelligence or consciousness that predates the nervous system.[3] This matrix provides a basis for a number of healing and related phenomena that have seemed elusive or mysterious in the past. First, it is the matrix that responds to a wide range of bodywork, energetic and movement therapies that often are said to lack correspondences with conventional biomedicine. These therapies are successful in "jump starting" the healing process, sometimes in medically "incurable" conditions, because they address this whole-body matrix system and aren't limited to neural and hormonal mechanisms.

2. Historical Background: Problems with the Neuron Doctrine.

Much of modern research on consciousness has been based on the 1963 Nobel Prize studies of Sir John Carew Eccles. His model explained how the brain makes myriads of decisions that give rise to the conscious "moment." However, in spite of the major direction he established in neuroscience, Eccles concluded in 1993 that his model could not account for non-physical and transcendent properties of mind: feelings, thoughts, memories, intentions, emotions.[4] This was not welcome news to many in the neuroscience community. Eccles suggested that it might be necessary to explore the quantum properties of the neural synapse to locate the ultimate connection between mind and brain. Hence the timeliness of the essay in the issue of Bridges [2005, “The possible mediating role of quantum mechanical phenomena in mind-body interactions”, Spring, v. 16, #1, pp. 15-20] by Larry Goldberg, exploring the role of quantum mechanical phenomena in consciousness.

3. Neurons as Cells.

In 1961, MIT scientist Francis O. Schmitt,[5] the founder of the Neurosciences Research Program, suggested that electrophysiological methods were unlikely to resolve the problems of memory and consciousness. He pointed out the enormous capacity of biopolymers to store information:

> *Only in giant macromolecular polymers is the diversity possible that is required for the specificity manifested in fundamental life phenomena. A polymer composed of 1 000 monomers of 4 monomer species (e.g., RNA) could have 41,000 variants; with 20 monomer species (protein) there could be 20^{1000} variants!*

But, where in the organism might we find the giant macromolecular polymers that Schmitt referred to? We know that they are in neurons-but what about other cells and tissues?

In 1999, Stuart Hameroff[6] reminded us that neurons are cells:

> *. . . individual neurons are far more complex than simple switches, with enormous capacity for intracellular information processing. The neuron doctrine ignores the fact that neurons are living cells.*

While many scientists continued to pursue neural/synaptic mechanisms of consciousness, Hameroff and others began to explore cellular memory, and a number of researchers focused on the microtubule as a potential memory device. Neurons are packed with microtubules, which are polymers of the protein, tubulin, along with other microtubule proteins.

4. The Evolution of Intelligence.

Some philosophers and evolutionary biologists have assumed that primitive organisms such as bacteria and protozoa cannot be conscious. They take the position that a nervous system is needed for consciousness. However, it does not take a rocket scientist to know that intelligence is present in all life, including plants. If you doubt this, look at a flower, and then tell me that plants lack intelligence!

Even the simplest microorganisms sense their environment and respond to it. For example, the most rudimentary of bacteria grow in the direction of nutrients; motile flagellated bacteria propel themselves toward nutrients and oxygen, and away from toxic chemicals. These organisms thus meet the criteria for sentience, which is defined as having sense perception, being conscious.

Hameroff noted that "simple" animals such as paramecia swim gracefully, avoid predators, find food and mates, and have sex, all without a single synapse. In 1951, the British neuroscientist, Sir Charles Sherrington,[7] said of this: "Of nerve there is no trace. But the cell framework, the cytoskeleton might serve." And in 1999 Hameroff added,

> *If the cytoskeleton can be so useful in protozoa, what might it be doing in the highly organized cytoskeleton of neurons? Are neurons stupid in comparison with protozoa?*

In 1858, Rudolf Virchow, the founder of cellular pathology, pointed out that each of the 50 billion cells in the human body is an "elementary organism." If primordial consciousness is present in microorganisms, that primordial consciousness must be present throughout the human body.

5. Sensation and Action.

In 1973, a classic paper on sensation and movement was published by Jelle Atema in Woods Hole.[8] Atema pointed out that all of our sensory receptors contain cilia. This opens up the possibility that a locomotor-sensory system is a built-in feature in the body of all animals.

In his paper, Atema admitted that he was unable to specify the nature of the conformational waves being propagated through the microtubules and other microfilaments comprising cilia and flagella- but at the same time, research half way round the world, in Kiev, Ukraine, was revealing a possible explanation. Davydov[9] reported a biological basis for the "soliton," the solitary wave, and how it might solve the important riddle of how energy is transferred from the place where it is generated to the places where it is needed.[10]

Incidentally, the first qualitative description of a soliton was published in 1834. J. Scott-Russell was watching a boat being drawn through a canal by a pair of horses. He observed a wave that "rolled forward with great velocity, assuming the form of a large solitary elevation, a rounded smooth and well-defined heap of water, which continued its course along the channel apparently without change of form or speed."[11] Tidal waves and tsunamis are solitons. Their destructive power arises from their coherence, which makes them very stable and prevents them from dissipating their energy. Atema probably did not know that Valerie Hunt was performing electromyographic studies on dancers showing that movement is possible under conditions in which nerve impulses are not reaching the muscles. Hunt concluded that there is some other mechanism for activating movements besides the classical neuromuscular control system. These studies are reported in her book, Infinite Mind[12]

6. The Next Evolutionary Step: The Extracellular Matrix.

The next step in the understanding of sensory systems involved the extracellular sugar polymer coatings of individual bacteria, viruses, and protozoa. Like cilia and flagella, these "antennas" extended the "reach" of organisms into their environments.

