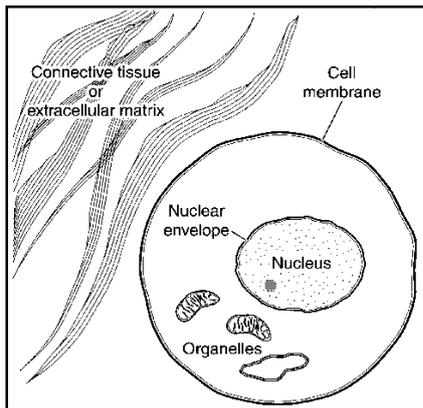


The Living Matrix Connective Tissue Concept

By James Oschman

♣ Read this essay, by leading author, biologist and pioneering biophysicist James Oschman¹, then write down your response to the following questions:

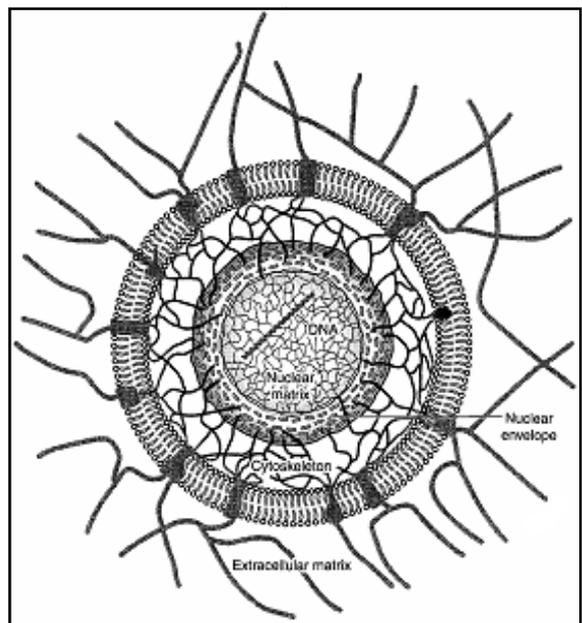
1. What does the author mean by the term, 'Living Matrix concept'?
2. What was Szent-Györgyi's insight, and how does it impact on our understanding of the human body-field?
3. What are the implications of the author's statement that the vibrations of our words and thoughts can bring about changes in the DNA molecules of our bodies?



The *Living Matrix* concept summarizes several major advances in our understanding of the nature of cells and tissues in the human body. To be specific, the images of the cell and its surroundings in most textbooks (see drawing, left) are seriously outdated, and this means that new students of biology and medicine start with an inaccurate and incomplete picture at the outset of their education. We shall see that many confusions and controversies are resolved by the more accurate picture conceptualized as *the living matrix*.

To summarize, this drawing depicts the cell as a bag of solution with a few organelles such as the cell nucleus and mitochondria more or less floating about within it. The cell and its contents form a distinct entity, separable from the surrounding extracellular matrix or connective tissue.

A more accurate picture (right) reveals that the DNA, nucleus, cytoplasm, and extracellular matrix form a continuously interconnected system. The following summarizes the story of how this new picture evolved and the science that has enlivened and energized *the living matrix*.



We begin with a story about energy. In 1941 Albert Szent-Györgyi, who had received the Nobel Prize in 1937 for the synthesis of Vitamin C, gave the Korányi Memorial Lecture in Budapest, Hungary. His talk was published in both *Science (Towards a New Biochemistry?)*¹ and *Nature (The Study of Energy Levels in Biochemistry)*² at a time when his country and all of Europe were descending into the chaos of WWII.

The remarkable insight that was the topic of his presentation was that proteins are semiconductors, rather than insulators, as had been thought previously. Semiconductors are intermediate in conductivity between conductors, such as copper wires, and insulators, such as the coverings of electrical cables. In essence, our bodies are composed mainly of materials that are similar in properties to the substances that make possible our modern computers, cell phones, televisions and so on. He introduced his new ideas as follows:

'If a great number of atoms is arranged with regularity in close proximity, as for instance, in a crystal lattice, the... electrons... cease to belong to one or two atoms only, and belong to the whole system... A great number of molecules may join to form energy continua, along which energy, viz., excited electrons, may travel a certain distance.'