In colonies of bacteria and simple colonial animals, this extracellular "fuzz" took on the properties of mechanical and informational linkages that gave the emergent organisms new and never before realized capabilities. The evolutionary progression to the higher organisms, including humans, involved the development of more and more sophisticated cell assemblies, such as the nervous and hormonal systems. But the higher organisms still rely on the primordial matrix system for fundamental aspects of sensation, information processing, defense, regeneration and movement. Because of its much longer evolutionary history, this matrix system is far more sophisticated than the nervous system. And Schmitt, cited above, realized the enormous potential of matrix biopolymers to store highly specific information, i.e. memories.

In his classic work, Matrix and Matrix Regulation, Alfred Pischinger stated that the smallest unit of life in the vertebrate organism is actually a triad: capillary/matrix/cell.[13] Hence there is a substantial theoretical and experimental basis for the storage, processing and movement of information and energy within the microscopic internal skeletons of cells of supposedly simple organisms.

Proposition: I suggest that these mechanisms extend beyond the cell, to the extracellular matrix and propose that the primordial sensation-movement system described by Atema exists in humans, and operates independently of the traditional neuromuscular system.

7. Capabilities of The Intelligent Body.

It is suggested here that there is a "consciousness" residing in the cellular and extracellular matrices found throughout the human body. This living matrix is a continuous, global or wholebody system that predates the nervous and hormonal systems in terms of evolutionary history. It is composed of biopolymers with enormous capacity to store information (Schmitt, cited above). The relationship of the matrix to the nervous system is that the nervous system is actually composed of this primordial system. The matrix reaches every portion of the organism that is reached by nerves, and the matrix also reaches places where nerves and capillaries do not reach.

Where in the catalog of human behavior does this primordial system reveal itself? My introduction to this question came from of Albert Szent-Györgyii[14]

> *It was at an early date that I began to feel that the wonderful subtlety of biological reactions could not be produced solely by molecules, but had to be produced partly by much smaller and more mobile units, which could hardly be anything else than electrons. The main actors of life had to be electrons whereas the clumsy and unreactive protein molecules had to be the stage on which the drama of life was enacted. Electrons, to be mobile, need a conductor, which led me to the conclusion that proteins have to be electronic conductors.*
>
> *Toward the end of the 1930's theories began to appear about the submolecu/ar structure of condensed matter. This opened the possibility of electronic mobility in proteins, and thus in 1941, I proposed that proteins may be conductors.*

Albert Szent-Györgyi and many others went on to reveal that the primordial protein matrix within and around cells is not composed of conductors, but of remarkable materials called *semiconductors*.

Moreover, much of the living body is composed of highly regular arrays of molecules that are best characterized as semiconducting liquid crystals. Of these materials, British biophysicist Mae Wan Ho 1997[15] has stated:

> *Liquid crystallinity gives organisms their characteristic flexibility, exquisite sensitivity and responsiveness, and optimizes the rapid noiseless intercommunication that enables the organism to function as a coherent coordinated whole.*

A number of phenomena demonstrate this responsiveness and noiseless intercommunication. The martial arts provide spectacular examples, in which the practiced master demonstrates an ability to sense and respond to his or her environment with extraordinary speed and precision that clearly transcends neuronal capabilities.

Athletes and other performers also routinely make judgments and sophisticated movements that are far ahead of neurological speed and that are inexplicable in terms of the established neuromuscular control system. For example, research has shown that it is impossible to hit a baseball. There is just not enough time between the instant a pitcher releases a baseball and the moment it crosses the plate for a hitter to spot it, react to it and swing the bat across the plate to meet it.[16]

Some other kind of link between sensation and action must exist and I propose that it is to be found in the primordial matrix consciousness described above. A great baseball hitter, Ted Williams, described his success this way: Study the pitcher intently. Then, when he throws the ball, guess where and when to swing the bat! In other words, rely on intuition.

Sports psychologists distinguish between *proceduralized knowledge*-when your body knows how to do something-and *declarative knowledge*--when your conscious mind knows how to do.[17] I am suggesting that proceduralized body knowledge is subconscious, residing within the living matrix, whereas declarative knowledge is a property of the nervous system.