This means that the human body contains free or mobile electrons that can move about within the fabric of the body. These electrons are energetic and can therefore transfer energy and information from place to place. The 1941 report proved to be prophetic, although it was not recognized as such at the time. The area where these ideas have had the most impact is in nanoelectronics – the world-wide search for ways of using atoms and molecules as miniature components of electronic circuits. Szent-Györgyi's insight is now recognized as one of the foundations of the modern molecular electronics industry.³

Like most new ideas, the concept that proteins are semiconductors was immediately rejected by the scientific community. Scientists who checked to see if electrons could be conducted through proteins found that the materials were better described as insulators. However, there was a flaw in their measurements. The proteins they studied had been prepared by dehydrating samples taken from living tissues, powdering them, and pressing them into pellets. It was soon discovered that taking the water out of the proteins destroyed their ability to act as semiconductors. The proteins and the water that adheres to them form a two part semiconducting system. Electrons can move through the proteins and protons can move through the water layers.

Over the years there has accumulated more and more support for the fact that most of the molecules in living systems have semiconductor properties to some degree. We are also finding that many of the miracles of life rely on the electronic aspects of our cells and tissues.

¹ Szent-Györgyi, A. 1941, *Towards a New Biochemistry*, *Science* 93:609-11

² Szent-Györgyi, A. 1941, *The Study of Energy Levels in Biochemistry*, *Nature* 148:157-159

³ Hush, N.S. 2006, *An Overview of the First Half-century of Molecular Electronics*, *Annals of the New York Academy of Sciences* 1006:1-20

In 1947, Szent-Györgyi moved to the Marine Biological Laboratory (MBL), in Woods Hole, Massachusetts, where he established the Institute for Muscle Research. I (James Oschman) first learned of his ideas at a fascinating lecture he presented at the MBL in 1969. After the lecture I asked a colleague about how these ideas, which were entirely new to me, had been received by the scientific community. I was surprised to learn that the consensus was that, while Szent-Györgyi had done important work in the past, this line of inquiry was unimportant. He was actually too old to do serious science, and he should retire.

Over the years I asked many of my colleagues to tell me what aspect of this work bothered them, but nobody knew enough about the subject to provide a solid critique. They simply knew it was wrong. I consider this both unscientific and disrespectful. I have learned that this is a typical behaviour of scientists – they are professional sceptics, and often reject new ideas whether they understand them or not.

During my career as a cell biologist and biophysicist, I continued to wonder about electrons and proteins and electronic biology. Eventually I had an opportunity to learn more about the subject, when I became a Staff Scientist at the MBL and occupied the laboratory across the hall from Szent-Györgyi's Institute for Muscle Research. Gradually I came to know the distinguished international family of scientists who worked with or visited Szent-Györgyi's laboratory, and had many valuable conversations with them. In the process I came to understand what was preventing the scientific community from following this story. To discuss electrons intelligently, one must know a little bit about quantum physics. Few biologists had sufficient understanding of quantum physics to be able to converse about electrons and the electronic aspects of biology. Unfortunately this is still true today. It is not because quantum physics is difficult or unimportant. In fact, quantum physics goes to the foundation of biology and medicine. Szent-Györgyi and his colleagues were developing a whole new field of research called electronic biology.⁴

One of the reasons for looking deeply into this work was a discovery that took place across the hall from my lab. In collaboration with Peter Gascoyne and Ron Pethig, Szent-Györgyi demonstrated that the protein, collagen, is a semiconductor⁵. Collagen is the most abundant protein in the world and is the main component of a tissue that has always fascinated me: the connective tissue. This is the material that forms the bones, ligaments, tendons, cartilage and the coverings of the bones and muscles known as fascia. The fascia forms the largest system in the body as it is the system that touches all of the other systems. It can be described as the construction fabric of the animal body. Alfred Pischinger, Hartmut Heine and their colleagues in Germany referred to the matrix as the 'ground regulation system' and the key to health and disease⁶.