These phenomena also reveal themselves in the insights of therapists when they find themselves mentally "directed" to the part of the body or psyche that is causing problems for their clients. When the mind is quiet, so that proceduralized body knowledge is allowed to act as a guide, uncanny insights come forth. A number of therapists are adept at this and have published books and tapes to assist others in harnessing their own powers of intuition and insight.[18] Sometimes these experiences are associated with a phenomenon I have labelled "somatic recall" in which both therapist and patient simultaneously have vivid visions or other sensory experiences related to a traumatic event that may have happened many years earlier.[19]

Liquid crystallinity gives rise to another property: biological coherence. Most of the tissues in the body are liquid crystals: highly ordered molecular arrays that have properties of both solids and liquids. This is true of the actin and myosin arrays in muscles, the phospholipids in cell membranes and myelin sheathes, collagen in connective {issue, the arrays of microtubules in nerves and sensory receptors, and the DNA. The six feet of DNA packed into every cell in the body, noted by Karl Maret in his …, [Bridges, 2005, "Seven key challenges facing science," Spring, v. 16, #1, pp. pp.4-9] has to be packed into a nearly crystalline form in order to fit into such a tiny volume. These liquid crystals have an extraordinary and vital property: when they are energized to a certain level of excitation, as by the electric fields present within the body, the molecules begin to vibrate in unison, until they reach a high level of coherence.

Such systems must emit highly coherent, laser-like signals and be exquisitely sensitive to similar signals from the environment. Biological coherence is the subject of extensive research, beginning with the work of Fröhlich and colleagues[20] and continuing with the research of Ho and others.[21]

8. The Conscious and the Subconscious.

Can the word "consciousness" be used to describe a consciousness that is not of neural origin? Of course it can! Ever since the work of Freud and lung in Western psychology we have had concepts of the subconscious and unconscious, and their correlates-images, dreams, and flashes of intuition.[22]

In the past, these terms have had little meaning to the physiologist, or cell or molecular biologist. Here I propose that the cellular and extracellular matrix that extends throughout the human body gives rise to a variety of psychological phenomena. I now see the matrix as where a vast amount of subconscious sensory information is stored and processed, an amount of data that would completely overwhelm the capacities of the simple nervous system. This total system is wonderfully described by Tor Nørretranders[23] in a fascinating book entitled The User Illusion:

> *Each second, our consciousness reveals to us a tiny fraction of the 11 million bits of information our senses pass on to our brains. Most of the information from our senses goes to our unconscious. Trust your hunches and intuitions-they are closer to reality than your perceived reality, as they are based on far more information.*

Access to this system is via intuition that enables therapists and athletes and dancers to reach new and transcendent levels of accomplishment. I see intuition as something that emerges from the living matrix after a vast amount of subliminal information has been stored and evaluated for its deeper meanings.

I now view intuition as an emergent property of a very sophisticated semiconducting liquid crystalline matrix that is capable of storing and processing a vast amount of subliminal or nonneural information. The sophistication of my computer, with its software programs and memory and information storage capacities corresponds to the sophistication of neural consciousness. But these capabilities pale to insignificance in comparison with the evolutionary ancient solid-state subconscious system that is expressed within every cell and sinew of my body and that operates continuously to analyze the world around me.

9. Microgenesis.

To understand how information stored and processed by this subconscious matrix system reaches consciousness, consider the theory of mind developed by Jason W. Brown[24] from clinical observations of patients with various aphasic-disorders of perception and action. Each aphasia provided Brown with a clue about a stage in the normal unfoldment of the conscious present. When these clues were. put together, the result was the description of a process that Brown calls microgenesis. It is the "rapidly flickering recapitulation of an individual's entire past as the content in which each moment of the 'now' is experienced" (Deane Juhan).[25]

An aspect of this model is that traumatic memories and personality structure continuously select or sculpt our perceptions of the world on a moment-by-moment basis, before we become conscious of "the world out there." The existence of this system helps us understand how new methods of energy psychology are able to resolve post-traumatic stress without the lengthy efforts of trying to recall

and recapitulate the moment of trauma, as has been done in traditional psychotherapeutic approaches.

From the perspective being developed in this article, I see microgenesis as a means of accessing the status of the entire body, not just the brain. One way this can happen is by the use of the coherent emissions from the various liquid crystals within the matrix. My recent book[3] is an attempt to elucidate the relationship between quantum coherence and conscious experience.[22] Briefly, the theory is that the coherent "laser beam" of holographic consciousness arises within the highly ordered semiconducting liquid crystals of the living matrix.

These internal Fröhlich oscillations reverberate within the organism, repeatedly referencing the status of the body. Each subconscious "sweep" of the body references: 1) the inner boundary of the body, 2) the tensions and positions of all body parts, 3) all sensations, both liminal and subliminal, 4) the entire traumatic history, 5) all cellular memories, and 6) all connective tissue memories.

And each "sweep" of the body has the possibility of erasing the traumatic history. Establishing the conditions for this to take place is being accomplished by methods being developed in the field of energy psychology. Finally, each "sweep" of the body reaches into every part of the body, including each part of the nervous system. To the extent that the nervous system is an integral part of the matrix, and vice versa, there is no need to search for a specific point of connection between them: they are connected everywhere. In that regard, neurosurgeon Karl Pribram[26] was unable to find the laser he needed to complete his holographic model of the brain, because the "laser" was not in the brain; it is throughout the body. I propose that holographic memory and microgenesis are whole-body phenomena that cooperate to generate the conscious present.

Since the primary channels of this microgenetic holographic memory system are the acupuncture meridians, it is not surprising that many energy psychology methods involve tapping on key points of the meridian system.

10. Where is Consciousness?

Many years ago body workers told me they were convinced that consciousness is in the body and not in the brain. This came as a surprise, for I had been taught that consciousness is a process that takes place only in the brain. Over the years this new perspective of body consciousness became compelling. Key research was done by Candace Pert and her colleagues, and is summarized in Your Body is Your Subconscious Mind.[27] Decades of research on neurochemistry showed Pert that the molecules of emotion, and their receptors, can be found everywhere in the body, on every kind of cell.[28] The so-called "neuropeptides" and their receptors were not, as previously thought, confined to the nervous system. Mind, as correlated with "neurochemistry," had proven to be a whole-body phenomenon. Your body is, at least, a crucial component of your subconscious mind!

In my opinion the therapists who touch real living human bodies (in contrast to those who poke electrodes into cells, or who study individual molecules) obtain vital clues about some of the questions that can never be answered from the reductionist perspective alone. A new understanding of life is emerging from the synthesis of reductionist and whole-person perspectives. At a recent conference on energy psychology,[29] a leading practitioner, Belleruth Naparstek, concluded: *Post-*

traumatic stress is not mental, it is biophysical. Post-traumatic stress is not a mental health problem. They (the patients) may look mentally ill, but they are not. we have spent years looking at this incorrectly.

I believe what Dr. Naparstek is referring to stems from psychologists not understanding the reality of the body, and the unsuccessful search for mind limited to the brain. We have searched the brain and nervous system because we know how to study their electrical properties. It now is time to develop ways of connecting our instruments directly to the living matrix, so we can explore more subtle realms of sensation, memory and consciousness. The way to do this emerges from the research on electronic biology developed by Albert Szent Györgyi. As with most new ideas, the scientific community rejected his concepts.

The time has come, however, to use these tools to help determine what consciousness and intelligence really are.

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SECTION FOUR:

DRIVE IN LIVING MATTER TO PERFECT ITSELF

Albert Szent-Györgyi

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Albert Szent-Györgyi has the unusual distinction of being awarded two Nobel Prizes (1937 and 1955) for his scientific researches. He was born in Hungary in 1893 and received his M.D. degree from the University of Budapest and his Ph.D. from Cambridge University. Before coming to the United States in 1947, he was professor of medical chemistry at Szeged, Hungary and professor of biochemistry at the University of Budapest. Since 1947, he has been director of research at the Institute for Muscle Research, Marine Biological Laboratory, Woods Hole, Massachusetts. His books include: Oxidation, Fermentation, Vitamins, Health and Disease; Muscular Contraction; Contraction of Body and Heart Muscles; Bioenergetics; Submolecular Biology; Bioelectronics; The Living State.

For quite some time science has recognized the principle of entropy as a fundamental factor in the universe. Entropy causes organized forms to gradually disintegrate into lower and lower levels of organization. This tendency by itself leads one to consider the world as a whole to be like a great machine running down and wearing out.

But there is mounting evidence for the existence of the opposite principle: syntropy - or "negative entropy" - through the influence of which forms tend to reach higher and higher levels of organization, order, and dynamic harmony. In the following essay, Albert Szent-Györgyi, research biologist twice awarded the Nobel Prize, describes his conception of an "innate drive in living matter to perfect itself," and suggests that such a syntropic principle can be found even at the sub-atomic level of matter.

Syntropy is closely related to the process of synthesis, and today many are calling increasing attention to a psychological drive toward synthesis, toward growth, toward wholeness and self-perfection., Szent-Györgyi's conception has therefore far-reaching implications not only for the physical and biological sciences, but perhaps even more for psychology and for our view of the human being, of society, and of the world.

Albert Szent-Györgyi's paper was originally presented as a lecture delivered for the Symposium on the Relationship between the Biological and Physical Sciences at Columbia University.

I have always been an amateur scientist but a professional poacher. I have never been married to any single principle, and my relations to sciences have been most promiscuous. This is perhaps the reason why I was chosen to discuss here The Relationship Between the Biological and Physical Sciences.

Difference between animate and inanimate world. That title suggests some basic difference between the animate and inanimate world, and so at the outset we find ourselves in a contradiction. We probably all feel that there is some basic difference between the living and the non-living, while as scientists we cannot believe that the laws of the universe should lose their validity at the surface of our skin. Life must actually have been created by these laws. So our first step has to be to clear our minds about this contradiction. """-

Organization. They can be so cleared, to a great extent, by the simple fact that things can be put together in two different ways, at random or meaningfully. This is a cardinal point. I would like to illustrate it by an example. Six toothpicks and two corks on a table will be but six toothpicks and two corks. Their qualities are additive. However, if I put these toothpicks and corks together in a specific way, they will make a (somewhat symbolic) horse which can no longer be fully described in terms of the constituents. New qualities are developed which are no longer additive. With a few more pieces I could set a man on this horse; then I would again have something new - neither a horse nor a man but a man-on-a-horse. This is what is called "organization," putting things together in a meaningful way; it is one of the basic features of nature.