These ideas remained in the background of my other research until I was invited to present them to the alternative medicine community, beginning with the Rolfers and Acupuncturists. In stark

⁴ Szent-Györgyi, A. 1960, Introduction to a Submolecular Biology, New York, Academic Press; Szent-Gyorgyi, A. 1957, Bioenergetics, New York, Academic Press; Szent-Gyorgyi, A. 1968, Bioelectronics, New York, Academic Press; Szent-Gyorgyi, A. 1976, Electronic Biology and cancer, New York, Marcel Dekker, Inc.

⁵ Gascoyne, P.R.C., Pethig, R., Szent-Györgyi, A., 1981. Water structure-dependent charge transport in proteins. Proceedings of the National Academy of Sciences 78:261-265

⁶ Puschinger, A., 2007. The Extracellular Matrix and Ground regulation: Basis for a Holistic Biological Medicine, North Atlantic Books, Berkeley, CA.

contrast to the general scientific community, the practitioners of bodywork, energetic and movement therapies were fascinated with these ideas and found in them the possible validation of their work. Energy and energy flows are fundamental to Oriental Medicine and to most of the other complementary and alternative therapies. Acupuncturists suspected that this science was directly related to the flow of 'Chi' described in the various forms of East Asian Medicine. It occurred to me that the mental block the biomedical community seemed to have about these therapies might be due in part to the mental block they had about the whole field of electronic biology. I now know that this is substantially correct, and have become dedicated to telling the story summarized here to all who will listen.

A key piece of the puzzle that led to *the living matrix* concept came during one of my frequent visits to Cambridge University in England. An English colleague mentioned a remarkable discovery that had taken place at the Medical Research Council Laboratory of Molecular Biology a short distance south of Cambridge. The date was 1969, and the scientist involved was Mark Bretscher. He had discovered that one of the proteins in the membrane of red blood cells extends across the cell surface, essentially connecting the inside of the cell with the outside. His research on this subject was reported in several scientific journals in 1971⁷. I like mentioning his contribution because it has had profound implications for biology and medicine, but Bretcher's historic discovery is rarely mentioned.

The proteins and arrays of proteins spanning cell membranes have now been widely studied; they are vital to life; and they have profound medical implications. In essence, the family of trans-membrane proteins, which came to be known as integrins, focal adhesion complexes, and so on, completes the 'circuitry' of electronic biology. In other words they provide conceptual as well a mechanical, functional, communication and energetic connections between all that happens inside of cells with the processes taking place everywhere else in the body, and *vice versa*. Bretcher's work provided the missing piece of a puzzle that goes to the foundation of health and every branch of medicine and therapeutics.

Terms such as *holistic* and *whole systems* now have a precise and detailed picture to go with them: a physical substrate that connects all parts of the organism with all others. Study of *the living matrix* is providing many details of what we mean when we use the term, *holistic*. *The living matrix* is a conceptual substrate in that it provides a framework for organizing a vast number of discoveries in the fields of cell and molecular biology as well as genetics and epigenetics.

The role of water in relation to *the living matrix* has been explored by Mae-Wan Ho in collaboration with David Knight. They have suggested that the water associated with collagen constitutes a major part of the acupuncture meridian system and is involved in memory functions. They also proposed that there is a body consciousness, possessing all of the hallmarks of consciousness – sentience, intercommunication, and memory, existing alongside 'brain consciousness.' They propose that 'brain consciousness' which we usually consider to be the only consciousness, is embedded within this

⁷ Bretscher, M.S., 1971. A major protein which spans the human erythrocyte membrane. *J. Mol. Biol.*, 59:351-357; Bretscher, M.S., 1971. Major human erythrocyte glycoprotein spans the cell membrane. *Nature New Biology*, 231: 229-232

'matrix consciousness' and is coupled to it. In the context of such a system the acupuncture meridians are regarded as a specialized information network, based on liquid crystalline resonant pathways, that link and coordinate the various structures and functions within the organism, separate from or along with neural communications⁸. I agree with this perspective and have suggested that the matrix system operates much faster than the nervous system and is responsible for the rapid and coordinated activities of elite athletes and other performers when they are operating 'in the zone' of peak achievement⁹.