Hierarchy of levels. If elementary particles are put together to form an atomic nucleus, something new is created which can no longer be described in terms of elementary particles. The same happens over again if you surround this nucleus by electrons and build an atom, when you put atoms together to form a molecule, etc. Inanimate nature stops at the low level of organization of simple molecules. But living systems go on and combine molecules to form macromolecules, macromolecules to form organelles (such as nuclei, mitochondria, chloroplasts, ribosomes or membranes) and eventually put all these together to form the greatest wonder of creation, a cell, with its astounding inner. regulations. Then it goes on putting cells together to form "higher organisms" and increasingly more complex individuals, of which you are an example. At every step new, more complex and subtle qualities are created, and so in the end we are faced with properties which have no parallel in the inanimate world, though the basic rules remain unchanged.

LEVELS OF ORGANIZATION

Reductionism. Any level of organization is fascinating and offers new vistas and horizons, but we must not lose our bearings or else we may fall victim to the simple idea that any level of organization can best be understood by pulling it to pieces, by a study of its components that is, the study of the next lower level. This may make us dive to lower and lower levels in the hope of finding the secret of life there. This made, out of my own life, a wild-goose chase. I started my experimental work with rabbits, but I found rabbits too complex, so I shifted to a lower level and studied bacteria; I became a bacteriologist. But soon I found bacteria too complex, and shifted to molecules and became a biochemist. So I spent my life in the hunt for the secret of life.

It is most important for the biologist to give himself an account of these relations when he asks himself on which level of organization to work when embarking on research with the desire to understand life. Those who like to express themselves in the language of mathematics do well to keep to lower levels.

Energy transformations. We do not know what life is but, all the same, know life from death. I know that my cat is dead when it moves no more, has no reflexes and leaves my carpet clean - that is, no longer transforms chemical energy into mechanic, electric or osmotic work. These transformations of energy are most closely linked up with the very nature of life. We, ourselves, get our energies by burning our food and transducing its chemical energy into heat and various sorts of work.

So for twenty years I studied energy transformations by going to the source of the vital energies and worked on biological oxidation on the molecular level. These studies netted me a Nobel Prize (which was most pleasant) but left me eventually high and dry without a better understanding.

So I turned to muscle, the seat of the most violent and massive energy transformations. This study led me and my associates to the discovery of ;1 new muscle protein, and we could then ourselves make little muscles and make them jump .outside the body. 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 fmish 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 fmished up with electrons. But electrons are just electrons and have n~ life at all. Evidently on the way I lost life; it had run out between my fmgers.

Holistic attitude. 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. The biologist wants to read in the book of creation.

If there was a creator, he could not have been a molecular biologist only. He must have known a great deal of quantum mechanics and mathematics, too, and must have been a good geneticist and physiologist. He must have been all of that, and so if we want to follow his trail and read in the book of creation, we must be a bit of everything.

Scientific method at various levels. Even if limiting our work to a single level, we have to keep the whole in mind. Naturally, the higher we climb on the ladder of organization and complexity, the less our material becomes accessible to mathematical analysis, but we must not think ourselves to be scientists only when speaking in equations. · *[A holistic attitude is just as important for the psychologist and the educator, who deal primarily with functions and processes which occur at the highest levels of organization in the individual. A simple reductionist approach will prevent a correct evaluation of such processes and the understanding of their true nature, and might in some cases hide the very fact that they exist. ed.]*

To finish my life's story, now I am climbing up again on the ladder of organization on which I worked my way down through half a century, and am working on the cellular level-for the cell is

the cornerstone, the greatest wonder, of living nature, and is, today, a somewhat neglected dimension. Not only do I not regret my earlier climbing down to electrons; I even feel I might not have climbed down far enough, and it is possible that we have to wait for discovery of new science, some sort of super-wave-mechanics, till we can really approach life; but electrons and quantum mechanics are the limit set to the biologist by physics today.

Uniqueness. Quantum mechanics, which deals with the electronic structure of molecules, taught me something most important: how wonderfully subtle and complex is a structure of even a simple molecule. As a student I learned that the benzene ring is a hexagon, and this was all there was to it. Quantum mechanics has taught me that in the simplest aromatic molecule every carbon atom has its individuality which can be described only by half a dozen electronic indices, which give to the molecule a very sharp profile, a very specific individuality, most complex in the very complex molecules of the living edifice.

Random mutation insufficient as cause of evolution. This brings me to the problem on which I plan to spend the next fifty years of my research. The problem is this: most biological reactions are chain reactions. To interact in a chain, these precisely built molecules must fit together most precisely, as the cog-wheels of a Swiss watch do. But if this is so, then how can such a system develop at all? For if anyone of the very specific cogwheels in these chains is changed, then the whole system must simply become inoperative. Saying that it can be improved by random mutation of one link sounds to me like saying that you could improve a Swiss watch by dropping it and thus bending one of its wheels are axles. To get a better watch all the wheels must be changed simultaneously to make a good fit again.

DRIVE TO IMPROVEMENT

There is no need to descend into the electronic world for examples on this line. In the winter, at Woods Hole, the sea gulls are my main company. These gulls, the "herring gulls," have a red patch on their beaks. This red patch has an important meaning, for the gull feeds its babies by going out fishing and swallowing the fish it has caught. Then, on coming home, the hungry baby gull knocks at the red spot. This elicits a reflex of regurgitation in mama, and the baby takes the fish from her gullet. All this may sound very simple, but it involves a whole series of most complicated chain reactions with a horribly complex underlying nervous mechanism. How could such a system develop? The red spot would make no sense without the complex nervous mechanism of the knocking baby and that of the regurgitating mother. All this had to be developed simultaneously, which, as a random mutation, has a probability of zero. I am unable to approach this problem without supposing an innate "drive" in living matter to perfect itself.

Unsolved problems. I know that many of my colleagues, especially the molecular biologists, will be horrified, if not disgusted, to hear me talk about a "drive" and will call me a "vitalist," which is worse than to be called a communist. But I think that the use of such words as "drive" does no harm if we do not imagine we have found an explanation by finding a name. If we look upon such words as simply denoting great unsolved problems of science, they can even lead to useful experimentation. *[Previously the author had spoken of a tendency rather than a drive, as in the following: "My feeling is that living matter carries, in itself, a hitherto undefined principle, a*

tendency for perfecting itself" ("The promise of medical science." In G. Wolstenholme (ed.), Man and his future, Little, Brown, Boston, 1963, pp. 188-195). ed.]

Life keeps life going. By "drive" I denote here simply the ability of life to maintain and improve itself. You know this from your daily life. You know well that if you use your car too much and your legs too little, your car gets worn out while your legs atrophy, just fade away. This is one of the most characteristic differences between the living and non-living. The non-living is worn out by use, while the living is improved, developed by it. Life keeps life going, building up and improving itself, while inactivity makes it go to pieces.

An early American physiologist, Bowditch, discovered an unexpected phenomenon which reflects these relations and makes them accessible to experimentation. I am alluding to his "staircase." If I ask you what you expect if I make the heart rest for a little while and then make it go again, your guess will probably be that the first beat after the rest will be stronger than the last one before it. But the opposite is true: it will be weaker, and the tension developed will gradually rise to its original level in the subsequent beats. Here is the same problem in a nutshell.

Entropy and syntropy. Dr. Hajdu and I have tried to find out what is behind this "staircase" phenomenon and found that what happens is simply that, in rest, potassium leaks out of the muscle fibers, and is pumped back in the subsequent contractions. For the muscle to work well the potassium must have a high concentration inside the fibers and low outside them. What happens in rest is an increase in randomness; the entropy of the potassium increases in rest and decreases again in function. Function thus keeps the living system on its low entropy state, in its highly specialized spatial structure - puts or keeps everything in its place. Life thus keeps life going, building up itself.

[Entropy, which we described as the tendency of organized forms to gradually disintegrate into lower and lower levels of organization, is predominant in inanimate matter*, and is easiest to observe (the machine ultimately breaking down, energy eventually being used up, etc.). It has long been accepted by science and is described by precise mathematical formulations. Syntropy, the opposite principle, the tendency to reach higher and higher levels of organization, harmony, and order, is predominant in living organisms. It becomes increasingly prominent in the more advanced species - those where consciousness is most developed - thus culminating, as far as we know, in man.*

[Syntropy is only now beginning to capture the attention of the scientific community and is far from being generally accepted, yet some of the foremost contemporary thinkers consider it a fundamental principle of nature. ."""" Buckminster Fuller, for example, states: "The history of man seems to demonstrate the emergence of his progressively conscious participation in theretofore spontaneous universal evolution. . . . My continuing philosophy is predicated. . . on the assumption that in dynamic counterbalance to the expanding universe of entropically increasing random disorderliness there must be a universal pattern of omnicontracting, convergent, progressive orderliness and that man is that anti-entropic reordering function. . ." (R.B. Fuller, No More Secondhand God, Southern Illinois University Press, 1963, p. xii.)

[The concept of syntropy, in such views as Fuller's, has, as we have said, the most far-reaching implications, both philosophical and practical, for the full development of the human being, his

integration within the scheme of nature, and his ultimate purpose. The fact that syntropy is much more difficult to observe than entropy has been the cause of much perplexity, and an obstacle to its wider acceptance as a principle of nature. An Italian mathematician, Luigi Fantappie, suggested a reason for this difficulty: human consciousness, he observed, is at the top of the organization ladder of nature, and intimately associated with the syntropy side of the entropy-syntropy polarity. Therefore it is normally oriented toward, and attracted by, its polar opposite, entropy, and able to observe the entropic world from a most detached and objective perspective, with greater ease and precision. In his book, Principi di una Teoria Unitaria del Mondo Fisico e Biologico (1944) (Principles of a Unified Theory of the Physical and Biological World), Fantappie offers a clear presentation based on rigorous mathematical formulations - for both syntropy and entropy, and deals with the implications of syntropy in the physical, biological, psychological, and spiritual dimensions. An abridged presentation of this work will appear in forthcoming issues of Synthesis. ed.]