My first publication on what is now known as *the living matrix* was in an article entitled *The connective tissue and myofascial systems* that was prepared in 1981 for a meeting that never took place¹⁰. That article, which many came to regard as a classic, and subsequent reports are available from our web page, www.energyresearch.us. The 1981 paper described the interconnectedness of the extracellular and cellular matrices throughout the body.

A second report in 1984 was entitled *The structure and properties of ground substances*¹¹. The essay was dedicated to Dr. Albert Szent-Györgyi in commemoration of his 90th birthday. The main new perspective described in that report was that histologists had for many years described 'ground substances' in the cell nucleus, the cytoplasm and extracellular matrices, and mounting evidence was suggesting that all of these fabrics were interconnected.

The whole system, connective tissues, membrane proteins, and the structural fabric of the cell and nucleus are what we referred to as 'the connective tissue/cytoskeleton matrix' in a paper presented in January of 1993¹². Later in the same year, we began using the term *living matrix*¹³. The specific sentence in that paper was, 'Therefore while we are discussing the cell membrane we keep in mind that we are dealing with a component of a vibratory living matrix, a component that is connected with elements of the cytoskeleton, nuclear matrix, connective tissue, and fascia.' *The living matrix* concept has been widely accepted in the alternative medicine community, as evidenced by more than a thousand references to it on the World Wide Web.

Of great significance was a report from an eminent group at Johns Hopkins School of Medicine under the direction of Dr. Donald Coffey. They were studying the nuclear matrix and its interconnections with both the DNA and with molecules that extend across the nuclear envelope and connect to the cytoskeleton¹⁴. What this meant was that we could now trace the continuity inward from the extracellular matrix and connective tissues, across the cell surface via the integrins and related molecules first described by Bretscher, throughout the cell cytoplasm via the cytoskeleton, and across the nuclear envelope to the genetic material.

⁸ Ho, M-W. And Knight, D.P., 1998. The acupuncture system and the liquid crystalline collagen fibres of the connective tissues. *American Journal of Chinese medicine* 26(3-4): 1-13

⁹ Oschman, J.L., 2003. *Energy medicine in therapeutics and Human performance*. Elsevier, London.

¹⁰ Oschman, J.L., 1981. *The connective tissues and myofascial systems*. N.O.R.A. Press, Dover, NH.

¹¹ Oschman, J.L., 1983, *Structure and properties of ground substances*. *American Zoologist* 24(1): 199-215

¹² Oschman, J.L., 1993. A biophysical basis for acupuncture. *Proceedings of the First Symposium of the Society for Acupuncture Research held in Rockville, MD, on January 23-24 1993*

¹³ Oschman, J.L., and Nora H. Oschman, 1993. Matter, energy and the living matrix. October 1993 issues of *Rolf Lines*, the news magazine for the Rolf Institute, Boulder, Colorado, 21(3): 55-64

¹⁴ Berezney, R., Coffey, D.S., 1977. Isolation and characterization of a framework structure from rat liver nuclei. *Journal of cell Biology* 73:616-637

In 1991, the same group produced an inspiring report on the way signals propagate through this matrix, which they termed a tissue tensegrity matrix system¹⁵. The tensegrity aspect had evolved from the work of Buckminster Fuller and others¹⁶. Tensegrity is defined as a continuous tensional network (called tendons) supported by a discontinuous set of compressive elements (called struts). The 1991 report by Pienta and Coffey gave precise language and experimental validation to the transfer of energy and information through *the living matrix*:

Cells and intracellular elements are capable of vibrating in a dynamic manner with complex harmonics, the frequency of which can now be measured and analyzed in a quantitative manner... a tissue-tensegrity matrix system... is poised to couple the biological oscillations of the cell from the peripheral membrane to the DNA...[and in the other direction]. [Words in brackets added by the author]

When I discussed these findings with my scientific colleagues, many said that this was no big deal, these connections were well established and so what? But when I discussed these same findings with alternative practitioners from various therapeutic schools, they were invariably enthusiastic and excited. For they all felt that this was the body they had been touching, a body characterized by physical and energetic interconnectedness. This interconnected body appeared to be so different from the reductionist body of Western biomedicine that it was difficult for the two communities to communicate with each other.

The film, *The Living Matrix*¹⁷, expands far beyond the story documented above by connecting the physical matrix of the body to the larger biofields that surround the body, and also by taking us into the practical realities of the deeper, submicroscopic levels of quantum reality. This larger scope is vital, for it brings in an appreciation of the broader meaning of 'healing energy.'

The largest generator of electricity in the body is the heart. It is obvious that the matrix is one system that conducts the 'music of the heart' to all parts of our bodies. Research from the Institute of HeartMath has documented the emotional aspects of the harmonics produced by the heart¹⁸ and these harmonics have important roles in healing¹⁹. The new research on epigenetics is teaching us that the way we think about ourselves and even the words used by the people around us can cause changes at the level of our DNA molecules. It is said that the DNA in every cell in your body is listening to every word you say. From the ideas expressed above, one can see that the vibratory living matrix probably plays a key role in delivering the vibrations of our words and thoughts to every DNA molecule in our bodies.

¹⁵ Pienta K.J., Coffey D.S., 1991, Cellular harmonic information transfer through a tissue tensegrity-matrix system, *Medical Hypotheses* 34:88-95

¹⁶ Tensegrity is a naturally occurring construct first recognised and developed by sculptor Ken Snelson and visionary R. Buckminster Fuller. For a detailed discussion, go to Dr Stephen M. Levin's website, <http://www.biotensegrity.com/>

¹⁷ 'The Living Matrix: A New Film on the Science of Healing,' produced by Harry Massey, directed by Greg Becker, 2009. For more information, visit www.thelivingmatrixmovie.com.

¹⁸ McCraty, R., Atkinson, M., Tiller, W.A., Rein, G., Watkins, A.D., 1995. The Effects of Emotions on Short-Term Power Spectrum Analysis of heart rate variability, *American Journal of Cardiology* 76(14): 1089-1093

¹⁹ Oschman, J.L., 2000. *Energy Medicine: the scientific basis*. Churchill Livingstone/Harcourt, Edinburgh.

The physical living matrix as described above also plays key roles as the interface between the matter the body is composed of and the fabric of space that extends in all directions and to all parts of the universe. Indeed, our bodies contain more 'empty space' than anything else, and quantum physics tells us that empty space is not, in fact, empty. Space is alive with energy and information and connects us to the deeper levels of consciousness and healing at a distance that are described by some of the other participants in the film and conference. It is suspected that study of this interface will someday provide important clues about the nature of the placebo effect and healing through prayer. For one of the most popular and simple quantum models of matter states that electrons and protons and all objects made of them, including our own bodies, are actually formed from waves of energy²⁰. It is these waves of energy that give rise to the interconnectedness of all things. Some view the matrix as the transducer that converts our thoughts into material reality, acting through the wave structure of space.

While these are interpretations of quantum physics that some physicists find completely irrational, there are other physicists who can tell you that they see these phenomena taking place every day in their laboratories.

♣ Reminder – write in your reflective diary:

1. What does the author mean by the term, 'Living Matrix concept'?
2. What was Szent-Györgyi's insight, and how does it impact on our understanding of the human body-field?
3. What are the implications of the author's statement that the vibrations of our words and thoughts can bring about changes in the DNA molecules of our bodies?

²⁰ Wolff, M., 2008. Schrödinger's Universe: Einstein, waves and the origin of the natural laws. Outskirts Press, Parker, CO.