These are not merely abstruse problems of biology. We could show, with Dr. Hajdu, that if your heart fails in some infectious disease and you die, this is because it behaves like a heart which rested too much; and if digitalis pulls you through, it is by doing to it what work should have done.

Least free energy systems. But the heart may be too complex to allow a more detailed analysis, and according to the rules of my life I should take you lower down from the molecular to the electronic dimension. So I will talk about "charge transfer." It has become clear during the last decades that under certain conditions an electron of a molecule, say molecule A, can go over to . . . another molecule, molecule B. For this the two molecules must be in very intimate contact. . . . Evidently the electron goes over because by its doing so the free energy of the system decreases and the system becomes more stable. *[Other more familiar examples of energy transfer are a boulder rolling down the slope of a mountain, or a piece of iron being attracted by a magnet. In both cases, energy that was initially stored as* potential energy *becomes transformed into kinetic energy as the two elements (the boulder and the earth, or the magnet and the piece of iron) move toward each other. When the two elements again come to rest, finding a new, more stable point of equilibrium, the* kinetic energy *is released, and either is dissipated as heat or can be utilized to do useful work.*

[In general, each time two or more elements come closer together, energy is released. It is interesting to observe that often as the process continues, and all elements in a system come as close as possible to one another, releasing the greatest amount of energy, they arrange themselves not randomly, as an aggregate, but according to specific patterns, determined by geometrical laws, where order, harmony, and often great beauty are readily apparent. Crystals, are formed this way. They have qualities and properties beyond those of their component parts, and are thus a true synthesis *of atoms.*

[We can see therefore that synthesis not only does not require energy - except when needed initially, to get the process going - but releases energy that was up to then locked in matter, and makes it available.

[This same process is very apparent in the psychological domain. When a number of individuals form a harmonious group, thus becoming psychologically close to one another, much energy is released, which becomes available and can be turned outward to useful purposes. Or within the

individual, when, as the result of effort, we "overcome a psychological block" and feel "more together," we have supplied the initial energy to allow some of our personality elements to move closer to each other, and form a more harmonious structure. The energy released by such a step toward greater psychological synthesis *is immediately experienced, often as a feeling of elation or greater well being, or as the urge to action, sometimes even as a "peak experience." Whenever such energy becomes available - and particularly if suddenly, or in large quantity, as in the case of a psychological "breakthrough"- it can be deliberately channeled and utilized to keep the process of synthesis going, and accelerate it. If this is not done, it will largely dissipate - thus wasting much of the potential benefit of the breakthrough - or even disturbing other aspects of the inner synthesis, occurring in nearby psychological "space." ed.]*

The "charge transfer energy" will thus contribute to the forces keeping the two molecules together. Without it the system would be less stable, would tend more to go to pieces. Here then is a simple example of function maintaining structure. We could continue this spirited game and add molecules C, D, E, and F to the system and imagine the electrons flowing from B to C, and from there to D, E and F continuously.

System gives out energy as it improves. This is not a meaningless speculation, a "jeux d'esprit," for all of our vital energies are actually derived from such an electron flow. The energies which are driving you are the energies which these "flowing" electrons gradually lose in this transfer from one molecule to the other. Finally this energy is translated into "high energy phosphate," the immediate source of the energy by which your cells live. This flow of electrons can be expected to help keep the molecules of the chain together, in their very specific steric relations, and we can expect the system to tend to go to pieces as soon as the electron flow stops. We have thus a clear-cut example of life being kept in the living condition by life itself, kept by work in good working order. We can even expect the system of our molecules A and B to tend to add further molecules, to decrease free energy further, and thereby to become more stable, better and more complex. So actually we arrive at a "drive" to improvement, to building up.

In thermodynamics such a system as I just described would be called an "open system," which reaches its energy minimum-that is, its greatest stability-by working. So the "drive" can even be expressed in the idioms of accredited science.

"WISDOM" OF LIVING MATTER

Hallucinogenic drugs. These problems are so fascinating that I would like to spend a few more minutes with them. Many years ago I proposed, with my colleagues, Isenberg and McLaughlin, that electrons may be transferred by certain molecules at specific points only, and showed that indoles will probably transfer their electron at Carbon No.3. *[The term "indole" refers to a particular type of ring pattern formed by some of the atoms within certain organic molecules. "Carbon No.3" is a carbon atom placed at a specific location in the indole ring. ed.]*

Many of the drugs which provoke hallucination, the "hallucinogens," contain an indole ring. With Karreman and Isenberg we also showed that hallucinogens have a strong tendency to give off electrons, are good "electron donors." We concluded that hallucination, in this case, may be caused by transfer of electrons from the drug to the nerve cell. Both our assumptions have found

corroboration very recently the first by Green and Martieu in Pullman's laboratory, the latter by Snyder and Merrill, who showed that the hallucinogenic property goes parallel to the electron-donating ability in a great number of hallucinogens and related compounds.

In order to be able to pass an electron on at a certain point, the molecules must be fitted together most accurately, and linked together strongly in two dimensions to form a "membrane" as in the case of mitochondria, where all our vital energies are generated by the flow of electrons. So these considerations may lead even to an answer of one of the most puzzling problems of biology: what's a membrane? The knowledge gained might also help to cure mysterious diseases, answer problems of everyday medicine.

Since I was not afraid to use the word "*drive*," I might as well be even more audacious and use the word "*wisdom*." I am not the first to do so. The great American physiologist, Walter B. Cannon, talked and wrote a great deal about the "wisdom of the body." . . .

"Wisdom" of the body. I would like to illustrate with one example what I call "wisdom." If you look at a motor nerve cell, which gives the immediate command to your muscles to contract, you will find a great number of fibers from other nerve cells, hundreds of them, ending at its surface. These fibers bring messages from faraway nerve centers and modify the action of this motor nerve cell and the motion this nerve cell will induce.

Perhaps I could make this clearer by a little story about a kitten which shared my tent once in Cornwall, England. One day a snake crept into our tent. My kitten stiffened in horror. When I touched its tail, the kitten jumped up vertically about two feet high. This happened because the nerve fibers which ended on the motor nerve cells conveyed the message that there was danger of life and any motion had to be fast and violent. These messages came, as I said, from faraway complex nerve centers which worked up and evaluated the visual impressions of my kitten.

Genetic coding not blueprint of individual. The problem I want to bring out here is this: how could these hundreds of nerve fibers, coming from faraway nerve centers, ever find the right motor nerve cell? All this could not have been coded into the egg cell from which my kitten grew. Of course, this egg cell must have contained (in conjunction with the sperm) all the information which is necessary to build such a wondrous organism as a cat. But all those excessively complex networks which make a brain could not have been inscribed into the egg cell. The egg cell cannot be a blueprint; it can only be an instruction manual, which contains instructions on how to build macromolecular systems with sufficient wisdom to find their place and function. That all this could not have been inscribed in the egg cell we could show by cutting these nerve fibers and introducing a new factor of which the egg did not know. We could expect that the fibers would again fmd their severed ends through their own wisdom. As suggested by the experiments of Sperry, even if we should cut a great number of these fibers simultaneously, they would not get mixed up and each of them would find its very own ending again -a really remarkable wisdom.

Function generates its own structure. This "wisdom" may be even much more difficult to understand than the "drive," but also must have its well-defined mechanism. Perhaps this "wisdom" and "drive" are essentially the same, and may be the property of living matter in general- the property that has driven matter to generate life, which then tends to build its own mechanisms. I

feel strongly that, for instance, the human speech center was not developed by random mutation, but had to be developed as soon as man had something to say - the function generating its own mechanism. Of course I know that to make any such change permanent, the change must be communicated by some sort of feedback mechanism from periphery to DNA. We do not know of any such feedback, but it was only a few years ago that we had not the least idea of how DNA communicates with the periphery either.

Maybe this drive is not an exclusive property of living systems, but is the property of matter in general. We know today that fairly complex organic molecules can be built without the intervention of living matter, while by the word "organic" our scientific fathers wanted to express the idea that it is only life which can build such molecules. Sidney Fox in Florida even builds protein-like substances without life. It may have been this innate drive of matter which led to the origin of life and played, later, an important hand in its evolution.

AREAS OF IGNORANCE

Discovery of new physical sciences needed. I have tried to show that many of the greatest problems of biology are unsolved, if not untouched, and that we can expect to solve them by applying physics. But whether physics in its present state allows us the analysis of the underlying mechanisms, I do not know.

I rather doubt it, and we may have to wait for the discovery of entirely new physical sciences till we can penetrate deeper into the nature of life. In my student days we hardly knew more than tne structure of a few amino acids and sugars, and we felt obliged to explain life. It was not so long ago that the young Max Planck was advised by one of the best physicists to become a pianist rather than a physicist because physics was a finished and closed subjeGt to which nothing could be added. So we biologists have to look out most anxiously for any new development in physics and any new instrument physics may give into our hands. Meanwhile, we must not feel obliged to explain life with our present knowledge, and we should not shy away from admitting our ignorance - the first step towards new knowledge being to recognize ignorance.

Unknown factors. I have been often reproached for being a vitalist, mysticist, obscurist, and teleologist while the real situation was clear and simple, there being a complete interdependence between structure and function. Since every function must have its underlying structure which must be of physical nature, all we have to do is to apply physics to structure. This may be so, but, all the same, I feel we must be careful with this interdependence as we don't know how many unknowns our equations still contain. Certainly there is such an interdependence as there is complete interdependence between the needle of your gramophone and the groove on your record; and once the needle follows the groove, your victrola must produce the sound it does. All you have forgotten is only Beethoven or Bach whose music you might have been playing, and without whose genius your gramophone would be useless. Of course, Bach and Beethoven, too, were built of macromolecules, but, all the same, we do well to keep our reverence before their genius, which is still far beyond the possibility of detailed physical analysis. Such a speechless deep reverence and amazement before the wonders of nature is the main result of my half a century's poaching, and if I were to sum up my summary now, I would do it in Shakespeare's words, saying: "There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy."