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The Electrical Properties of Cancer Cells

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Introduction

About 100 years ago in the Western world ago **the study of biochemical interactions** became the prevailing paradigm used to explain cellular functions and disease progression. The pharmaceutical industry subsequently became very successful in using this model in developing a series of effective drugs. As medicine became transformed into a huge business during the 20th century medical treatments became largely based on drug therapies. These pharmaceutical successes have enabled pharmaceutical manufacturers to become wealthy and the dominant influence in medicine. At this point in time the supremacy of the biochemical paradigm and pharmaceutical influences have caused almost all research in medicine to be directed toward understanding the chemistry of the body and the effects that patentable drugs have on altering that chemistry. Yet many biological questions cannot be answered with biochemical explanations alone such as the role of endogenously created electromagnetic fields and electrical currents in the body.

Albert Szent-Gyorgyi in his book Bioelectronics voiced his concern about some of the unanswered questions in biology: "No doubt, molecular biochemistry has harvested the greatest success and has given a solid foundation to biology. However, there are indications that it has overlooked major problems, if not a whole dimension, for some of the existing questions remain unanswered, if not unasked (Szent-Gyorgyi, 1968)." Szent-Gyorgyi believed that biochemical explanations alone fail to explain the role of electricity in cellular regulation. He believed that the cells of the body possess *electrical mechanisms* and use electricity to regulate and control the transduction of chemical energy and other life processes.

Dr. Aleksandr Samuilovich Presman in his 1970 book *Electromagnetic Fields and Life* identified several significant effects of the interaction of electromagnetic fields with living organisms. Electromagnetic fields: 1) have **information and communication roles** in that they are employed by living organisms as information conveyors from the environment to the organism, within the organism and among organisms and 2) are involved in life's vital processes in that they **facilitate pattern formation, organization and growth control** within the organism (Presman, 1970). If living organisms possess the ability to utilize electromagnetic fields and electricity there must exist physical structures within the cells that facilitate the sensing, transducing, storing and transmitting of this form of energy.

Normal cells possess the ability to communicate information inside themselves and between other cells. The coordination of information by the cells of the body is involved in the regulation and integration of cellular functions and cell growth. When cancer arises cancer cells are no longer regulated by the normal control mechanisms.

When an injury occurs in the body normal cells proliferate and either replace the destroyed and damaged cells with new cells or scar tissue. One characteristic feature of both proliferating cells and cancer cells is that these cells have cell membrane potentials that are lower than the cell membrane potential of healthy adult cells (Cone, 1975). After the repair is completed the normal cells in the area of injury stop growing and their membrane potential returns to normal. In cancerous tissue the electrical potential of cell membranes is **maintained at a lower level** than that of healthy cells and electrical connections are disrupted.

Cancerous cells also possess other features that are different from normal proliferating cells. Normal cells are well organized in their growth, form strong contacts with their neighbors and stop growing when they repair the area of injury due to contact inhibition with other cells. Cancer cells are more easily detached and do not exhibit contact inhibition of their growth. Cancer cells become independent of normal tissue signaling and growth control mechanisms. In a sense cancer cells have become desynchronized from the rest of the body.

I will present information in this monograph on some of the abnormalities that have been identified in cancer cells that contribute to loss of growth control from the perspective that cancer cells possess different electrical and chemical properties than normal cells. It is my opinion that the reestablishment of healthy cell membrane potentials and electrical connections by nutritional and other types of therapeutic strategies can assist in the restoration of healthy metabolism.

In writing this monograph I have come to the opinion that liquid crystal components of cells and the extracellular matrix of the body possess many of the features of electronic circuits. I believe that components analogous to conductors, semiconductors, resistors, transistors, capacitors, inductor coils, transducers, switches, generators and batteries exist in biological tissue.

Examples of components that allow cells to function as solid-state electronic devices include: transducers (membrane receptors), inductors (membrane receptors and DNA), capacitors (cell and organelle membranes), resonators (membranes and DNA), tuning circuits (membrane-protein complexes), and semiconductors (liquid crystal protein polymers).

The information I will present in this monograph is complex with many processes happening simultaneously. So I have attempted to group information into areas of discussion. This approach does cause some overlap so some information will be repeated. The major hypothesis of this monograph is that cancer cells have different electrical and metabolic properties due to abnormalities in structures outside of the nucleus. The recognition that cancer cells have different electrical properties leads to my hypothesis that therapies that address these electrical abnormalities may have some benefit in cancer treatment.

Electricity, charge carriers and electrical properties of cells

- The cells of the body are composed of matter. Matter itself is composed of atoms, which are mixtures of negatively charged electrons, positively charged protons and electrically neutral neutrons.
- **Electric charges** – When an electron is forced out of its orbit around the nucleus of an atom the electron's action is known as electricity. An electron, an atom, or a material with an excess of electrons has a negative charge. An atom or a substance with a deficiency of electrons has a positive charge. Like charges repel unlike charges attract.
- **Electrical potentials** – are created in biological structures when charges are separated. A material with an electrical potential possess the capacity to do work.
- **Electric field** – " An electric field forms around any electric charge (Becker, 1985)." The potential difference between two points produces an electric field represented by electric lines of flux. The negative pole always has more electrons than the positive pole.
- **Electricity** is the flow of mobile charge carriers in a conductor or a semiconductor from areas of high charge to areas of low charge driven by the electrical force. Any machinery whether it is mechanical or biological that possesses the ability to harness this electrical force has the ability to do work.
- **Voltage also called the potential difference or electromotive force** – A current will not flow unless it gets a push. When two areas of unequal charge are connected a current will flow in an attempt to equalize the charge difference. The difference in potential between two points gives rise to a voltage, which causes charge carriers to move and current to flow when the points are connected. This force cause motion and causes work to be done.
- **Current** – is the rate of flow of charge carriers in a substance past a point. The unit of measure is the ampere. In inorganic materials electrons carry the current. In biological tissues both mobile ions and electrons carry currents. In order to make electrical currents flow a potential difference must exist and the excess electrons on the negatively charged material will be pulled toward the positively charged material. A flowing electric current always produces an expanding

magnetic field with lines of force at a 90-degree angle to the direction of current flow. When a current increases or decreases the magnetic field strength increases or decreases the same way.

- **Conductor -** in electrical terms a conductor is a material in which the electrons are mobile.
- **Insulator** – is a material that has very few free electrons.
- **Semiconductor** – is a material that has properties of both insulators and conductors. In general semiconductors conduct electricity in one direction better than they will in the other direction. Semiconductors can functions as conductors or an insulators depending on the direction the current is flowing.
- **Resistance** – No materials whether they are non-biological or biological will perfectly conduct electricity. All materials will resist the flow of an electric charge through it, causing a dissipation of energy as heat. Resistance is measured in ohms, according to Ohm's law. In simple DC circuits resistance equals impedance.
- **Impedance -** denotes the relation between the voltage and the current in a component or system. Impedance is usually described "as the **opposition** to the flow of an alternating electric current through a conductor. However, impedance is a broader concept that includes the **phase shift** between the voltage and the current (Ivorra, 2002)."
- **Inductance** – The expansion or contraction of a magnetic field varies as the current varies and causes an electromotive force of self-induction, which opposes any further change in the current. Coils have greater inductance than straight conductors so in electronic terms coils are called inductors. When a conductor is coiled the magnetic field produced by current flow expands across adjacent coil turns. When the current changes the induced magnetic field that is created also changes and creates a force called the counter emf that opposes changes in the current. This effect does not occur in static conditions in DC circuits when the current is steady. The effect only arises in a DC circuit when the current experiences a change in value. When current flow in a DC circuit rapidly falls the magnetic field also rapidly collapses and has the capability of generating a high induced emf that at times can be many times the original source voltage. Higher induced voltages may be created in an inductive circuit by increasing the speed of current changes and increasing the number of coils. In alternating current (AC) circuits the current is continuously changing so that the induced emf will affect current flow at all times. *I would like to interject at this point that a number of membrane proteins as well as DNA consist of helical coils, which may allow them to electronically function as inductor coils. Also some research that I have seen also indicates that biological tissues may possess superconducting properties. If certain membrane proteins and the DNA actually function as electrical inductors they may enable the cell to transiently produce very high electrical voltages.*
  Capacitance - is the ability to accumulate and store charge from a circuit and later give it back to a circuit. In DC circuits capacitance opposes any change in circuit voltage. In a simple DC circuit current flow stops when a capacitor becomes charged. Capacitance is defined by the measure of the quantity of charge

that has to be moved across the membrane to produce a unit change in membrane potential.

- **Capacitors** – in electrical equipment are composed of two plates of conducting metals that sandwich an insulating material. Energy is taken from a circuit to supply and store charge on the plates. Energy is returned to the circuit when the charge is removed. The area of the plates, the amount of plate separation and the type of dielectric material used all affect the capacitance. The dielectric characteristics of a material include both conductive and capacitive properties (Reilly, 1998). In cells the cell membrane is a leaky dielectric. *This means that any condition, illness or change in dietary intake that affects the composition of the cell membranes and their associated minerals can affect and alter cellular capacitance.*
- Inductors in electronic equipment exist in series and in parallel with other inductors as well as with resistors and capacitors. Resistors slow down the rate of conductance by brute force. Inductors impede the flow of electrical charges by temporarily *storing energy as a magnetic field* that gives back the energy later. Capacitors impede the flow of electric current by *storing the energy as an electric field.* Capacitance becomes an important electrical property in AC circuits and pulsating DC circuits. The tissues of the body contain pulsating DC circuits (Becker and Selden, 1985) and AC electric fields (Liboff, 1997).

Cellular electrical properties and electromagnetic fields (EMF)
EMF effects on cells that I will discuss in later sections of this monograph include:

- Ligand receptor interactions of hormones, growth factors, cytokines and neurotransmitters leading to alteration/initiation of membrane regulation of internal cellular processes.
- Alteration of mineral entry through the cell membrane.
- Activation or inhibition of cytoplasmic enzyme reactions.
- Increasing the electrical potential and capacitance of the cell membrane.
- Changes in dipole orientation.
- Activation of the DNA helix possibly by untwisting of the helix leading to increase reading and transcription of codons and increase in protein synthesis
- Activation of cell membrane receptors that act as **antennas** for certain windows of frequency and amplitude leading to the concepts of electromagnetic reception, transduction and attunement.

Attunement:

- In my opinion there are multiple **structures in cell that act as electronic components**. If biological tissues and components of biological tissues can **receive**, **transduce** and **transmit** electric, acoustic, magnetic, mechanical and thermal vibrations then this may help explain such phenomena as:

1. Biological reactions to atmospheric electromagnetic and ionic disturbance (sunspots, thunder storms and earthquakes).
2. Biological reactions to the earth's geomagnetic and Schumann fields.
3. Biological reactions to hands on healing.

4. Biological responses to machines that produce electric, magnetic, photonic and acoustical vibrations (frequency generators).
5. Medical devices that detect, analyze and alter biological electromagnetic fields (the biofield).
6. How techniques such as acupuncture, moxibustion, and laser (photonic) acupuncture can result in healing effects and movement of Chi?
7. How body work such as deep tissue massage, rolfing, physical therapy, chiropractic can promote healing?
8. Holographic communication.
9. How neural therapy works?
10. How electrodermal screening works?
11. How some individuals have the capability of feeling, interpreting and correcting alterations in another individual's biofield?
12. How weak EMFs have biological importance?

In order to understand **how weak EMFs have biological effects** it is important to understand certain concepts that:

1. Many scientists still believe that weak EMFs have little to no biological effects.
    a. Like all beliefs this belief is open to question and is built on certain scientific assumptions.
    b. These assumptions are based on the **thermal paradigm** and the **ionizing paradigm**. These paradigms are based on the scientific beliefs that an EMF's effect on biological tissue is primarily thermal or ionizing.
2. Electric fields need to be measured not just as strong or weak, but also as low carriers or high carriers of information. Because electric fields conventionally defined as strong thermally may be low in biological information content and electric fields conventionally considered as thermally weak or non-ionizing may be high in biological information content if the proper receiving equipment exists in biological tissues.
3. **Weak electromagnetic fields** are: bioenergetic, bioinformational, non-ionizing and non- thermal and exert measurable biological effects. Weak electromagnetic fields have effects on biological organisms, tissues and cells that are **highly frequency specific** and the **dose response curve is non linear**. Because the effects of weak electromagnetic fields are non-linear, fields in the proper frequency and amplitude windows may produce large effects, which may be beneficial or harmful. **Homeopathy** is an example of use weak field with a beneficial electromagnetic effect. Examples of a thermally weak, but high informational content fields of the right frequency range are **visible light** and **healing touch**.
4. Biological tissues have electronic components that can receive, transduce, transmit weak electronic signals that are actually below thermal noise
5. Biological organisms use weak electromagnetic fields (electric and photonic) to communicate with all parts of themselves
6. An electric field can carry information through frequency and amplitude fluctuations.
7. Biological organisms are holograms.

8. Those healthy biological organisms have coherent biofields and unhealthy organisms have field disruptions and unintegrated signals.
9. Corrective measures to correct field disruptions and improve field integration such as acupuncture; neural therapy and resonant repatterning therapy promote health.

More details about the electrical roles of membranes and mitochondria

- Electricity in the body comes from the food that we eat and the air that we breathe (Brown, 1999). Cells derive their energy from enzyme catalyzed chemical reactions, which involves the oxidation of fats, proteins and carbohydrates. Cells can produce energy by oxygen-dependent aerobic enzyme pathways and by less efficient fermentation pathways.
- The specialized proteins and enzymes involved in oxidative phosphorylation are located on the inner mitochondrial membrane and form a molecular respiratory chain or wire. This molecular wire (electron transport chain) passes electrons donated by several important electron donors through a series of intermediate compounds to molecular oxygen, which becomes reduced to water. In the process ADP is converted into ATP.
- When the electron donors of the respiratory chain NADH and FADH2 release their electrons hydrogen ions are also released. These positively charged hydrogen ions are pumped out of the mitochondrial matrix across the inner mitochondrial membrane creating an electrochemical gradient. At the last stage of the respiratory chain these hydrogen ions are allowed to flow back across the inner mitochondrial membrane and they drive a molecular motor called ATP synthase in the creation of ATP like water drives a water wheel (Stipanuk, 2000). *This normal energy production process utilizing electron transport and hydrogen ion gradients across the mitochondrial membrane is disrupted when cells become cancerous.*

What structures are involved in cancerous transformation?

- Many current cancer researchers believe that cancerous transformation arises due to changes in the genetic code. However more seems to be going on than genetic abnormalities alone. A series of papers written by Ilmensee, Mintz and Hoppe in the 1970-1980's showed that replacing the fertilized nucleus of a mouse ovum by the nucleus of a teratocarcinoma did not create a mouse with cancer. Instead the mice when born were cancer free (Seeger and Wolz, 1990). These studies suggest the theory that abnormalities in other cell structures outside of the nucleus such as the cell membrane and the mitochondria and functional disturbances in cellular energy production and cell membrane potential are also involved in cancerous transformation.

  In examining the data to support this theory I found:

- As far back as 1938 Dr. Paul Gerhardt Seeger originated the idea that destruction or inactivation of enzymes, like cytochrome oxidase, in the respiratory chain of the mitochondria was involved in the development of cancer. Seeger indicated in his publications that the initiation of malignant degeneration was due to

alterations not to the nucleus, but to cytoplasmic organelles (Seeger and Wolz, 1990).

- Mitochondrial dysfunction and changes in cytochrome oxidase have also been reported by other cancer researchers (Sharp et al., 1992; Modica-Napolitano et al., 2001)
- Seeger's findings after over 50 years of cancer research are: that cells become more electronegative in the course of cancerization, that *membrane degeneration* occurs in the initial phase of carcinogenesis first in the external cell membrane and then in the inner mitochondrial membrane, that the degenerative changes in the surface membrane causes these *membranes to become more permeable to water-soluble substances* so that potassium, magnesium, calcium migrate from the cells and sodium and water accumulate in the cell interior, that the degenerative changes in the inner membrane of the mitochondria causes *loss of anchorage of critical mitochondrial enzymes*, and that the mitochondria in cancer cells degenerate and are reduced in number (Seeger and Wolz, 1990).
- Numerous toxins have been identified that are capable of causing cancerous transformation. Many toxins not only cause genetic abnormalities, but also affect the structure and function of the cell membrane and the mitochondria.
- Toxic compounds that disrupt the electrical potential of cell membranes and the structure of mitochondrial membranes will deactivate the electron transport chain and disturb oxygen-dependent energy production. Cells will then revert to fermentation, which is a less efficient primeval form of energy production. According to Seeger the conversion to glycolysis secondary to the deactivation of the electron transport chain has a profound effect on the proliferation of tumor cells. Seeger believes that the virulence of cancer cells is inversely proportional to the activity of the respiratory chain. Conversion to glycolysis as a primary mechanism for energy production results in excessive accumulation of organic acids and pH alterations in cancerous tissues (Seeger and Wolz, 1990).

The body is an electrical machine and the matrix of cells that compose the body possess electrical properties.

- Among the electrical properties that cells manifest are the ability to conduct electricity, create electrical fields and function as **electrical generators** and **batteries**. This sounds like the basis of a good science fiction movie.
- In electrical equipment the electrical charge carriers are electrons. In the body electricity is carried by a number of mobile charge carriers as well as electrons. Although many authorities would argue that electricity in the body is only carried by charged ions, Robert O. Becker and others have shown that electron semiconduction also takes place in biological polymers (Becker and Selden, 1985; Becker, 1990).
- **The major charge carriers of biological organisms** are negatively charged electrons, positively charged hydrogen protons, positively charged sodium, potassium, calcium and magnesium ions and negatively charged anions particularly phosphate ions. The work of Mae Wan Ho and Fritz Popp indicate that cells and tissues also conduct and are linked by electromagnetic phonons and photons (Ho, 1996).

- The body uses the exterior cell membrane and positively charged mineral ions that are maintained in different concentrations on each side of the cell membrane to create a **cell membrane potential** (a voltage difference across the membrane) and a strong electrical field around the cell membrane. This electrical field is a readily available source of energy for a significant number of cellular activities including membrane transport, and the generation of electrical impulses in the brain, nerves, heart and muscles (Brown, 1999). The storage of electrical charge in the membrane and the generation of an electrical field create a battery function so that the liquid crystal semiconducting cytoskeletal proteins can in a sense plug into this field and powered up cell structures such as genetic material. The voltage potential across the membrane creates a surprisingly powerful electric field that is 10,000,000 volts/meter according to Reilly and up to 20,000,000 volts/meter according to Brown (Reilly, 1998; Brown, 1999).
- The body uses the mitochondrial membrane and positively charged hydrogen ions to create a strong membrane potential across the mitochondrial membrane. Hydrogen ions are maintained in a high concentration of the outside of the mitochondrial membrane by the action of the electron transport chain, which creates a mitochondrial membrane potential of about 40,000,000 volts/meter. When this proton electricity flows back across the inner mitochondrial membrane it is used to power a **molecular motor** called ATP syntase, which loads negatively charged phosphate anions onto ADP thus creating ATP (Brown, 1999).
- ADP, ATP and other molecules that are phosphate carriers are electrochemical molecules that exchange phosphate charges between other cellular molecules. According to Brown, "The flow of phosphate charge is not used to produce large-scale electrical gradients, as in conventional electricity, but rather more local electrical field within molecules (Brown, 1999)." The body uses phosphate electricity to activate and deactivate enzymes in the body by charge transfer, which causes these enzymes to switch back and forth between different conformational states. So in a sense enzymes and other types of proteins such as cytoskeletal proteins may function as **electrical switches**.
- **The liquid crystal proteins that compose the cytoskeleton** support, stabilize and connect the liquid crystal components of the cell membrane with other cell organelles. The cytoskeletal proteins have multiple roles.
- The proteins that compose the cytoskeleton serve as *mechanical scaffolds* that organize enzymes and water, and anchor the cell to structures in the extracellular matrix via linkages through the cell membrane (Wolfe, 1993). According to Wolfe, "Cytoskeletal frameworks also reinforce the plasma membrane and fix the positions of junctions, receptors and connections to the extracellular matrix (Wolfe, 1993)."
- Self-assembling cytoskeletal proteins are dynamic network structures that create a fully integrated electronic and probably fiberoptic *continuum* that links and integrates the proteins of the extracellular matrix with the cell organelles (Haltiwanger, 1998; Oschman, 2000).
- Cytokeletal proteins also structurally and electronically link the cell membrane with cell organelles.

- **Cytoskeletal proteins are altered in cancer cells.** Alterations include: *reversion to arrangements typical of embryonic cells*, and breakage of contact and connections with ECM and neighboring cells. *It is my opinion that change of connections of the cytoskeletal proteins with ECM components and the cell membrane will disrupt the flow of inward current into the cell, affect genetic activity and is an important factor in disabling oxygen-dependent energy production.*
- Cells can obtain energy from food either by fermentation or oxygen-mediated cellular respiration. Both methods start with the process of glycolysis, which is the splitting of glucose (6 carbon) into two molecules of pyruvate (3 carbon).
- Most biologists believe that glycolysis, the oldest metabolic way to produce ATP, has been conserved in all living organisms. Glycolysis happens in the cytoplasm and does not require oxygen in order to produce ATP, but it is also a much less efficient method than aerobic respiration.
- The enzyme pyruvate dehydrogenase occupies a pivotal role in determining whether energy is extracted from glucose by aerobic or anaerobic methods (Garnett, 1998). This enzyme exists in an altered form in cancer cells (Garnett, 1998). *Over all membrane changes, mitochondrial dysfunction, loss of normal cellular electronic connections and enzyme changes are all factors that contribute to the permanent reliance of cancer cells on glycolysis for energy production.*

Electronic roles of the cell membrane and the electrical charge of cell surface coats:

- **Cell membrane potential** - All cells possess an electrical potential (a membrane potential) that exists across the cell membrane. **Why is this so?**
- Cell membranes are composed of a bilayer of highly mobile lipid molecules that electrically act as an insulator (dielectric). The insulating properties of the cell membrane lipids also act to restrict the movement of charged ions and electrons across the membrane except through specialized membrane spanning protein ion channels (Aidley and Stanfield, 1996) and membrane spanning protein semiconductors (Oschman, 2000) respectively.
- Because the cell membrane is selectively permeable to sodium and potassium ions a different concentration of these and other charged mineral ions will build up on either side of the membrane. The different concentrations of these charged molecules cause the outer membrane surface to have a relatively higher positive charge than the inner membrane surface and creates an electrical potential across the membrane (Charman, 1996). All cells have an imbalance in ***electrical charges*** between the inside of the cell and the outside of the cell. The difference is known as the membrane potential.
- Because the membrane potential is created by the difference in the concentration of ions inside and outside the cell this creates an electrochemical force across the cell membrane (Reilly, 1998). “Electrochemical forces across the membrane *regulate chemical exchange across the cell* (Reilly, 1998).” The cell membrane potential helps **control cell membrane permeability** to a variety of nutrients and helps turn on the machinery of the cell particularly energy production and the synthesis of macromolecules.

- All **healthy living cells** have a membrane potential of about -60 to –100mV. The negative sign of the membrane potential indicates that the inside surface of the cell membrane is relatively more negative than the than the immediate exterior surface of the cell membrane (Cure, 1991). In a healthy cell the inside surface of the cell membrane is slightly negative relative to its external cell membrane surface (Reilly, 1998). When one considers the transmembrane potential of a healthy cell the electric field across the cell membrane is enormous being up to 10,000,000 to 20,000,000 volts/meter (Reilly, 1998; Brown, 1999).
- Healthy cells maintain, inside of themselves, a high concentration of potassium and a low concentration of sodium. But when cells are injured or cancerous **sodium and water flows in to the cells** and potassium, magnesium, calcium and zinc are lost from the cell interior and the cell membrane potential falls (Cone, 1970, 1975, 1985; Cope, 1978).
- In writing this monograph I found that trying to describe what factors are primary and result in other changes was like arguing over whether the chicken came before the egg or vice versa. What is known is that in cancer changes in cell membrane structure, changes in membrane function, changes in cell concentrations of minerals, changes in cell membrane potential, changes in the electrical connections within the cells and between cells, and changes in cellular energy production all occur. Before I continue to explore these issues I want to discuss the electrical zones of the cell.

Cells actually have a number of discrete electrical zones.

- For years I have been frustrated when I read papers and books that discussed the electrical properties of cells. It was not until I read Roberts Charman's work that I began to understand that the electrical properties of a cell vary by location.
- According to Charman **a cell contains four electrified zones** (Charman, 1996). The *central zone* contains negatively charged organic molecules and maintains a steady bulk negativity. An *inner positive zone* exists between the inner aspect of the cell membrane and the central negative zone. The inner positive zone is composed of a thin layer of freely mobile mineral cations particularly potassium and according to Hans Nieper (Nieper, 1985) a small amount of calcium as well. The *outer positive zone* exists around the outer surface of the cell membrane and consists of a denser zone of mobile cations composed mostly of sodium, calcium and a small amount of potassium. Because the **concentration of positive charges is larger on the outer surface of the cell membrane than the concentration of positive charges on the inner surface of the cell membrane an electrical potential exists across the cell membrane.** You might ask at this point the question, **how can the surface of cells be electrically negative if a shell of positively charged mineral ions surrounds the exterior surface of the cell membrane?** The answer lies in the existence of an outer electrically negative zone composed of the glycocalyx.
- The *outermost electrically negative zone* is composed of negatively charged sialic acid molecules that cap the tips of glycoproteins and glycolipids that extend outward from the cell membrane like tree branches. The outermost negative zone is separated from the positive cell membrane surface by a distance of about 20

micrometers. According to Charman, "It is this outermost calyx zone of steady negativity that makes each cell act as a negatively charged body; every cell creates a negatively charged field around itself that influences any other charged body close to it (Charman, 1996)."

- It is the negatively charged sialic acid residues of the cell coat (glycocalyx) that gives each cell its **zeta potential**. Since the negatively charged electric field around cells are created by sialic acid residues, any factor that increases or decreases the number of sialic acid residues will change the degree of surface negativity a cell exhibits. I will discuss later in this paper how cancer cells have significantly more sialic acid molecules in their cell coat and as a result cancer cells have a greater surface negativity. *In my opinion one of reasons that enzyme therapy is beneficial in cancer is because certain enzymes can remove sialic acid residues from cancer cells reducing their surface negativity.*

The electrical properties of cancer cells part 1

- Some of the characteristic features of cancerous cells that affect their electrical activity are:
    1. Cancer cells are less efficient in their production of cellular energy (ATP).
    2. Cancer cells have cell membranes that exhibit different electrochemical properties and a different distribution of electrical charges than normal tissues (Cure, 1991. 1995).
    3. Cancer cells also have different lipid and sterol content than normal cells (Revici, 1961).
    4. Cancer cells have altered membrane composition and membrane permeability, which results in the movement of potassium, magnesium and calcium out of the cell and the accumulation of sodium and water into the cell (Seeger and Wolz, 1990).
    5. Cancer cells have lower potassium concentrations and higher sodium and water content than normal cells (Cone, 1970, 1975; Cope, 1978).
- The result of these mineral movements, membrane composition changes, energy abnormalities, and membrane charge distribution abnormalities is a drop in the normal membrane potential and membrane capacitance. I will now discuss these features in more depth.
- One of the characteristic features of injured and cancerous cells is that they are **less efficient in their production of cellular energy** (ATP). One of the mysteries of cancer is whether energy abnormalities cause or contribute to the mineral alterations or whether mineral alterations and membrane changes cause or contribute to the energy abnormalities by disrupting mitochondrial production of ATP. But all these abnormalities are present and in my opinion all of them should be addressed by therapeutic strategies.
- A *change in mineral content of the cell*, particularly an increase in the intracellular concentration of positively charged sodium ions and an *increase in negative charges on the cell coat* (glycocalyx) are two of the major factors causing **cancerous cells to have lower membrane potential** than healthy cells (Cure, 1991).

- Cancer cells exhibit both *lower electrical membrane potentials and lower electrical impedance* than normal cells (Cone, 1985; Blad and Baldetorp, 1996; Stern, 1999).
- Since the membrane potential in a cancer cell is consistently weaker than the membrane potential of a healthy cell. The electrical field across the membrane of a cancer cell will be reduced. The reduction in membrane electrical field strength will in turn cause alterations in the metabolic functions of the cell.
- In the resting phase normal cells maintain a high membrane potential of around -60mv to -100mv, but when cells begin cell division and DNA synthesis the membrane potential falls to around –15mv (Cure, 1995). When a cell has completed cell division its membrane potential will return back to normal.
- According to Cone two of the most outstanding electrical features of cancer cells is that they **constantly maintain** their membrane potential at *a low value* and their intracellular *concentration of sodium at a high concentration* (Cone, 1970, 1975, 1985).
- Cone has discussed in his publications that a sustained elevation of intracellular sodium may act as a **mitotic trigger** causing cells to go into cell division (mitosis) (Cone, 1985).
- It is generally thought that a *steady supply of cellular energy* and a healthy cell membrane are needed to maintain a normal or healthy concentration of intracellular minerals and a healthy membrane potential. This means that conditions associated with **disruption of cellular energy production** and **membrane structure/function** will result in *changes in the intracellular mineral concentration and a low membrane potential.*
- This statement may be true for injured cells, but Cure has proposed that another additional factor may be involved in changing the cell membrane potential of cancer cells, the concentration of sodium and potassium inside of cancer cells, and the mechanisms that cancer cells use to produce energy.
- Cure has proposed that the accumulation of an **excessive amount of negative charges on the exterior surface of cancer cells** will depolarize cancer cell membranes. He thinks that the depolarization (fall in membrane potential) of the cancer cell membrane due to the accumulation of excess negative surface charges may **precede and create** the reduction in intracellular potassium and the rise in the intracellular sodium launching the cell into a carcinogenic state (Cure, 1991). I know this must read like I am splitting hairs, but if the creation of an excessive negative charge on the surface of a cell can initiate a carcinogenic change then it means **genetic changes can result from the development of cellular electrical abnormalities**.
- This has profound implications because it would mean that the development of genetic abnormalities is not always the prime factor leading to cancerous transformation.
- Cure's theory ties into Dr. Paul Gerhardt Seeger's work **that cancer arises from alterations in the functions of cell organelles outside of the nucleus** (Seeger and Wolz, 1990).
- This idea may mean that certain chemicals, viruses and bacteria create cancers by **modifying the electrical charge of the cell surface** resulting in alterations in:

cell membrane and organelle membrane electrical potentials, the functions of these membranes, intracellular mineral content, energy production and genetic expression.

- It also means that therapeutic methods that manipulate the electrical charge of cell membranes, the composition of cell membranes and the content of intracellular minerals can result in alterations in genetic activity.
- A healthy cell membrane potential is strongly linked to the control of cell membrane transport mechanisms as well as DNA activity, protein synthesis and aerobic energy production. Since injured and cancerous cells cannot maintain a normal membrane potential they will have electronic dysfunctions that will impede repair and the reestablishment of normal metabolic functions. Therefore a **key component of cell repair and cancer treatment** would be to reestablish a healthy membrane potential in the body's cells (Nieper, 1966a, 1966b, 1966c, 1967a, 1967b, 1968, 1985; Alexander, 1997b; Nieper et al., 1999).

The electrical properties of cancer cells part 2

- The idea of classifying cancers by their electrical properties is not a new idea in fact it was first proposed by Fricke and Morse in 1926 (Fricke and Morse, 1926). For example, the electrical conductivity and permittivity of cancerous tissue has been found to been found to be greater than the electrical conductivity and permittivity of normal tissues (Foster and Schepps, 1981). Because cancerous cells demonstrate greater permittivity, which is the ability to resist the formation of an electrical field they **will resonate differently from normal cells**.
- **The electrical conductivity** of a tissue depends on both the physico-chemical bulk properties, i.e., properties of tissue fluids and solids and the microstructural properties, i.e., the geometry of microscopic compartments (Scharfetter, 1999). In turn the electrical **conductivity** and **permittivity** of biological materials will vary characteristically *depending on the frequency applied* (Scharfetter, 1999).
- In biological tissues electrical currents are carried by both ionic conduction and electron semiconduction. Whereas in electrical equipment only electrons or electron holes carry the electrical current. Therefore the electrical properties of biological tissues are dependent on all the physical mechanisms, which control the mobility and availability of the relevant ions such as sodium, chloride, potassium, magnesium and calcium (Scharfetter, 1999).
- The electrical charges associated with semiconducting proteins and extracellular matrix proteoglycans also contribute to the conductivity of a tissue. So the electrical properties of tissues also relates to electron availability, which can be affected by such factors as the degree of tissue acidity, the degree of tissue hypoxia, the degree that water is structured, and the availability of electron donors such as antioxidants, and the presence of electrophilic compounds on the cell membrane and in the extracellular matrix (ECM).
- The cell membrane ECM interface is the location where molecules like hormones, peptide growth factors, cytokines, and neurotransmitters initiate chemical signaling from cell to cell and where these chemical-signaling events can be **regulated and amplified** by the weak nonionizing oscillating electromagnetic fields that are naturally present in the ECM (Adey, 1988). The cell membrane

ECM interface has a lower electrical resistance than the cell membrane so *electrical currents will be preferentially conducted* through this space (Adey, 1981). This cell surface current flow is involved in controlling many of the physiological functions of the cells and tissues (Adey, 1981).

- Conductivity in both healthy tissues and cancerous tissues can be affected by variations in: temperature, oxygen levels, mineral concentrations in intracellular and extracellular fluid, the types of minerals present in intracellular and extracellular fluids, pH (both intracellular and extracellular), level of hydration (cell water content and extracellular water content), the ratio of structured/unstructured water inside of the cell, membrane lipid/sterol composition, free radical activity, the amount of negative charges present on the surface of cell membranes, the amount and structure of hyaluronic acid in the ECM, the emergence of endogenous electrical fields, the application of external electromagnetic fields, and the presence of chemical electrophilic toxins and heavy metals both within the cell and in the ECM.
- According to Dr. Robert Pekar, "**Every biological process is also an electric process**" and "health and sickness are related to the bio-electric currents in our body (Pekar, 1997)."
- The electrical properties of cancer cells are different than the electrical properties of the normal tissues that surround them. From the papers that I have read in preparing this monograph many authors have reported that cancer cells have higher intracellular sodium, higher content of unstructured water, lower intracellular potassium, magnesium and calcium concentrations, and more negative charges on their cell surface (Hazelwood et al., 1974; Cone, 1975; Cope, 1978; Brewer, 1985, Cure, 1991). These abnormalities result in cancer cells having lower transmembrane potentials than normal cells and altered membrane permeability. These cell membrane changes interfere with the flow of oxygen and nutrients into the cells and impair aerobic metabolism causing cancer cells to rely more on anaerobic metabolism for energy production. Anaerobic metabolism, excessive sodium concentrations, low transmembrane potential and pH alterations in turn create intracellular conditions more conducive to cellular mitosis.
- Recognizing that cancer cells have altered electrical properties also leads to strategies toward correcting these properties.
- Some of the areas to explore are:
    1. Manipulation of fatty acids and sterols to address membrane composition.
    2. Methods to reduce intracellular sodium concentrations, since an intracellular excess of positively charged sodium ions **reduces** the negative interior potential of the inner membrane surface resulting in a fall in membrane potential.
    3. Use of compounds like mineral transporters to increase intracellular delivery of magnesium, potassium and calcium.
    4. Methods that can help remove the silaic acid and excessive negative charges from the external surface of cancer cells (glycocalyx) such as enzymes and electrical treatments. Since an excess of negative charges in the glycocalyx also can reduce the membrane potential of cancer cells.
    5. Manipulating electrical charges on both sides of tumor cell membranes.

6. **Corrective intracellular, extracellular and membrane measures** can be used to address the abnormal electrical properties of cancer cells. **Intracellular measures** could include the use of intracellular potassium and magnesium mineral transporters and the amino acid taurine to reestablish more normal intracellular levels of these minerals inside of the cell. Calcium aspartate can be used to deposit calcium on the inner side of the cell membrane. **Extracellular measures** could include the use of calcium 2-AEP to lay down a shell of positive calcium ions on the surface of cells to neutralize the negative surface charges. Also enzymes and antihCG vaccines can reduce the number of negatively charged sialic acid residues on the surface of cancer cells. **Cell membrane measures** could include use of squalene to improve sodium excretion form the cell and oxygen entry into the cells.
7. **In summary.** Improved cell membrane potential and membrane capacitance will affect: mitochondrial production of ATP, cell membrane permeability, production of proteins and other macromolecules. Certain nutrients have the ability to support the electrical potential of the cell membrane. These nutrients include essential fatty acids, phospholipids, sterols and nutrients such as mineral transporters that help normalize intracellular mineral concentrations in diseased cells. The combination of cell membrane repair and correction of deficiencies of intracellular mineral concentrations primarily potassium, magnesium, zinc and calcium and correction of excessive intracellular levels of sodium will result in improvement of cell membrane capacitance back toward a healthier charge. Mineral transporters such as orotates, arginates and aspartates can be used to adjust intracellular mineral concentrations. Some clinicians also try to improve the cellular capacitance of cancer cells by use of PEMF, microcurrent, infrared and phototherapy equipment**.**

Anatomical concepts

Tissue cells exist within a continuum where they are attached to other cells of the same type. The cells of the body require a steady supply of nutrients so they are typically located in close proximity to blood vessels. The extracellular matrix occupies an intermediate position between the blood vessels and the cell membrane. The major anatomical areas I will examine are:

1. The intravascular space and its components
2. The cell membrane covering of cells and the attached glycocalyx
3. The extracellular space and the components of the extracellular matrix
4. The ECM-glycocalyx-membrane interface

The intravascular space and its components has many functions including nutrient transport into the cell, toxin transport away from the cells and a control function where soluble hormones and growth stimulants and inhibitors are carried to cells from distant locations and away from secreting cells to distant locations.

The cell membrane covering of all cells and the attached glycocalyx: Chemical and anatomical roles of the cell membrane.

- The cell membrane is the gatekeeper of the cell that controls the inflow and outflow of nutrients and electric currents to and from the cell interior. It regulates the active transport of nutrients such as minerals and amino acids, and the release of toxins.
- The cell membrane is an interface between the cell interior, other cells and components of the extracellular matrix (ECM). The cell membrane mediates adherence and communication with other cells, the ECM and components of the immune system.
- Normal multicellular organisms require coherent and coordinated communication of each cell with the other cells in the organism. In order to synchronize cellular processes in a multicellular state *a communication system must exist.*
- For most of the last century biological science has concentrated almost exclusively on explaining the communication system of multicellular organisms with vascular systems by focusing on circulatory chemical signals carried by the bloodstream to other areas of the body. This paradigm attributes communication at the cellular levels to molecular interactions, chemical concentrations and chemical kinetics.
- The cell membrane contains docking ports on its surface called receptors that allow the cell to pick up distant chemical signals (hormones, neurotransmitters, prostagladins) sent by other cells through the blood stream and local chemical signals generated by components of the ECM and immune cells. *I will discuss later in this monograph that it is likely that many of these cell receptors also function as antennas for particular frequencies of electromagnetic energy (Haltiwanger, 1998).*
- The cell membranes of cancer cells are different from normal cells. Cancer cell membranes have alterations in their lipid/sterol content (Revici, 1961) and in the types of glycoproteins and antigens that they express (Warren et al., 1972; Hakomori, 1990). Cancer cells also exhibit the ability to express their own growth factors and the ability to ignore growth factor inhibition control exerted by the ECM.

The extracellular space and the components of the extracellular matrix connect to the cytoskeleton of the cells

- The ECM occupies an intermediate space between the intravascular space and the boundary of the cells. The ECM can be considered to function as a prekidney, since all substances that have to be eliminated through the bloodstream and kidneys must first pass through the ECM. The ECM is also a transit and storage area for nutrients, water, and waste.
- The ECM pervades the entire organism and reaches most cells in the body. The ECM has anatomic, physical, chemical, and electronic functions.
- **Anatomically** the ECM consists of a recticulum consisting of polymeric protein-sugar complexes bound to water forming a gel state (Oschman, 2000). The cytoplasm inside of cells also exists in a gel state. The liquid crystal properties of the molecules in these compartments allow them to undergo cooperative phase

transitions in response to changes in temperature, pH, ion concentrations, oxygen concentration, carbon dioxide concentration, ATP concentration, electrical fields and other physical factors.

- Cells are organized structures with an internal architecture of cytoskeletal proteins that connect all components of the cell. The enzymes of the cell are attached to the cytoskeletal framework and membranes creating solid-state chemistry (Ho, 1996). Enzymes are not just floating randomly around. Cytoskeletal filaments and tubules form a continuous system that links the cell surface to all organelle structures including passage through the nuclear membrane to the chromosomes. The cytoskeleton is also attached through cell membrane connectors to liquid crystal protein polymers located in the external ECM and to other cells.
- The liquid crystal protein polymers of the ECM are mostly composed of collagen, elastin, hylauronic acid, and interweaving glycoproteins such as fibronectin. Fibronectins binds the ECM proteins to each other and to cell membrane integrins. The cell membranes contain proteins called integrins, which creates a continuum linking the internal liquid crystal cytoskeletal proteins to liquid crystal proteins located outside of the cell in the ECM (Oschman, 2000).
- When cells become swollen with water (injured cells and cancerous cells) the cell geometry changes, which will create different connections, different electron and photon flows, different chemistry, and different pH.
- Cancer cells have different cytoskeletal structures, different fat/sterol content of their membranes, different enzymes, and different proteins and cell membrane receptors due to genetic alterations.
- Some of the proteins of cancer cells are regressive reversions to embryological proteins, which creates different binding = loss of connectedness, and different chemistry esp. in energy production. The regressive reversions of cancer cells causes these cells to express different extracellular matrix material creating a more negative charge on the exterior of cancer cells, an alteration in the ionic content inside of cancer cells, and a different interaction with the environment.
- **Physically the ECM** acts as a **molecular sieve** between the capillaries and the cells (Reichart, 1999). The concentration of minerals in the ECM, the composition of proteoglycans, the molecular weight of the proteoglycans, the amount of bound water in the ECM, and the pH of the ECM control the filtering aspect of the ECM.
- The ECM is **a transit area** for the passage of nutrients from the bloodstream into the cells and for toxins released by the cells that pass through to the bloodstream. It is also a transit area for immune cells that move out of the bloodstream. These immune cells are involved in inflammatory reactions by secreting cytokines and digesting old worn out cells. They may also facilitate healing by carrying and delivering components from other areas of the body to the cell membrane. These migrating immune cells, as well as fixed cells in the ECM, regulate cellular functions by secreting growth factors and cell growth inhibitors (Reichart, 1999).
- The ECM functions as **a storage reservoir** for water, nutrients and toxins and a pH buffering system where the proteins of the ECM buffer acids released by the cells.
- In healthy conditions most of the water in the ECM is bound to the interweaving proteoglycans forming a gel, which creates a physical barrier that limits, directs,

and evenly distributes the flow of fluid from the venule end of the capillaries to the cells.

- When conditions create edema in the ECM. Fluid flows more easily from leaky capillaries, but these large flows of fluid are unevenly distributed, which interferes with nutrient delivery, oxygen perfusion and waste disposal. In edematous conditions the ECM becomes more hypoxic, more acidic and electrically more resistant. Bioflavinoids are some of the most effective nutrients in reducing capillary leakage, which helps reduce edema. In a sense bioflavinoids could be considered to be electrical nutrients because they can help improve the electrical conductivity of the ECM by helping reduce capillary leakage and ECM edema.
- **Biochemically the ECM** is a metabolically and electrically active space that is involved in regulating cell growth control. Cellular components of the ECM are involved in the local production of growth factors, growth inhibitors and cytokines that affect the growth and metabolic activity of tissue/organ cells (Reichart, 1999). Immune cells such as leukocytes, lymphocytes and macrophages that migrate into the ECM are involved in initiating the removal of old and damaged cells and in stimulating the growth of new cells.
- Fibroblasts and fibrocytes are the main cells that produce the proteins and ground substance of the ECM in soft tissue.
- The glycocalyx (sugar cell coat) is produced by the cells of parenchymal organs and secreted onto their cell surfaces. The ECM and the glycocalyx work together to regulate information transfer to and from tissue/organ cells by both electrical field fluctuations leading to electroconformational coupling and soluble signaling molecules.
- **Electronic functions of the ECM:** According to James Oschman, communication systems in living organisms involve two languages chemical and energetic (Oschman, 2000). Chemical communication in the body takes place mainly through the circulatory system. Energetic communication in the body, according to Western Medical paradigms, takes place almost exclusively in the nervous system. Oschman and Mae Wan Ho (Ho, 1998) have written extensively about an evolutionarily older solid-state electronic communication system that operates both in series and in parallel with the nervous system through the liquid crystal protein polymer connective system continuum. It is through this continuum that information is carried in biological systems via endogenous DC electric fields, their associated magnetic fields and ultra-weak photon emission.
- This continuum of liquid crystal connections will allow electrons and photons to move in and out of cells. In my opinion cytoskeletal filaments **function as electronic semiconductors and fiberoptic cables** integrating information flow both within the cell and with other cells. This continuum enables an organism to function as a biological hologram.
- In my opinion the extracellular connective system is an unrecognized organ that is spread diffusely throughout the body. In medicine doctors are trained to think of organs as discrete tissues that have particular anatomical locations, but I see the connective tissues as a specialized organ that integrates all parts of the body into a holographic matrix where each organ even each cell is in communication with all

other parts. But what about circulating vascular cells and migrating immune cells? They are not attached to connective tissue fibers, how do they communicate? I believe these cells communicate both by chemical and resonant interactions. I believe that energetic communications in the body takes place through hard wired biologic electronic systems, biologic fiberoptic systems as well as through resonant interactions.

The electronic functions of the cells and the ECM are involved in healing and tissue regeneration.

- **Cells are electromagnetic in nature**, they generate their own electromagnetic fields and they also harness external electromagnetic energy of the right wavelength and strength to communicate, control and drive metabolic reactions.
- The cells of an organism are embedded in a matrix of organized water and most of the body's cells are hardwired into a holographic liquid crystal polymer continuum that connects the cytoskeletal elements of the inside of the cell through cell membrane structures with a **semiconducting** and **fiberoptic liquid crystal polymer** connective tissue communication system (Haltiwanger, 1998; Oschman, 2000).
- Most of the molecules in the body are **electrical dipoles** (Beal, 1996). These dipoles electronically *function like transducers* in that they are able to turn ***acoustic waves into electrical waves and electrical waves into acoustic waves*** (Beal, 1996). The natural properties of biomolecular structures enables cell components and whole cells to oscillate and interact resonantly with other cells (Smith and Best, 1989). According to Smith and Best, the cells of the body and cellular components possess the ability *to function as electrical resonators* (Smith and Best, 1989).
- Professor H. Frohlich has predicted that the fundamental oscillation in cell membranes occurs at frequencies of the order of 100 GHz and that biological systems possess the ability to create and utilize coherent oscillations and **respond to external oscillations** (Frohlich, 1988). Lakhovsky predicted that cells possessed this capability in the 1920's (Lakhovsky, 1939).
- Because cell membranes are composed of dielectric materials a cell will behave as dielectric resonator and will produce an evanescent electromagnetic field in the space around itself (Smith and Best, 1989). "This field does not radiate energy but is capable of interacting with similar systems. Here is the mechanism for the electromagnetic control of biological function (Smith and Best, 1989)." *In my opinion this means that the applications of certain frequencies by frequency generating devices can enhance or interfere with cellular resonance and cellular metabolic and electrical functions.*
- **Electric fields** induce or a cause alignment in dipole movements. A dipole movement is a function of polarization processes and the strength of the electric field. When biological tissue is exposed to an electric field in the right frequency and amplitude **windows** a preferential alignment of dipoles becomes established. Since the cell membrane contains many dipole molecules, an electric field will cause preferential alignment of the dipoles. This may be one mechanism that electrical fields alter membrane permeability and membrane functions.

- Both internally generated and externally applied electromagnetic fields can affect cell functions. The primary external electromagnetic force is the sun, which produces a spectrum of electromagnetic energies. Life evolved utilizing processes that harness the energy of light to produce chemical energy, so in a sense light is the first nutrient.
- Endogenous weak electric fields are naturally present within all living organisms and apparently involved in pattern formation and regeneration (Nuccitelli, 1984).
- Regeneration is a healing process where the body can replace damaged tissues. Some of the most important biophysical factors implicated in tissue repair and regeneration involve the natural electrical properties of the body's tissues and cells (Brighton et al., 1979), such as cell membrane potential and protein semiconduction of electricity. The body utilizes these fundamental bioelectronic features to naturally produce electrical currents that are involved in repair and regeneration (Becker, 1961, 1967, 1970, 1972, 1974, 1990). Robert O. Becker has shown in his research that the flow of endogenous electrical currents in the body is not a secondary process, but in fact is an initiator and control system used by the body to regulate healing in bone **and other tissues** (Becker, 1970, 1990; Becker and Selden, 1985).
- For example, in bone the proper production and conduction of endogenous electrical currents is required to stimulate primitive precursor cells to differentiate into osteoblasts and chondroblasts (Becker and Selden, 1985; Becker, 1990). Once the bone forming osteoblasts are created, they *must maintain a healthy cell membrane electrical potentia*l and have available certain critical nutrients in order to form the polysaccharide and collagen components of osteoid. Endogenous bone electrical currents created through piezoelectricity (Fukada, 1957, 1984) are also required for deposition of calcium crystals (Becker et al., 1964). *When the biophysical electrical properties of the tissues are considered, it makes sense to develop therapeutic strategies that support the body's biophysical electrical processes to potentiate the healing of injured, diseased, and cancerous tissues.*

The ECM-glycocalyx-membrane interface

- **Cell membranes are composed of** phospholipids, sterols and embedded and attached proteins. The composition of the cell membrane directly affects cell *membrane functions* include membrane permeability, cell signaling, and cell capacitance.
- **Glycoproteins** secreted from the cell interior and cellular components of the ECM create the glycocalyx covering of cells. Some of these glycoproteins are components of cell membrane receptors making them important in signaling processes such as activation by growth factors.
- These glycoproteins characteristically have a negative electrical charge. Cancer cells however have excessively high concentrations of negatively charged molecules on their exterior surface, which act as electric shields (Cure, 1991, 1995).
- Cell membrane glycoproteins act as molecular chemical receptors and electromagnetic or electric field antennas (Adey, 1988). If Adey is right then cells function both as chemical and *electrical receivers and transmitters* .

Signaling mechanisms may be either chemically or resonantly mediated.

- **Chemical communication** is mediated by chemical soluble signals that travel through the bloodstream and then through the ECM from distant locations or chemicals that are locally produced in the ECM. These soluble signaling molecules may be produced in distant sites by endocrine cells or are secreted by cells embedded within the ECM or cells that migrate into the ECM such as macrophages, T-cells and B-cells. When these soluble signaling molecules are presented to the organ cells they can either activate or inhibit cellular metabolic reactions by activating cell membrane or cytoplasmic glycoprotein receptors (Reichart, 1999).
- Chemical signal activation of cell receptors will cause the receptor's molecular structure to shift to from an inactive to an activated conformational state. This is a phase transition. When a receptor is activated it will bind to and activate other membrane bound proteins or intracellular proteins/enzymes. The outcome of receptor activation may: increase the transport of certain molecules or mineral ions from one side of the cell membrane to the other side; increase or inhibit the activity of enzymes involved in metabolic synthesis or degradation; activate genes to produce certain proteins; turn off gene production of other proteins or cause cytoskeletal proteins to change the shape or motility of the cell. When the receptor protein switches back to its inactive conformation it will detach from the effector proteins/enzymes and the signal will cease (Van Winkle, 1995).
- **Cell receptors can also be activated by electric fields** (vibrational resonance) that have particular frequencies and amplitudes through a process known as *electroconformational coupling* (Tsong, 1989). Electrical oscillations of the right frequency and amplitude can alter the electrical charge distribution in cell receptors causing the cell receptors to undergo conformational changes just as if the receptor was activated by a chemical signal. Ross Adey has extensively described in his publications that the application of weak electromagnetic fields of certain windows of frequency and intensity act as **first messengers** by activating glycoprotein receptors in the cell membrane (Adey, 1993). This electrical property of cell receptor- membrane complexes would allow cells to scan incoming frequencies and tune their circuitry to allow them to resonate at particular frequencies (Charman, 1996).
- Adey and other researchers have reported that one effect of the application of weak electromagnetic fields is the release of calcium ions inside of the cell (Adey, 1993). Adey has also documented that cells respond constructively to a wide range of frequencies including frequencies in the extremely low frequency (ELF) range of 1-10 Hz a range of frequencies known as the Schumann resonance frequencies that are naturally produced in the atmosphere (Adey, 1993).
- Adey has also reported that certain frequency bands between 15-60 Hz have been **found to promote cancers**. Frequencies in this range have been found to alter cell protein synthesis, mRNA functions, immune responses and intercellular communication (Adey, 1992).

- The ECM also contains nerve fibers connected through the autonomic nervous system back to the brain, which then regulates hormone homeostasis by feedback control through the hypothalamic pituitary axis.

Resonance communication mechanisms

- The ground substance of the ECM contains an electrical field that will fluctuate in response to the composition of proteoglycans especially the degree of negative charge, which is dependent on the concentration of sialic acid residues and the ion/mineral content of the ECM. The fluctuations/oscillations of the electric field of the ECM when strong enough can lead to local depolarization of portions of the cell membrane and changes in membrane permeability.
- The oscillation of the electrical potential can affect through resonance (electrochemical coupling) the conformational structures of cell membrane receptors. The receptors can switch back and forth between conformations, which will lead to turning on the activity of membrane embedded enzymes and opening and closing ion channels.
- Electrical field fluctuations that occur in the ECM and these field fluctuations are involved in cell signaling mechanisms. A number of researchers such as Becker and Adey believe that natural weak endogenous electric fields **actually control the chemical process of cell membrane signaling.** *This means that measures that enhance or disturb the production of these natural electric fields can impact cell-signaling processes.* In the future electrical medicine will advance to the point where you can dial up and administer frequencies that will act like pharmacological agents. When this occurs the phrase 'beam me up Scottie' may take on a whole new meaning.
- The natural oscillating electrical potential of the ECM can be adversely affected or constructively supported by exposure to external electromagnetic fields. Adverse electromagnetic field exposure can be initiated by exposure to high power tension lines, transformers and electronic equipment such as cell phones. Constructive support includes use of *certain nutrients* and devices like infrared emitters, phototherapy equipment, multiwave oscillators and microcurrent equipment that emit electromagnetic fields and electrical currents in physiological ranges.
- **Acoustical (sound) waves** of the right frequency can also affect cell-signaling and cellular metabolic processes.

The Bioelectrical control system

- The body uses electricity (biocurrents) as part of the body's mechanism for controlling growth and repair (Borgens et al., 1989). Some of these biocurrents travel through hydrated liquid crystal semiconducting protein-proteoglycan (collagen-hyaluronic acid) complexes of the ECM. Key elements that support this physiologic function include proper hydration, and normal protein configurations, which allow for the water to be structured in concentric nanometer thick layers (Ling, 2001). The production of normal ECM components, and proper ion concentrations are also important.

- Healthy production of collagen and hyaluronic acid in the ECM is in turn dependent upon the interactions of: internal cellular machinery that produces proteins and sugars, especially proper reading of the genetic code; availability of construction material like amino acids such as lysine and proline that are needed for collagen production; intracellular availability of cofactors of protein and sugar producing enzymes such as zinc, magnesium, trace minerals, vitamin C, bioflavinoids and B-complex vitamins; and the availability of endogenously produced and ingested precursor molecules such as glucosamine, mannose, galactose etc.
- **Biocurrents in the ECM pass through the cell membrane into the cell and electrons produced in the cell also pass out through the cell membrane.**
- Dr. Merrill Garnett has spent four decades studying the role of charge transfer and electrical current flow in the cell (Garnett, 1998). Dr. Garnett believes that biological liquid crystal molecules and structures such as hyaluronic acid, prothrombin, DNA, cytoskeletal proteins and cell membranes are involved in maintaining both an inward and outward current. The inward current flows from the cell membrane to cell structures like mitochondria and DNA and the outward current flows back along liquid crystal semiconducting cytoskeletal proteins back through the cell membrane to the ECM.
- Dr. Garnett has reported that **all cancer cells have abnormal electron transfer** systems and that normal cell development involves normal energy flows (Garnett, 1998).
- Dr. Garnett believes that electrical charges stored in the cell membrane (capacitance) and electrical charges of oxygen free radicals are normally transferred to DNA and are involved in DNA activation and the creation of an electrical field around DNA. DNA is very effective in transferring large amounts of electrical charge along its long axis (Garnett, 1998). In fact new research shows that DNA molecules may be good **molecular semiconductors** (Li and Yan, 2001).
- Dr. Garnett believes that an electrical pathway from the cell membrane fats to DNA is a natural pathway, **related to development** in cells that use **aerobic mechanisms** of ATP production (Garnett, 1998). As a corollary this natural electrical pathway is *transiently disrupted* in healthy cells while they are involved in wound healing and permanently disrupted in cancer cells that rely on anaerobic glycolysis for energy production. He believes that cells that are transformed into cancer cells have highly altered energy metabolism that includes increased reliance on glycolysis and a shift to the use of glutamine in the TCA cycle (Garnett, 1998). Cancer cells and normal cells that are growing in hypoxic areas use anaerobic energy production pathways that are regressions to earlier stages of embryonic development, but unlike normal cells that reverse back to aerobic metabolism cancer cells **remain permanently locked** into the anaerobic method of energy production.
- He has theorized that an alternating current oscillating circuit exists inside of cells between the cell membrane and the DNA that is conducted over electronic protein polymers inside of the cell. This circuit is activated during differentiation to

trigger the expression of genes (Garnett et al., 2002). *If Garnett is correct then it means that cells use their electrical properties to control gene expression.*

- Garnett has conjectured that the part of the DNA coiled around protein structures called **nucleosomes** may exhibit **electronic inductance**. "As a coil, it has **electronic inductance**, and since we have a series of coils, we have **a series inductance circuit**. DNA current passes initially through the helix in a state where it can discharge its field energy. Hence we have **a pulse within the DNA** interacting with other biomolecules like the membrane. The pulse can go in and come out, and the DNA is not imperiled (Garnett, 2000)."
- He has subsequently developed after thousands of attempts a water-soluble and fat-soluble liquid crystal polymer compound composed of palladium and lipoic acid (Poly MVA) that is able to enter the cell and reestablish the electrical connection between the cell membrane and DNA. Garnett's research shows that liquid crystal polymers like prothrombin, hyaluronic acid and palladium-lipoic acid complex (Poly MVA) normally produces **fern structures**. *In my opinion these types of structure are molecular antennas and electrical conductors.*
- This **new nontoxic drug** acts as an electrical shunt that causes cells that utilize anaerobic glycolysis to undergo membrane rupture and die while leaving aerobic cells that utilize efficient oxygen-dependent electron transfer undamaged (Garnett, 1998; Garnett and Remo, 2001). Aerobic cells are protected from this electrocution because their functional mitochondria **normally engage in electron transport** ending with oxygen as the final electron acceptor (Garnett and Remo, 2001).

Electrical properties of the ECM

- The proteoglycans that compose the ground substance of the ECM are negatively charged. The number and type of sialic acid residues that cap the glycoproteins of the cell coat also determine the degree of negative charge of the cell surface. The negative charges of the ECM-glycocalyx interface helps determine water balance, ion balance and osmotic balance both in the ground substance of the ECM and inside of the cells.
- The ECM proteoglycans exist in **fern shapes** that allow electric charges to flow and **disorganized shapes** that impair transit through the ECM of electrical currents and nutrients. These disorganized shapes occur when tissue inflammation is present and toxins are present in the ECM. These factors create areas of high electrical resistance. Tissues of the body that are injured have a higher electrical resistance than the surrounding tissue. The cell membranes of these tissues become less permeable to the flow of ions and more electrically insulated. This results in the endogenous bioelectric currents avoiding these areas of high resistance (Wing, 1989). The reduction in electrical flow through an injured area is one factor that interferes with healing.
- Increasing the electrical resistance of a tissue will impede the flow of healing biocurrents (Becker, 1985). Decreasing the electrical flow through an injured area also results in a decrease of the membrane capacitance of the cells in that area.
- Conversely improving the electrical conductance of the ECM will improve healing and improve cell membrane charge. Correction of tissue inflammation

and ECM toxicity can improve the electrical functions of the ECM. Therefore the composition and degree of toxicity of the ECM-glycocalyx interface will affect the electrical field and the flow of biocurrents in the ECM. The electrical field and biocurrent conduction in the ECM in turn will affect: cell membrane capacitance, permeability of the cell membrane, signaling mechanisms of the cell membrane, intracellular mineral concentrations, nutrient flow into the cell and waste disposal (Wing, 1989; Oschman, 2000).

- **The ECM can be cleared of toxins** by a variety of measures. Detoxification strategies could include the use of antioxidants and the support of antioxidant pathways, oral enzymes, homeopathic and herbal preparations, chelation (IV and oral), infrasonic devices, multiwave oscillators, microcurrent devices and phototherapy devices (lasers and LEDS). Some clinicians use live blood microscopy to see if their therapies are increasing the entry of wastes into the bloodstream. If a live blood slide shows a marked increase in wastes after a treatment compared to a slide obtained before treatment then the clinician can tell that his or her treatment is cleaning the walls of blood vessels and removing toxins from the extracellular space.
- The body's biocurrents and the electrical field of the ECM controls cell differentiation and the metabolic activity of mature cells. Mesenchymal cells will differentiate under the influence of electrical fields: fibroblasts to fibrocytes, myoblasts to myocytes, chondroblasts to chondrocytes and osteoblasts to osteocytes (Becker, 1985).
- The bioelectric control system's contribution to cell differentiation and cell growth can be assisted by: use of certain types of waters that enhance the liquid crystal properties of ECM polymers, promoting cell production of ECM proteins and proteoglycans; providing exogenous growth factor control and mediators of inflammation, promoting internal production of growth factors and inflammatory mediator by ECM cells and other factors.

Pathology of the ECM

- The ECM can be a storage site for nutrients or it can be a dumping ground for toxins, which can disrupt the metabolic and electrical functions of the ECM.
- Deposition of pathological deposits of proteins and toxins can lead to degenerative processes (e.g. amyloid can lead to Alzheimer's, immune complex deposition can lead to autoimmune inflammation).
- Inflammatory processes can lead to the deposition of crystals, calcium, cholesterol, and edema.
- The ECM is a buffering system for acids excreted by the cells. Impairment in the ability to excrete these acids or over production of acids by metabolic dysregulation will first lead to acidification of the ECM. Chronic acidification of the ECM will eventually lead to increased acidification of the intracellular compartment, which can create impairment of cellular metabolic processes especially aerobic energy production. Eventually disruption of cellular organelle functions and structures will occur.

- Excessive acidification of the ECM will eventually lead to saturation of the buffering capacity of ECM proteins. This will result in mobilization of calcium, magnesium and heavy metals from the skeleton.
- When calcium, magnesium, and other minerals are chronically mobilized from the bone for use as mineral buffers. These minerals will be lost through the kidneys and will create total body depletion of these minerals. Excessive and prolonged acidic conditions will result in increased mineral mobilization from the skeleton. Such a condition will first create osteopenia and in the long run will eventually progress to osteoporosis and compression fractures.
- Increased mobilization of heavy metals will lead to metabolic stress on the kidneys as these organs attempt to excrete these metals by use of glutathione detoxification. If the glutathione system becomes depleted due to excessive toxic burden these heavy metals will accumulate in the kidneys. Heavy metal accumulation in the kidneys may account for $1/6^{th}$ of the cases of hypertension in middle-aged people. This mechanism is one reason that the incidence of hypertension rises in post-menopausal women. *In my experience supporting kidney glutathione detoxification can reduce hypertension in some individuals.*

This section contains information about:

1. **The different intracellular mineral concentrations in tumors**
2. **pH alterations in tumors**
3. **How to alter intracellular pH in cancers**
4. **Tumor hypoxic regions**
5. **Tumor cell coats the role of hCG and sialic acid**
6. **The low transmembrane potential of cancer cells**
7. **How to increase low transmembrane potential in cancer cells**
8. **How to increase intracellular mineral concentrations of potassium, magnesium and calcium when low mineral conditions exist in malignant tissues**
9. **The role of Nieper minerals transporters**
10. **And why the number 42 is the universal answer to all questions**

Mineral and water abnormalities in cancerous and injured tissues: sodium, potassium, magnesium and calcium: their effect on cell membrane potential.

- The cell membrane is a dividing structure that maintains biochemically distinct compartments between the inside (intracellular) and outside (extracellular) spaces (Marieb 1998).
- The lipid structure of a cell membrane makes it relatively impermeable to the passage of charged molecules. Therefore charged molecules must cross through ion channels. Ion channels are transmembrane protein molecules that contain aqueous pores connecting the inside of the cell to the extracellular space. These channels can open and shut in response to a variety of signals. The passage of charged molecules through ion channels in the cell membrane endows the membrane with an electrical conductive property allowing for inward and outward current flows (Aidley and Stanfield, 1996). This is one factor that establishes electric circuits in biological tissues.

- In order to maintain balance in intracellular fluid and electrolytes, water, sodium and potassium are in constant motion between the intracellular and extracellular compartments (Edwards 1998).
- Extracellular fluids and intracellular fluids contain different concentrations of minerals. These minerals carry positive charges and are called cations. In order to maintain electric neutrality negatively charged molecules called anions must match these cations in concentration. Sodium is the main cation of ECF whereas potassium is the major cation of ICF. Chloride and bicarbonate are the main anions of ECF, while proteins and organic phosphates are the main anions of ICF.
- Uncharged molecules such as glucose or urea are also present in both compartments (Edwards, 1998).
- The passage of electrically charged ions through a membrane will create a flow of electric currents through the membrane. These ions in turn will affect the metabolism of the cell and the potential of the cell membrane.
- So it would be expected that all living cells of the body would naturally have a weak, electric current flowing through them. In fact there are bioelectrical circuits continually circulating throughout the body (Stanish, 1985).
- Overall mineral, water and membrane changes in cancerous tissues play important roles in changing the cellular geometry, metabolic biochemistry and electrical properties of cancer cells.
- Keith Brewer has reported that intracellular calcium and magnesium concentrations are lower in cancer cells due to impaired membrane transport (Brewer, 1985). According to Brewer **the transport of substances across the cell membrane is controlled by**: the electrical properties of the chemical bonds on and in the membrane, the electrical gradient across the membrane, and the electrical attractions between positively charged cations and polar molecules with positive and negative regions (Brewer and Passwater, 1976).
- F.W. Cope in his writings has described a characteristic pattern of electrolyte and fluid abnormalities that occur in any tissue that is damaged. He calls this pattern the 'tissue damage syndrome'. When cells are injured from any cause cells will lose potassium, and accumulate sodium and water (Cope, 1978).
- According to Cope, the proteins of a healthy cell exist in normal electronic configurational state where a significant proportion of cell water is structured or bound in concentric rings around the protein molecules. In addition *when the proteins are in their healthy configuration* the negatively charged sites on the protein matrix will have **a greater preference for association with potassium** rather than with sodium (Cope, 1978). If Cope is correct this may be one of the factors that accounts for the finding that healthy cells have high cell potassium and low cell sodium concentrations.
- A number of proteins are present within the cell and in the ECM. Other proteins lie on the inner and outer surface of cell membranes and some are embedded within the cell membrane. These proteins consist of linear chains of amino acid residues with attached carbohydrate and or lipid molecules. The electro attractive and repulsive forces between these components and the external or internal salt-water environment cause these proteins to fold into three-dimensional shapes called **conformational states**. Protein function is dependent on these

conformational states. The cell membrane and its associated membrane proteins are dynamically active with the associated proteins undergoing continuous changes in state. In proteins that are enzymes the conformational state determines whether or not the enzyme will expose its ligand binding sites.

- But if the membrane protein is an ion channel the conformational structure will determine whether the channel is open or closed. When the channel is open it is able to pass ions such as potassium, sodium, chloride, and calcium, across the cell membrane (Hille, 1992). The cell membrane is impermeable to ions unless its protein based ion channels are open. Normally the cell membrane establishes different concentrations of charged ions on either side of the membrane. This cell membrane property creates an electrical potential across the membrane.
- The ability of the cell proteins to stay in their normal configurational state is dependent on the cell being free from chemical, physical or hypoxic damage. When physical, chemical or hypoxic damage occurs to a cell many cell proteins will change to an abnormal damaged configurational state. In that state "the cell proteins lose their preference for association with potassium rather than sodium, and lose much of their ability to structure water" (Cope, 1978). When these protein changes occur potassium leaves the cell and is replaced by sodium. In addition the water content and the percentage of unbound water within the cell increases (the cell swells) (Ling and Ochsenfeld, 1976).
- Proteins can also be induced to resume their normal configuration **by measures that increase the intracellular concentration of potassium, magnesium, and ATP**. This will result in cell water becoming more structured and will cause the cell to release unstructured cell water and sodium (Cope, 1978). *Note: magnesium is involved in maintaining the intracellular concentration of potassium.*
- The structuring of water around intracellular proteins will also affect the configurational state, liquid crystal, and electrical properties of these proteins. Structured or bound water has less freedom of movement than unbound water. Nuclear magnetic resonance (NMR) can be used to measure the amount of water that is structured in normal and cancerous cells. Hazelwood and his colleagues showed in a 1974 NMR study that malignant tissues have significantly increased amounts of unbound water compared to normal tissues (Hazelwood, 1984).
- The changes in **the degree that water is structured in a cell or in the ECM** will affect the configurations and liquid crystal properties of proteins, cell membranes, organelle membranes and DNA. *Healthy tissues have more structured water than unhealthy tissues. Clinicians who recognize this fact have found that certain types of music, toning, chanting, tuning forks, singing bowls, magnetic waters, certain types of frequency generators, phototherapy treatments and homeopathic preparations can improve water structuring in the tissues and health when they are correctly utilized.*
- In cancer a number of features such as changes in the mineral concentrations inside of the cell, the degree that water is structured inside of the cell and an excess of negative electrical charges on the exterior surface of the cell cause the cell membrane potential of cancerous cells to be less than normal (Cone, 1970).

- Cancerous tissues and less differentiated regenerating tissues are more electronegative than normal cells and normal tissues (Ambrose et al., 1969; Schaubel et al., 1970; Becker, 1985).
- Cone reported in 1975 that the electrical potential of cancer cell membranes was significantly less than the membrane electrical potential of healthy cells. Basically the lower membrane potential of cancer cells is associated with higher intracellular sodium concentrations and lower intracellular potassium concentrations (Cone, 1975).
- Cone found that healthy cells have higher intracellular potassium, lower intracellular sodium and higher electrical cell membrane potential, while cancer cells have higher sodium, lower potassium, and lower membrane electrical potential. As a result of increased intracellular sodium cancer cells will retain more water causing them to be more spherical and have different geometry than normal cells. When cells become swollen with too much water: normal cell signaling mechanisms are disrupted; aerobic cellular metabolism of sugars is inhibited; and ATP production falls.
- **Intracellular sodium has a mitotic regulating effect.** Clarence D. Cone, Jr. has postulated that an unfavorable intracellular sodium-potassium ratio with excessive intracellular sodium and low intracellular potassium could affect the transmembrane potential of malignant cells (Cone, 1975) and predispose to malignant mitogenesis (Regelson, 1980).

Tumor cell differentiation, tumor hypoxia and low cellular pH can affect: gene expression, genetic stability, genetic repair, protein structures, protein activity, intracellular mineral concentrations, and types of metabolic pathways used for energy production

- Cancers often exhibit increasingly malignant behavior during their growth. WHY?
- One reason is that cancerous tumors are composed of cell populations that range from highly aggressive undifferentiated cells to well differentiated cells. Some cancers are almost completely composed of undifferentiated cells that are biochemically similar to embryonic cells because of increased expression of embryonic genes. Highly undifferentiated tumors typically produce gene products such as proteins like alpha-fetoprotein (AFP) and carcinoembryonic antigen (CEA), enzymes and hormones such as human chorionic gonadotropin (hCG) that are characteristic of embryonic tissues. On the other hand tumors with well-differentiated cells will produce gene products more closely resembling normal adult tissues. In general tumors with highly undifferentiated cells are more invasive than tumors composed of well-differentiated cells or tumors with mixed cell populations.
- Increased malignant behavior during tumor growth is also affected by the microenvironment of tumors, which is characterized by fluctuating areas of both acute and chronic hypoxia, low pH, and nutrient deprivation (Moulder et al., 1987; Rockwell, 1992).

- The severity of hypoxia and acidosis in tumors can affect tumor cell invasiveness, metastasis, the risk of recurrence and resistance to chemotherapy and radiation therapy (Teicher, 1994; Rofstad, 2000).
- Tumors exist in a dynamic Darwinian state of survival of the fittest. Tumors continually secrete growth factors that initiate the formation of new blood vessels, yet many tumors grow so rapidly that they out grow their blood supply so that large tumors will have areas that are poorly oxygenated (hypoxic) and other areas that are well oxygenated (Vaupel et al., 1991). Hypoxic and well-oxygenated areas will actually fluctuate coming and going as blood vessels form and then regress (Holash et al., 1999).
- Tumors with areas of mixed oxygenation will often contain heterogeneous groups of cells that exhibit biochemical diversity. The same tumor will have some cells that are utilizing different metabolic reactions to create energy than other groups of cells in the same tumor. This is one reason why different cell populations in the same tumor will respond differently to treatment measures. Some cells will be killed by some treatments while other cells will survive and in a sense be selected for further growth (Gray et al., 1953; Graeber et al., 1996).
- Fluctuating oxygen levels will result in fluctuations in the types of genes that are activated, types of proteins that are produced and the types of metabolic reactions that occur (Dang et al., 1997). Fluctuations in the types of metabolic reactions used to create energy will result in variations in lactic acid production, acid excretion and acid accumulation both within the cells and in within the ECM.
- In vitro studies have shown that tumor cell surface adhesion molecules are down regulated upon exposure to hypoxia conditions (Hasan et al., 1998). This means that hypoxia can result in decreased cell adhesion of tumor cells to the ECM. Loss of contact with the ECM permits tumor cells to spread to more distant locations and reduces the ability of the ECM to exert growth inhibition.
- Some researchers have focused on the finding that the hypoxic and acidic microenvironment of tumors will create further genetic instability and mutations (Reynolds et al., 1996). Hypoxia and acidic tumor microenvironments will cause certain genes to become activated and expressed and other genes to be inactivated so that the metabolic reactions of tumor cells will be altered. These conditions can also create DNA damage and impair DNA repair mechanisms (Yuan et al., 1998, 2000).
- Low intracellular pH can alter the conformational structure and function of cellular proteins, including DNA polymerases (Eckert and Kunkel, 1993).
- One common characteristic of many tumors is the reduced activity of a special protein called p53 that is involved in triggering cell death. Hypoxic conditions will favor selection of tumor cells with reduced apoptotic potential (Graeber et al., 1999).
- Tumor cells that are hypoxic lack enough oxygen to activate their aerobic metabolic pathways. These cells will typically begin to rely on anaerobic metabolism to supply their energy needs (Rossi-Fanelli et al., 1991). Tumor cells in hypoxic conditions will convert most of their pyruvate to lactate instead of to acetyl Coenzyme A (Warburg, 1956). This type of energy production is very

inefficient so tumors require much larger amounts of sugar in order to maintain their energy production. Tumor cells in a sense become sugar junkies.

Tumor cells express several adaptations in order to sustain their sugar addiction and metabolic strategies to address this issue.

- Tumor cells will express larger amounts of glucose receptors/transporters on their cell surface in order to increase their sugar uptake (Van Winkle, 1999). In fact hypoxia stimulates the transcription of numerous genes including genes that code for enzymes of the glycolytic pathway and cell membrane glucose transport proteins GLUT-1 and GLUT-3 (Semenza, 2002). The administration of cesium salts has been reported to limit tumor cell uptake of glucose, which starves the cancer cell and reduces its ability to make energy by fermentation.
- Tumor cells will increase the activity of an intracellular enzyme called glucokinase. An extract of avocado called mannoheptulose has been found to inhibit glucose entry into tumor cells and reduce the activity of glucokinase an enzyme that sequesters sugar inside of the cell (Board et al., 1995).
- Some tumor cells express glycoproteins that promote protein breakdown (Stipanuk, 2000). The secretion of cytokines, especially tumor necrosis factor, increases in cancer. Some of these cytokines increase the breakdown of tissue proteins (Bender, 2002). The amino acids released by protein breakdown can be used in gluconeogenesis. Tumor necrosis factor not only promotes protein breakdown, but it also increases gluconeogenesis (Bender, 2002).
- Many tumor cells will produce lactate when they metabolize glucose anaerobically. The lactate is exported from the tumor cells and is utilized by the liver in gluconeogenesis (Bender, 2002).
- **Overall gluconeogenesis is stimulated when cancer is present**. Gluconeogenesis requires a great deal of energy and excessive gluconeogenesis is thought to be a significant factor that contributes to cancer cachexia (Gold, 1968).
- Dr. Joseph Gold recognized in the 1960's that metabolic strategies that inhibited the enzyme phosphoenol pyruvate carboxykinase (PEP-CK) would reduce gluconeogenesis and decrease the severity of cachexia (Gold, 1968). Dr. Gold after testing a series of compounds found that hydrazine sulfate could effectively reduce excessive gluconeogenesis in cancer (Gold, 1974, 1981).

Tumor acidification versus tumor alkalization

- **One of the characteristic features of cancers is that cancerous cells rapidly divide and proliferate.** In general growing cancers have many cells that are undergoing mitosis. According to Keith Brewer, normal and malignant cells undergo mitosis between a pH range of 6.5 – 7.5 and the mitosis rate slows as the intracellular pH approaches the extremes of this range. If a cell can be forced into a pH outside of this range cell division ceases (Brewer, 1985).
- Recognition of this fact serves as the basis for therapies that increase or decrease the pH of tumor cells.
- When it was first discovered that tumors utilize anaerobic metabolism of glucose it was thought that providing more oxygen would convert tumors back to aerobic

metabolism (Warburg, 1930), unfortunately tumors still exhibit high levels of glycolysis even under aerobic conditions (Weinhouse, 1976).

- Because glycolytic metabolism predominates in tumors some lactic acid accumulation and intracellular acidification may occur **in tumors under hypoxic conditions** although most of the lactic acid and hydrogen ions are exported into the ECM leading to acidification of the ECM (Ojugo et al., 1999). The extracellular pH around tumor tissues is usually more acidic than the extracellular pH of normal tissues. Extracellular pH levels as low as 7.09 have been measured in some human tumors (Van der Zee et al., 1989). It is thought that both lactate and hydrogen protons are exported from tumor cells into the extracellular space as a way of limiting intracellular acidity (Ojugo et al., 1999).
- Tumor cells are so efficient in sequestering and exporting acids that they are often able to maintain their cytoplasmic pH nearly equal to that of normal cells, which is about 7.0- 7.3 (Newell et al., 1993; Stubbs at al., 1994).
- Intracellular cytoplasmic pH is maintained in tumor cells by sequestration of acids in cytoplasmic vesicles and cell membrane mechanisms that include: a sodium hydrogen ion exchanger, lactate transport out of tumor cells, and chloride and bicarbonate exchange (Webb et al., 1999). Sodium movement into the cells enables the membrane exchange system to pump hydrogen ions out of the cell (Mahnensmith and Aronson, 1985). The net result of activating the sodium-hydrogen ion exchanger is that *sodium accumulates inside of tumor cells.*
- Intracellular concentrations of sodium are typically higher in malignant cells than in normal cells (Cone, 1975; Cope, 1978; Seeger and Wolz, 1990; Cure, 1991, 1995).
- Although tumor cells are relatively efficient in exporting acid (hydrogen protons) into the ECM and sequestering acids in cytoplasmic vesicles. I believe the buildup of intracellular acids in cytoplasmic vesicles may still possibly interfere with mitochondrial production of ATP by disrupting the hydrogen ion gradient across the mitochondrial membrane. This would create a positive feedback loop where anaerobic glycolysis creates an intracellular acidic condition that further interferes with oxygen-mediated electron transport in the mitochondria. Therefore in order to maintain energy anaerobic glycolysis would be continued.
- **Tumor acidification:** When agents are used to block the movement of lactate and hydrogen protons from tumor cells the effects of therapies that increase cellular acidification are enhanced. Blockage of the export of lactic acid will result in a significant reduction in intracellular pH.
- **Augmentation of tumor acidification by increasing lactic acid production and blocking tumor cell lactate excretion:** The bioflavinoid quercitin has been found to inhibit the synthesis of heat shock proteins in tumors and to block the export of lactate from tumors creating lethal levels of intracellular acidity (Kim et al, 1984). The use of quercitin as a cancer treatment has been the subject of several patents. Unfortunately, this treatment is generally effective only in the hypoxic portion of tumors and is generally ineffective in tumors and areas of tumors that are not hypoxic. Use of quercitin is most effective when hyperthermic treatments are used concurrently.

- The creation of a hyperglycemic condition can contribute to further intracellular acidification. A number of researchers have reported on the use of oral and IV glucose as a way to increase tumor acidity (Volk et al., 1993; Leeper et al., 1998).
- Research studies have shown that extracellular acidification of tumors will enhance the effect of hyperthermia (Gerweck, 1977; Wike-Hooley, 1984; van de Merwe et al, 1993) and inhibit the development of thermotolerance in cultured tumor cells (Goldin and Leeper, 1981).
- Manfred von Ardenne of Germany was one of the pioneers who back in the 1960's began developing a treatment of cancer utilizing IV glucose to create increased levels of tumor acidity. He would then use hyperthermia to kill cancer cells that were already compromised by excessive acidity (von Ardenne, 1994).
- Cancer researchers are studying the use of both intracellular and extracellular acidification of tumors to enhance the cytotoxic effects chemotherapeutic agents (Atema et al., 1993; Skarsgard et al., 1995; Kuin et al., 1999).
- **Tumor alkalization**: Cesium is a naturally occurring alkaline element that was promoted for use in cancer by a scientist named Keith Brewer, since cesium is preferentially taken up by tumor cells (Brewer, 1985). Use of Cesium is thought to reduce the cellular uptake of glucose by cancer cells leading to starvation of the cell. Cesium also was reported by Brewer to raise the cell pH of cancer cells up to a range of 8.0. Brewer thought that raising the pH of cancer cells this high would kill cancer cells. Use of cesium in cancer has met with mixed results (Sartori, 1984). ***I caution anyone who might be tempted to use this treatment to read extensively about cesium before administering this compound.***

The pH of the intracellular and extracellular compartments will also affect the intracellular potassium concentration.

- **Acidic and alkaline conditions:** Cellular uptake of potassium is postulated to be regulated by a membrane associated energy and magnesium dependent sodium/potassium pump. Although Dr. Gilbert Ling has a completely different opinion of the mechanisms that cells use to regulate intracellular potassium concentrations (Ling, 2001). He basically believes that the membrane pump theory is wrong. He has extensively published information on his association-induction (AI) hypothesis, which includes the idea that ATP bonding to intracellular proteins mediates selective and preferential absorption of potassium over sodium (Ling, 2001). I personally find Dr. Ling's work to be highly technical, but very informative.
- Movement of potassium out of the cell interior is regulated by **acidity of the cell interior**, the **permeability of the cell membrane** and **chemical and electrical gradients** to the potassium ions.
- Accumulation of positively charged hydrogen cations inside of the cells through either respiratory or metabolic acidosis will promotes a shift of potassium out of the cells, leading to higher than normal levels of potassium in the bloodstream (hyperkalaemia), lower than normal potassium intracellularly and increased potassium loss through the kidneys.

- When intracellular acidity develops from alterations in intracellular metabolism, such as occurs in anaerobic metabolism, excessive amounts of hydrogen ions are created inside of the cell.
- Cancer cells attempt to reduce cytoplasmic hydrogen cation concentrations by exporting the hydrogen cations into the EC space and by compartmentalizing the hydrogen cations in cytoplasmic storage vesicles (Webb et al., 1999).
- The accumulation of excess in positive charge will cause cancer cells to export both hydrogen ions and potassium in order to maintain electrical neutrality. This appears to me to be one more way that cancer cells lose potassium.
- When cancer cells export hydrogen ions the ECF space becomes more acidic (lower pH). The amount of acids produced by cancer cells may even be severe enough to overwhelm the body's homeostatic pH regulatory mechanisms.
- Cancer cells as a group are very efficient in exporting and compartmentalizing hydrogen cations. Some cancer cells are so efficient that they actually become more alkaline than normal cells, but other cancer cells that are not able to completely reduce the concentration of positively charged hydrogen ions in their cytoplasm will have a pH that is typically lower than nonmalignant cells. The studies I found on cancer cell pH showed that there was diversity in intracellular pH levels. In general cancer cells in hypoxic areas will have to deal with larger amounts of acid.
- The cell cytoplasm of malignant cells may or may not be acidic depending on how efficient tumor cells are in sequestering and exporting acids. But the ECM around tumor cells is acidic. By definition acidic tissues are electron deficient. So a tumor may have areas that have a relative state of electron deficiency. *This condition of electron deficiency may help explain why measures that increase electron availably like magnetized waters, lemon juice, negative ion generators, standing by water falls, standing by the ocean surf, use of electron rich antioxidants, consumption of electron dense foods (fresh vegetables and vegetable juices and essential fatty acids like fresh flax oil) help some people with chronic degenerative conditions and cancers get better. Note: many chronic degenerative conditions are associated with tissue acidity.*
- Awareness of such findings gives credence to nutritional approaches to cancer such as the dietary program advocated by Max B. Gerson. Dr. Gerson during his medical career advocated low sodium intake and high potassium supplementation through use of raw vegetable juices and potassium supplementation (Cope, 1978; Ling, 1983).

Tumor cell coats contain human chorionic gonadotropin and sialic acid as well as negatively charged residues of RNA, which give tumor cells a strong negative charge on their cell surface

- All cells have cell surface glycoproteins. As cells specialize they develop unique sets of cell surface glycoproteins that allow cells of the same type to recognize, communicate and adhere to each other (Reichart, 1999).
- These cell surface glycoproteins contain varying concentrations of sialic acid, which is one of the primary molecules responsible for conferring a negative

charge to the cell surface of all cells (Cure, 1995; Acevedo et al., 1998). The chemical characteristics of hCG make it a sialoglycoprotein (Acevedo, 2002)

- Human chorionic gonadotropin (hCG) is a hormone usually associated with pregnancy, however hCG or subunits of **hCG can be found on the surface of all cancer cells** (Acevedo et al., 1998; Acevedo, 2002). Dr. Acevedo has proposed that the presence of hCG on the surface of cancer cells **is a universal marker for cancer** (Acevedo et al., 1995; Acevedo, 2002).
- According to Dr. Acevedo malignant transformation will cause the genes that code for hCG to become activated causing cancer cells to begin producing this hormone (Acevedo, 2002). When cancer cells secrete this hormone it collects on the cell surface. Since hCG contains large amounts of sialic acid this results in cancer cells having a **stronger cell surface negative charge** than normal cells (Acevedo et al., 1998).
- Cure in his papers presents data that cancer cells are also coated by negatively charged residues of RNA, which is another contributing factor to the strong cell surface negative charge of cancer cells (Cure, 1991, 1995). Cure also presents data that suggests that bacteria can secrete compounds that can increase the negative charge of cells to which they are attached or bacteria and viruses can cause cells that they infect to secrete compounds that increase the negative charge of the cells.
- Because immune defense cells such as NK cells and macrophages also have a negative charge these cells are repulsed by the strong negative electrical field of cancer cells when they try to approach these cells (Van Rinsum et al., 1986; Cure, 1995; Acevedo et al., 1998). According to Dr. Acevedo, "Since all the normal cells from our immune system, macrophages, NK cells and B cells, express in their membranes a "normal" negative charge, the high negative charge of hCG and its subunits demonstrated to be present in the cell membranes of embryonic and fetal cells, in sperm cells in every stage of development, and in all cancer cells irrespective of type or origin as membrane-associated hCG, make all these cells **immunologically inert**. The cells from the immune system *are restricted from approaching, and adhering to cancer cells*, since negative charges repel. That is the reason why the embryo and fetus, which under normal conditions are 50% foreign to the mother, are able to survive the immune system of the mother, and why sperm cells and cancer cells also survive (Acevedo, 2002)."

Biologically Closed Electric Circuits

- **The application of electrical currents into cancerous tissue has been found to have a beneficial effect in some cases of cancer.** Dr. Björn Nordenström and Dr. Rudolf Pekar have pioneered research where specially made platinum needles (electrodes) are inserted directly into tumors (Nordenström, 1983; Pekar, 1997). This form of therapy is known as electrochemical therapy because it destroys portions of cancerous tumors by both electrical and chemical means. The needles are connected to an electrical device that produces a direct current. The needles with a **positive charge are anodes**, while the needles with a **negative charge are cathodes**.

- When low voltage (6 to 8 volts) and low micro-amperage (40-80mA) direct currents are administered the tumor area around the anode becomes highly acidic due to the attraction of negatively charged chloride ions and the formation of hydrochloric acid (pH 1-2). The tumor areas around the cathode become highly basic (pH 12-14) due to the attraction of positively charged sodium ions and the formation of sodium hydroxide (Yu-Ling, 1997). Chlorine gas emerges from the skin at entry points of the anodes and hydrogen gas emerges from the entry points of the cathodes (Chou et al., 1997). This strong change in pH is one of the factors involved in killing and injuring tumor cells. *So in a sense direct current stimulation is a form of pH therapy. I suspect that devices that create electromagnetic fields and current flows in the body all have some effect on intracellular and extracellular pH.*
- The effectiveness of this type of treatment is dependent on electrode placement and dosage of electrical charge administered in coulombs (Chou et al., 1997).
- Dr. Yu-Ling reported at Fourth International Symposium on Biologically Closed Electric Circuits that by 1997 over seven thousand cases of malignant tumors had been treated in China by this treatment (Yu-Ling, 1997).
- **One of Nordenström's techniques is to place the positive electrode into the tumor and the negative electrode outside of the tumor (O'Clock, 1997).** This will result in an increased flow of electrons into the tumor, a change in the electrical field around a tumor and activation of membrane receptors and ion channels. If tumor cells are in fact electron deficient this increased flow of electrons, membrane receptor effects and movement of ions through ion channels will have definite effects on cellular metabolic processes. O'Clock's work has also confirmed Ross Adey's findings that windows of frequency and amplitude exist for tumor cell suppression and proliferation (O'Clock, 1997).
- The application of direct current to tumor cells has been found to change the membrane potential of tumor cells, nutrient uptake by tumor cells, reduce DNA production by tumor cells and increase immune activity particularly **the attraction of white blood cells to the tumor site** (Chou et al., 1997; Douwes and Szasz, 1997; O'Clock, 1997).
- The application of direct current causes electrolysis, electrophoresis, electroosmosis and electroporation to occur in biological tissues creating microenvironmental chemical changes and microelectrical field changes (Li et al., 1997).
- Changing the membrane potential and membrane permeability of tumor cell membranes with direct current changes both the extracellular and intracellular environment of the tumor cells (Douwes and Szasz, 1997).
- The chemistry of the microenvironment of healthy cells, injured cells and cancerous cells and the microelectrical field of these cells are interrelated. *Changes in one results in changes in the other*. This is easier to remember if you understand that all the chemistry of biological organisms involves an exchange of energy.
- In my opinion this type of electrical treatment tumors will destroy some cells by electrolysis and cause other cancer cells to lose their stealth cloaking coating of negatively charged glycoprotein complexes that have hidden the tumor from the

immune system. Loss of this cloaking device allows activation of immune defenses to attack the tumor, including production of cytokines and interferon and tumor destruction by cytotoxic T-cells and macrophages.

Bacteria and viruses in cancer

- Another interesting idea is the concept that bacteria and viruses can change the cell coats of cells and these infections are associated with certain types of cancer. Back in the 1950's Virginia Livingston-Wheeler promoted the idea that cancers are associated with a particular type of pleomorphic bacteria, she named **"Progenitor cryptocides"** (Greek for the hidden killer), after she consistently grew this microbe from cancerous tissues. For detailed information on her work see (Livingston-Wheeler and Wheeler, 1977; Livingston-Wheeler and Addeo, 1984; Cantwell, 1990).
- Certain types of bacteria are known to colonize areas of the body particularly areas that have compromised blood supply and regional hypoxia. These bacteria naturally produce biofilms as a way of protecting themselves from the immune system. For example, pseudomonas bacteria can produce a secretion of carbohydrates that they encapsulate themselves within (Straus et al., 1989). These negatively charged cell coats **electrically repulse attacking immune cells**. By attaching themselves to human tissue it is very likely that these bacteria are using electrical defenses and practicing a natural form of gene therapy.
- In fact some researchers are experimenting with the use of anaerobic bacteria as a form of cancer gene therapy. When anaerobic bacteria are injected into the body they will accumulate in hypoxic tumor areas. If suitably modified these bacteria could be engineered to produce antimalignant proteins as they reproduce (Lemmon et al., 1997).
- It takes no great stretch of the imagination to conceptualize the ideas that infectious agents could: 1) alter the genetic machinery of the cells to which they are attached promoting the production of certain proteins and hormones; 2) create biofilms around cells altering their surface charge and impacting cell mineral concentrations, cell membrane functions etc; 3) or secrete their own form of chorionic gonadotropin which would change the electrical characteristics of the cells to which they are attached.
- Human chorionic gonadotropin is also a growth factor for certain types of cancer. After reviewing the papers of Acevedo and Cure I have formed the opinion that that the presence of hCG on tumor cell surfaces will increase the negative electrical charge of cancer cells
- It is well recognized that cancer cells can produce this hormone, but certain types of tumor-associated bacteria also produce this hormone (Backus and Affronti, 1981). When Virginia Livingston Wheeler reported this same finding back in the early 1970's (Livingston-Wheeler and Livingston, 1974) her findings were dismissed and **she was labeled a quack**. Acevedo and others have repeatedly shown that some tumor-associated bacteria will produce hCG or components of this hormone.
- For example, Acevedo and his colleagues in 1987 did immunocytochemical studies using antisera to hCG, and to its alpha- and beta-subunits. They

demonstrated the expression of hCG-like material in nine bacterial strains. “Seven of these were isolated from patients with cancer and were definitely identified as Streptococcus faecalis (three strains), Staphylococcus haemolyticus (two strains) and Staphylococcus epidermidis and Escherichia coli (single strains). The other two strains were cell-wall-deficient (CWD) variants, one identified as Streptococcus bovis, isolated from the blood of a patient with a fever of unknown origin and a possible brain abscess (Acevedo et al., 1987).”

- Coatings of proteins, glycoproteins and glycolipids encapsulate many viruses. These viral coats may contain either sialic acid or the enzyme sialidase. If sialic acid predominates the virus will have a negative charge, but if sialidase predominates the virus will have a positive charge (Cure, 1995). Either way many viruses are endowed with electrical charges. If sialidase predominates the positively charged virus will be electrically attracted to the negatively charged cell surface.
- An interesting clinical note is that arginine supplementation can activate latent herpes viral infections. Arginine contains a strongly basic guanidine group. It is possible that arginine can enhance the infectivity of certain types of viruses by changing the electrical charge of the virus or cell membranes.
- Inhibition of the sialidase enzyme will stop the entrance of viruses into cells. This leads to my point that viral inhibition may occur through chemical measures or electronic neutralization. Chicken soup is a well-known remedy for viral infections of the respiratory tract. When chicken soup is prepared without salt it contains large amounts of free electrons, which can electrically neutralize viruses with positively charged coats preventing viral entry into the cells.
- Theoretically electronic microcurrent, infrared, and phototherapy devices, homeopathic preparations and herbal preparations that supply the body with a plethora of free electrons should also exhibit antiviral activity.
- Treatments that have been reported to disrupt tumor cell coats include pancreatic enzymes (Acevedo et al., 1998), plant enzymes such as bromelain (Nieper, 1996), beta-carotene (Nieper, 1985); heparin (Nieper at al., 1999), and vaccines against HCH (Acevedo et al., 1998; Triozzi and Stevens, 1999).

Treatment Section: **Interfaces/nodal points where changes in cellular electrical activity and physiology can be made.**

Cellular and ECM electric field effects may be enhanced:

- By application of external conducted or inductive electric fields
- By correcting mineral deficiencies and improper cell location of minerals
- By correcting cell membrane abnormalities secondary to dietary deficiencies of essential fatty acids and imbalances in fatty acid metabolism.

Treatment devices

Microcurrents in biologically closed electric circuits may be created by:

1. Tissue-penetrating magnetic fields from PEMF devices that create magnetic field induction of electric currents in conductive biological structures.
2. Direct current and alternating current microcurrent devices applied to the skin by electrodes or into tissues through needles.
3. Acupuncture needling.
4. Production of a wide band width of electromagnetic energy by multi-wave oscillators
5. Needle implants into tumors with application of DC current.
6. Phototherapy treatments with lasers and LEDS.

- **The use of electrical and phototherapy devices** such as lasers and LEDS will change the electric field of the ECM and create current flow both in the ECM and through the cell membrane depending on the frequency applied. These changing electrical fields will modify the electrical potential of cell membranes, intracellular mineral concentrations and cellular energy production by affecting the activity of ionic membrane pumps (Liu et al., 1990; Blank, 1992).
- **Modification of the electrical potential of cell membranes can be used to increase the abnormally low transmembrane potential of cancer cells and injured tissues.** Effects that are seen when membrane potential is increased include: enhanced cellular energy (ATP) production, increased oxygen uptake, changes in entry of calcium, movement of sodium out of the cell, movement of potassium into the cell, changes in enzyme and biochemical activity, and changes in cellular pH.
- It appears that modulation of the electric field of the ECM and changing current flows in biologically closed electric circuits can increase low transmembrane potential, increase the entry of potassium and calcium, increase sodium and water movement out of the cells, reduce intracellular acidity, improve oxygen entry into hypoxic cells, increase mitochondrial production of ATP through aerobic metabolism.
- At this time researchers both promote and warn against the use of electric and magnetic field devices in cancer. The history of the electromagnetic treatment of cancer is long and colorful. Because it would require an entire book to fully explore this history I will limit this discussion to a few points.
- Back in the early 1920's George Lakhovsky developed an instrument he called a Radio-cellular oscillator, which he used to experiment on geraniums that had been inoculated with cancer (Lakhovsky, 1939). From these experiments he decided that he could obtain better results if he constructed an apparatus capable of generating an electrostatic field, which would generate a range of frequencies from 3 meters to infrared (Lakhovsky, 1934). Lakhovsky believed that living organisms are capable of interrelating by receiving and giving off electromagnetic radiations. *Note: If Lakhovsky's theory is correct then the potential exists for direct energetic communication between living organisms.*
- Lakhovsky theorized that each cell of the body is characterized by its own unique oscillation. He also believed that one of the essential causes of cancer formation was that cancerous cells were in oscillatory disequilibrium. He believed the way

to bring cells that were in disequilibrium back to their normal oscillations was to provide an oscillatory shock (Lakhovsky, 1939).

- Royal Rife on the other hand believed that oscillatory shock could be used to kill infectious organisms and cancer cells. Either way changing the oscillation of cancer cells has been thought to be beneficial.
- Lakhovsky theorized that an instrument that provided a multitude of frequencies would allow every cell to find and vibrate in resonance with its own frequency. In 1931 he invented an instrument called the Multiple Wave Oscillator. Until his death in 1942 he treated and cured a number of cancer patients (Lakhovsky, 1939). Other individuals who have used his MWO have also reported similar results.
- Individuals such as Royal Rife in the 1930's and Antoine Priore in the 1960's also invented electronic equipment that was reported to benefit patients with cancer (Bearden, 1988). Whether you believe these experiments or not is up to you. But if Lakhovsky, Rife and Priore were right, then equipment that addresses and attempts to correct the electrical derangements of cancer cells can be beneficial in some cases.

Polychromatic states and health: a unifying theory?

- Prigonine's 1967 description of dissipative structures gave a model and an understanding of how open systems like biological organisms that have an uninterrupted flow of energy can self-organize. Biological systems are designed to take in and utilize energy from chemical sources (food), but they can also utilize energy and information from resonant interactions with electromagnetic fields and acoustical waves to maintain their dynamic organization. According to Ho, "Energy flow is of no consequence unless the energy is trapped and stored within the system where it circulates before being dissipated (Ho, 1996)."
- In my opinion this means that cellular structures that tranduce, store, conduct and couple energy are critical features of any living organism.
- Living systems are characterized by a complex spectrum of coordinated action and rapid intercommunication between all parts (Ho, 1996). The ideal complex activity spectrum of a healthy state is polychromatic where **all frequencies** of stored energy in the spectral range are equally represented and utilized (Ho, 1996). In an unhealthy state some frequencies may be present in excess and other frequencies may be missing. For example it has been reported that a healthy forest emits a polychromatic spectrum of acoustical frequencies and an unhealthy forest will have holes in its frequency spectrum. Yet when the forest regains its health it again emits a polychromatic spectrum of frequencies. The frequency holes got filed in!
- When an area of the body is not properly communicating it will fall back on its own mode of frequency production, which according to Mae-Wan Ho leads to an **impoverishment of its frequency spectrum**. In looking at the example of cardiac frequency analyzers it has been discovered that sick individuals have less heart rate variability than healthy individuals.

- The concept of polychromatism makes sense when you consider phenomena such as the healing effects of: sunlight, full spectrum lights, music, tuning forks, chanting, toning, drumming, crystal bowls, sound therapy, prayer, love, the sound of a loved one's voice, essential oils, flower essences, healing touch, multiwave oscillators, and homeopathics. Something or things (frequency or frequencies) that were missing are provided by these treatments.
- From the consideration of applied frequency technologies it can be theorized that one aspect of why these consonant technologies work is because they supply frequencies that are missing in the electromagnetic and acoustical spectral emissions of living organisms. When missing frequencies are supplied they in a sense fill gaps in the frequency spectrum of a living organism. Dissonant technologies would identify frequency excesses and pathogenic frequencies and would provide frequency neutralization by phase reversal.
- Electromagnetic technologies such as Rife and radionics may act by phase reversal and neutralization of pathogenic frequencies. Royal Rife also theorized that his equipment used resonant transmission of energy that caused pathogenic organisms to oscillate to the point of destruction.
- If we consider polychromatism to be the model of the healthy state then it makes sense that technologies such as electrodermal screening and voice analysis that detect frequency imbalances (excesses and deficiencies) can play beneficial roles in health care.
- I believe that in the future doctors will more widely utilize equipment such as electrodermal screening, acoustical spectrum analyzers, electromagnetic spectral emission analyzers and their software for diagnostic purposes. This type of equipment can be used to identify and treat frequency imbalances.
- This discussion ties in such concepts as acupuncture and neural therapy.
- **Acupuncture** may help address and remove impedances or blocks to energy mobilization by helping to reconnect disconnected energy pathway back into a coherent and harmonic flow.
- **Neural therapy** may act by neutralizing aberrant local signal generators in traumatized and scarred tissue. In a sense removing disharmonious music from a particular location. I imagine the application of neural therapy to be like a band conductor correcting a student who is playing out of key.

Ways to support the electrical properties of cells with mineral nutrition and cell membrane repair

- In order for cells to operate and control electromagnetic energy and chemical energy production, the cell membranes, which covers the cells and the membranes of cell organelles like the mitochondria and the nucleus must be healthy and the **right minerals** must be in the **right location** and in the **right concentrations**. Dr. Hans Nieper recognized this fact and he spent his life developing mineral transporters and looking for and using other orthomolecular substances that could support and repair the outer cell membrane and inner membranes of cell organelles.
- **Optimize membrane structure and function** through use of Nieper mineral transporters. The electrical charge of the cell membrane is maintained both by the

structure of the membrane and it's associated minerals, however these minerals must be in the proper location at the proper concentration for optimization of cellular potential and metabolic activity. Mineral transporters serve the function of special delivery vehicles placing minerals in optimal cellular and subcellular locations (Alexander, 1997a, 1997b; Nieper et al., 1999). Dr. Nieper found this approach improved these membranes natural ability to store electrical charge known as the membrane capacitance function.

- **Capacitors** are well known electronic components that are composed of two conducting sheets or metal plates separated by a thin layer of insulating material known as a dielectric. Cells contain several forms of biological capacitors, which consist of an insulating material (the membrane) covered on both sides by collections of charged dissolved minerals, which serve the same function as a conducting metal plate. Because the exterior cell membrane and the membranes of cell organelles like the mitochondria in animals and the chloroplasts in plants are biological capacitors they have the capacity to accumulate and store charge and hence energy to be given up when needed. Since energy is needed to run any type of machinery be it mechanical or biological it makes sense that nutrients that can enhance energy production and energy storage can have profound biological effects.
- **Improvement in cellular bioenergetics can also be enhanced nutritionally** by use of certain nutrients that help provide structural materials for cell membrane repair and facilitation of mitochondrial enzyme production of ATP. Some of the most effective compounds are the mineral transporters aminoethanolphosphates (2-AEP's), orotates, aspartates and arginates developed by Dr. Hans Nieper. 2-AEP mineral transporters enhance cell membrane capacitance in several ways. First by repairing damaged cell membranes and second by effectively delivering minerals to the outer surface of cell membranes. The orotate, aspartate and arginate mineral transporters are advanced mineral delivery systems that effectively deliver minerals into the interior of cells. Mineral delivery into the cell interior is important because many of the cell's cytoplasmic and mitochondrial enzymes require minerals in order to be activated.
- Biological utilization of a mineral encompasses far more than just mineral absorption. Biological utilization of minerals includes mineral absorption, mineral transport in the blood stream and mineral delivery into the cells. Most mineral supplements generally break apart during the processes of digestion releasing ionized minerals into the lumen of the digestive tract, which are then moved into the bloodstream. Just getting a mineral into the blood stream doesn't guarantee that the mineral can be directed to any particular tissue or be transported across the cell membrane to the cell interior (Nieper, 1961, 1966a).
- The joining of carrier molecules with minerals forms electrically neutral compounds that have different transport properties than unbound ionized minerals (Nieper et al., 1999). Calcium orotate, calcium arginate, calcium aspartate, calcium 2-AEP, magnesium orotate, magnesium arginate, potassium arginate, potassium orotate, potassium-magnesium aspartate, zinc orotate and zinc aspartate are all mineral transporters. When these mineral transporters are properly manufactured to be acid resistant, they deliver minerals still bound to the

transporter into the alkaline environment of the small intestine where the mineral compounds are absorbed relatively intact from the digestive tract into the blood stream with the mineral still bound to the transporter (Alexander, 1997a, 1997b; Nieper et al., 1999).

- The mineral-transporter complex remains stable in the blood stream with low dissociation, and the minerals are not released until the mineral-transporter complex enters the target tissues/cells. The attachment of minerals to carrier molecules forms electrically neutral stable complexes that allow selective direction of minerals to particular tissues that metabolically use the carrier molecules. This form of directed mineral nutrition even enhances mineral entry even into cells that have disturbed cell membranes. Use of mineral transporters can increase the bioavailability of minerals to injured and cancerous tissue (Nieper, 1966a, 1966b, 1966c, 1967a, 1967b, 1968, 1969, 1970, 1971, 1973, 1985; Buist, 1972, 1978).
- **Dietary correction of essential intracellular mineral deficiencies** such as potassium, magnesium, zinc and other trace elements is also critically important. An example would be the very similar cancer diets promoted by Dr. Hans Nieper or Dr. Max Gerson. **Dr. Gerson** clinically observed that when cancer patients were responding to treatment they would lose large amounts of sodium in their urine. This observation was one factor that made him theorize that cancer cells accumulate excess amounts of sodium and water and that the use of a high potassium diet could be very beneficial. Dr. Gerson advised his patients to use a program of natural detoxification that involved a diet containing large amounts of potassium. Gerson used large amounts of fresh vegetable juice and calf liver juice, which provides minerals, enzymes and electrons to the body. He believed such a diet would also assist in body detoxification particularly when coffee enemas were used to promote bile flow and bowel cleaning.
- **Cell membrane repair** can be initiated by changing the composition of cell membranes with lipid and sterol compounds such as 2-AEP, essential fatty acids, sterols and phytosterols. According to researchers such as Emanuel Revici, Mary Enig, Hans Nieper and Patricia Kane one of the major things that can be done to promote health is to improve membrane structure and membrane functions through nutritional interventions targeted at manipulating lipids, sterols and minerals.
- Essential fatty acids, phospholipids and sterols act as structural components of the cell membrane. Good sources of essential fatty acids and phospholipids are lecithin (phosphatidyl choline) which is found in eggs and soybeans, phosphatidyl serine, flax oil, avocado oil, walnut oil, hazelnut oil, hemp oil, grape seed oil, sesame oil, fish oil, olive oil, evening primrose oil, borage oil, blackcurrant seed oil, butter, coconut oil and phytosterols. Squalene is a compound found in high concentrations in shark liver oil and to a lesser degree in olive oil. Poor choices of fats are cottonseed oil, soybean oil, corn oil, canola oil, transfatty acids, and any hydrogenated or partially hydrogenated oil. *This pretty much eliminates any baked goods created by food manufacturing companies.*
- **2-AEP** is a nutritional supplement usually bound to calcium (calcium 2-AEP) or calcium, magnesium and potassium (2-AEP complex). 2-AEP is a cell membrane

repair molecule that is a precursor of phosphatidyl ethanolamine. 2-AEP helps act as a cell membrane sealant reducing cell entry of toxins and viruses and it helps maintain and improve the electrical potential of cell membranes particularly in cells involved in inflammatory processes (Nieper, 1988). Dr. Nieper reported that people who regularly used AEP mineral transporters along with calcium aspartate or calcium orotate had significantly less rates of prostate, colon and breast cancers.

- **Emanuel Revici** was an unconventional cancer researcher who developed a treatment for cancer called "guided 1ipid" therapy. Revici believed cancer patients had two basic patterns of lipid imbalance either an excess of sterols or an excess of fatty acids. He would test his patients determine, which pattern that they had then he would give either fatty acids or sterols to correct the imbalance (Revici, 1961).
- **Patricia Kane** has pioneered the use of RBC membrane analysis to determine nutritional adjustments specific for that individual.
- **Mary Enig** has extensively written about the role of dietary fats in disease causation and disease prevention.
- **Hans Nieper** developed a series of mineral transporters that such as 2-aminoethanol phosphates (AEP's), orotates, arginates, and aspartates that deliver minerals to specific cellular locations. He also was one of the first doctors to strongly recommend the use of a squalene and a cell membrane repair supplement called AEP for cell membrane repair. Squalene is a naturally occurring polyprenyl compound, structurally similar to beta-carotene, which composes up to 70% of the oils in shark livers. Squalene is an important nutritional compound that in conjunction with AEP, magnesium, zinc, selenium and the amino acid taurine can help stabilize the structure and functions of cell membranes. Squalene has a particular role in cancer and degenerative diseases in that along with AEP it helps support membrane structure and function. Squalene also has important roles in wound healing, immune system regulation and the production of steroid hormones. The body's natural production of dhea and pregnenolone can be increased by ingestion of squalene. These steroid hormones are surveillance hormones having important roles in reducing cancerous transformation in degenerative tissues.

Cellular membrane capacitance and cellular energy production may also be enhanced:

- **By inductively created or conducted electric fields** in specific *frequency and amplitude (amperage) windows and also by acoustic vibrations.*
- A cell or body is coupled to an electric field in proportion to its capacitance such that the greater the frequency of the electrical field the greater the current flow in the cell or body. For soft tissues low frequency natural or applied electrical fields create currents that are conducted primarily along the surface of cells in the ECM-cell membrane interface. Conduction of electrical currents in the ECM is the dominant effect when very low frequency electrical fields are created in or applied to biological tissues.

- When high frequency fields are applied with external signal generators this results in charging of the cell membranes causing an increase in cell membrane capacitance and increased conduction of current through the cell membranes.
- Because cell membranes naturally have capacitance this makes the cell membrane frequency-dependent conductors. At high frequencies a greater percentage of current will flow into and out the cell as a circuit loop. Higher frequency fields can strongly affect cell membrane permeability, which in turn can affect nutrient entry into the cells and toxin release from the cells and the ECM.
- I have done some research with both high frequency multiwave oscillators and experimental whole body phototherapy equipment and I have found that both type I and type II diabetics will have a fall in blood sugar when exposed to these devices. ***A note of caution****, diabetics and cancer patients should only stay in a multiwave oscillator field for 3-5 minutes when they first start because some individuals will have excessive toxin release and a rapid decline in blood sugar.* These individuals need time to clear toxins from their tissue and bloodstream through their organs of elimination. In my experience phototherapy is gentler and the effects produced while just as significant are not as rapid as the effects I have seen with multiwave oscillators. I believe the improvement with glucose control that can be achieved with these types of equipment is related to frequency-induced effects on insulin receptors and cell membrane glucose transport mechanisms.
- In summary an **increase in cellular membrane capacitance** may: change membrane permeability, increase cellular nutrient and mineral entry in to the cell and facilitate release of impregnated toxins from the membrane and cell interior.

Addressing genetic issues

- **The genetic machinery of the cell** controls ECM, glyocalyx, cell membrane, cell membrane receptor and internal cellular macromolecular composition. The genetic machinery of the cell can be altered to an abnormal state by: hereditary factors and environmental factors such as viruses, toxic chemicals, heavy metals, radiation, free radical damage and age-accumulated errors in transcription. Genetic abnormalities include DNA strand breaks, acquired dysfunction of DNA repair mechanisms, mutations in genes that drive the cell to divide, mutations in genes that suppress cell division, and failure to properly code mRNA. If improvements are made in genetic repair and removing genetic toxins the types of proteins, lipids and carbohydrates manufactured by the cell will change. Genetic mutations can by modified by downregulating oncogenes. Genetic repair can be improved by use of nutrients such as folic acid and zinc to increase the activity of DNA transcriptase and Vitamin B12, B6 and methionine to improve DNA methylation (Osiecki, 2002). Other strategies can also be used.
- Dr. Hans Nieper addressed **genetic repair** by use of products such as Dionaea muscipula and Iridodial.
- "Carnivorous plant extracts derived from the Venus Fly-Trap plant contain the active enzymes *endopeptidase* and *endonuclease*. These are special **gene-eliminating substances** (Nieper et al., 1999). Venus Fly-Trap plants excrete substances, which extinguish the gene information of ingested insects because

otherwise, the absorbed gene information from the insect would possibly go in their own gene system and change it. The carnivorous plant of the "Venus Fly-Trap" contains about a dozen substances, such as *plumbagin*, *droseron*, and *hydroxydroseron*, which extinguish open gene information. According to Dr. Nieper, the extract of Venus Fly-Trap extinguishes genetic replication of malignant cells. This extract is also useful in eliminating tissue damaged by radiation therapy, while leaving normal cells unaffected. Venus Fly-Trap is botanically termed ***Dionaea muscipula***.

- Iridodials are a primary source of *dialdehydes*, which "are **extremely powerful genetic-repair factors**" (Nieper et al., 1999). Dialdehydes are "lipid soluble agents that can penetrate the lipid membranes of the outer cells of tumours" (Nieper et al., 1999). Iridodial is extremely similar to the activated dialdehyde, called didrovaltrate. Insects and ants in particular and carnivorous plants are "the most effective producers of gene repair substances" (Nieper, 1990). Insects are phylogenetically extremely old. Their ability to conserve and safeguard their gene system is superb. Similar to sharks, they hardly ever develop tumors. They are able to host large amounts of viruses without showing ill effects. Yet insects have no immune system, phylogenesis only equipped them with a repair principle called Iridodial (Nieper, 1990). According to Hans Nieper, the aldehydic iridoides (Iridodial) from insects inhibits viruses from causing genetic alterations (Nieper, 1985). These gene-repairing Iridodials work by inactivating the undesired genetic material from an infecting virus thus protecting the cellular genome. Dr. Peter Thies of Germany first described the anti-malignant, genetic-repair properties of Iridodials in 1985. Also in 1985, Dr. Didier of Gifhorn, Germany first reported pulmonary tumor regression by use of Iridodial (Nieper, 1990).
- Dr. Nieper reported that both Dionaea muscipula and Iridodial could **extinguish cells, which were genetically impaired** (Nieper, 1996). Therefore, cells that were improperly programmed would be discarded (Nieper, 1984). Such undesired information may otherwise result in the conversion of a normal cell into a cancerous cell. Dr. Nieper found that cells already transformed could be induced to die while normal cells were left unaffected. Gene-repair therapy "represents in many ways, an imitation of the cancer defense of our body" (Nieper, 1985).
- Dr. Nieper reported that Iridodial and Dionaea muscipula were completely free of any side effects, and so non-toxic that they could be administered without complication in early and suspected stages of the disease for an unlimited time (Nieper, 1990). Dr. Hans Nieper believed that Iridodial and Dionaea Muscipula outdistanced most other substances for use in cancer. Dr. Nieper reported that his first choice in his nontoxic approach to cancer were the combined use of the extract of Venus Fly-Trap (Dionaea Muscipula) and the ant extract Iridodial (Nieper, 1990; 1996).

Protection of cell membranes, mitochondria and genetic machinery by use of exogenous antioxidants and promotion of the production and regeneration of endogenous intracellular and extracellular antioxidant and Redox systems particularly glutathione pathways.

- Oxygen is required by the metabolic reactions of our cells that obtain energy from the chemical burning of food. In the process of energy production some toxic compounds are normally produced. When energy is produced in the mitochondria of cells up some of the oxygen is converted to a variety of free radicals such as superoxide (O2-), hydrogen peroxide (H2O2) and hydroxyl (OH-) radicals. These free radicals are extremely reactive molecules that contain at least one unpaired electron in their outer orbital shell. Body exposure to chemical toxins and radiation also produce free radicals. Unless adequate amounts of cellular and extracellular antioxidants are available these free radicals will begin to damage cellular structures such as the cell membranes, the mitochondria, the nucleic acids of DNA and cellular proteins impairing the ability of the cells to repair themselves and reproduce (Morel et al., 1999).
- When cell membranes are damaged by free radicals their ability to hold an electrical charge (capacitance) and their ability to transport minerals and other nutrients is disrupted. When mitochondria are damaged the cells ability to make energy is impaired. When the genetic code is damaged cells cannot reproduce normal cells. Free radicals also cause lipid peroxidation, which can result in lowering HDL cholesterol and damage to the cell membranes lining blood vessels. When the delicate membranes lining blood vessels are damaged an inflammatory process may result which leads to thickening of blood vessels and arterial plaque. The tissue reactions created by free radicals are now thought to be involved in premature aging, cancer, atherosclerosis, arthritis, immune disorders and other degenerative diseases.
- The redox status of the cells depends on the concentrations of the oxidized (inactive) and reduced (active) components of the major redox molecules, which act as homeostatic redox buffers. For example the ratio of oxidized GSSG to reduced GSH, reflects the redox status within the cell. In healthy cells ration of GSSG/GSH usually averages 1%, which means that the intracellular concentration of GSH is roughly 100 times greater than the intracellular concentration of its oxidized component GSSG. Any change in this ratio will greatly affect the redox status within the cell). When oxidative conditions occur in injury the oxidized component predominates and genetic activity, cell organelle functions and cell detoxification functions are impaired.

Providing a source of free electrons: a short discussion on the biological effects of electricity and light: chemical antioxidants, electronic antioxidants and photonic antioxidants:

- Free radicals result from both natural biochemical processes and environmental factors, such as exposure to chemical toxins, heavy metals, ultraviolet light, x-rays, radiation therapy, nuclear radioactivity, alcohol and smoking.
- Because free radicals are defined as molecules that have lost an electron they can be said to be electron deficient. These electron deficient molecules then search the body in any attempt to find a replacement that they can steal, so they can also be thought of as electron thieves. The replacement electrons are generally stolen from cell proteins, cellular DNA, or cell membranes. When enough electrons are taken from these cells, the cells are damaged they can then die, under go

cancerous transformation or be repaired by an antioxidant. Because free radicals are continuously produced as a natural toxic byproduct of energy production the cells use a variety of antioxidant systems to prevent their accumulation. Antioxidants are life's free radical scavengers. The cellular antioxidants are chemical compounds that have the ability to supply the electron-deficient free radicals with electrons, therefore neutralizing their oxidative destruction of the cells biomolecules. The key element is that antioxidants supply electrons.

- From a biologist's point of view antioxidants are biological chemicals that are able to donate some of their own electrons to neutralize electron-deficient free radicals. Conventional wisdom typically holds that antioxidants have to be nutritive substances, however from a physicist's point of view antioxidant effects can also be achieved by other methods.
- New research has shown that external electronic devices such as microcurrent machines, low power lasers, LEDS, and infrared lamps can also supply electrons. This is the concept of electronic and photonic antioxidants by using physiologically acceptable wavelengths of light (visible and far infrared light) or providing electrical currents in the microcurrent range through application of DC electricity by microcurrent devices.
- Due to tissue interactions with the photons of light (the photoelectric effect), when light of the right frequency (far infrared or visible light) interacts with biological tissues electrons are produced. At a fundamental level a nutrient antioxidant is simply a chemical carrier of extra electrons and the same effect of providing extra electrons by chemical means can be also achieved by exposure to the photons of far infrared or visible light. Far infrared and visible light are bands of electromagnetic energy, which are particularly acceptable and beneficial to living creatures. This photonic antioxidant effect provides part of the explanation of how the "vital rays" of far infrared and visible light are involved in healing.
- In addition the use of these devices in cancer helps reestablish biocurrent flow in electrically resistive tissue reducing the resistance of the cancerous tissue and facilitating a more normal capacitance. Warning: microcurrents and PEMF devices should not be used on pregnant women or people with pacemakers.

Microcurrent electrical therapy and PEMF therapy

- **Microcurrent devices** deliver weak electrical currents directly to the tissues through the use of needle implants or attached electrodes.
- **A PEMF device** applies a magnetic field to the body, which *induces the production* of weak electrical currents in the tissues. As previously stated these weak biocurrents can influence the flow of blood and oxygen to the tissues and the flow of ions and of nutrients into the cells. This enhancement of circulation and nutrient exchange can be beneficial in improving cellular bioenergetics.
- Doctors, chiropractors, dentists, physical therapists and other practitioners currently use microcurrent electrotherapy for a variety of clinical conditions. In fact it is a rapid treatment for many pain-related disorders because it can provide fast relief of symptoms and promote faster tissue healing. The advantages of micro current electrotherapy are multiple. It has significantly less side effects than drugs. In many cases it can give symptom relief in minutes and it supports cellular

repair processes unlike many pharmacological agents that can have toxic effects when used long term for chronic conditions.

- The first modern acceptable electrotherapy devices to receive wide medical utilization were transcutaneous nerve stimulation devices called TENS units. TENS devices use a small current of electricity in the milliamp range at low frequencies typically eight cycles per second or less to block the body's ability to perceive the pain (Leo et al., 1986).
- TENS devices are believed to stimulate A-beta pain-suppressing nerve fibers to overwhelm chronic pain-carrying C fibers and to release endorphins (Melzack and Wall, 1965; Mercola and Kirsch, 1995). According to Dr. Mercola, for TENS devices to be effective they require that the current be strong enough to feel. "Patients are advised to set the current at the maximum comfortable tolerance, but the nervous system gradually accommodates to this high level of current, causing tolerance similar to that of chemical analgesics. Increasing the current causes mild electrical burns in about one third of the patients. The technique provides no significant residual effect (Mercola and Kirsch, 1995)."
- Microcurrent devices use a current of lower intensity in the microampere range with a longer pulse width. The currents that microcurrent devices use are 1000 times less than milliampere range of TENS with pulse widths 2500 times longer than the pulse in a typical TENS unit (Mercola and Kirsch, 1995).
- Unlike TENS devices microcurrent devices help stimulate cellular and tissue repair processes by using electrical currents in the physiological range used by the body. Administration of electric current in physiologic ranges by microcurrent devices have a number of advantageous cellular effects including: increasing ATP generation by almost 500%, enhancement of amino acid transport through the cell membranes and increasing cellular protein synthesis (Cheng et al., 1986). It is also likely that cell membrane transport of minerals is also enhanced because microcurrent devices help correct the reduced cellular capacitance of damaged cells and increase the reduced electrical conductance of injured tissue. Injured tissue begins to heal faster when cellular energy production increases, the cells regain normal capacitance and the tissues regain normal conduction of electrical currents (Becker, 1985; Vodovnik and Karba, 1992) allowing reestablishment of normal communication with the rest of the body through the liquid crystal connective tissue communication system (Ho, 1998).

Ensure adequate hydration

Initiate autorepair mechanisms by removal of energetic blockages (acupuncture, homeopathy, neural therapy, infrared emitters, phototherapy devices, microcurrent devices, pulsed electromagnetic field devices etc.)

Detoxification of toxic chemicals and heavy metals in the ECM by massage, oral and IV chelation, infrasonic devices, ultrasonic devices, infrared devices, phototherapy devices, and microcurrent devices. Many clinicians use detox strategies that mobilize toxins and promote excretion through skin (infrared saunas), liver-GI tract, and kidneys.

Improving cellular oxygen levels by opening up the microcirculation with enzymes like bromelain, papain, pancreatin and nattokinase and oral and IV EDTA. Increasing tissue oxygen levels with ozone therapy and hyperbaric oxygen.

Change the composition of the ECM/glycocalyx/cell membrane interface with compounds like glyconutrients that help change the composition and charge of proteoglycans and the composition and activity of cell receptors. Possible nutrients include Betaglucans, IP-6, Aloe vera extracts, arabinogalactans, glucosamine, polysaccharides derived from mushrooms and alginates.

Use of cell therapy: cell therapy may be provided orally or by implantation

- Active cell therapy research is now taking place with the implantation of stem cells such as mesenchymal cells, which can differentiate into osteoblasts, chondroblasts, myoblasts and fibroblasts.
- Cell therapy is also available with oral glandular products that provide organ specific components. These organ specific components supply a unique form of nutrition to organ cells that is different from oral and IV nutrient programs.
- Cell therapy can help balance hormone production by the endocrine glands when a preexisting endocrine deficiency exists.

In closing the goals to work toward in electronic cancer nutrition:

1. Intervene nutritionally at the level of the ECM-glycocalyx-cell membrane level with enzymes.
2. Repair cell membranes and cell membrane potential with proper selections of fats, sterols, phytosterols, AEP, squalene, and mineral transporters.
3. Improve cell signaling mechanisms (role of glyconutrients)
4. Correct imbalances in intracellular minerals that are needed for maintenance of cell membrane capacitance and enzyme cofactors by utilizing mineral transporters
5. Correct DNA breaks and DNA repair mechanisms with gene support nutrients, vitamin B12, B6, folic acid, cell therapy implants, gene repair extracts (Dionaea muscipula and Iridodial).
6. Improve macromolecular production, utilization and secretion of proteins (enzymes and structural proteins), peptide (hormones, growth factors, growth inhibitors and cytokines), lipids and carbohydrates (energy source and signaling molecules).
7. Improve intracellular energy production with vitamins, carnitine, coenzyme Q10, intracellular mineral transporters.
8. Correct pH alterations with diet.
9. Facilitate antioxidant functions.
10. Facilitate detoxification of the ECM and intracellular compartments.

Cancer References:

1. Acevedo HF. Human chorionic gonadotropin (hCG), the hormone of life and death: a review. J Exp Ther Oncol 2002 May-Jun;2(3):133-45.

2. Acevedo HF, Pardo M, Campbell-Acevedo E, Domingue GJ. Human choriogonadotropin-like material in bacteria of different species: electron microscopy and immunocytochemical studies with monoclonal and polyclonal antibodies. J Gen Microbiol 1987 Mar;133 (Pt 3):783-91.
3. Acevedo HF, Tong JY, Hartsock RJ. Human chorionic gonadotropin-beta subunit gene expression in cultured human fetal and cancer cells of different types and origins. Cancer 1995 Oct 15;76(8):1467-75.
4. Acevedo H, Gonzalez N, Moss R. Trophoblastic Hormones and Cancer: A Breakthrough in Treatment? Comprehensive Cancer Care Conference, Session 205: June 13, 1998. http://www.cmbm.org/conferences/ccc98/transcripts/205.html.
5. Adey WR. Tissue interactions with nonionizing electromagnetic fields. Physiol Rev 1981; 61:435-514.
6. Adey WR. Physiological signaling across cell membranes and cooperative influences of extremely low frequency electromagnetic fields. In: Biological Coherence and Response to External Stimuli, H. Frohlich, ed., Heidelberg, Springer-Verlag, pgs 148-170, 1988.
7. Adey WR. ELF magnetic fields and promotion of cancer: experimental studies. In *Interaction Mechanisms of low-level Electromagnetic Fields in Living Systems,* (eds. B. Norden and C. Ramel). Oxford, England: Oxford University Press, pgs 23-46, 1992.
8. Adey WR. Electromagnetics in biology and medicine. In *Modern Radio Science,* (ed. H. Matsumoto). Oxford, England: Oxford University Press, pgs 277-245, 1993.
9. Aidley DJ, Stanfield PR. *Ion Channels: Molecules in Action.* Cambridge, UK: Cambridge University Press, 1996.
10. Alexander AD. The healthy cell: Its structure and functions that are so essential to disease prevention and treatment. INI Newsletter June 1997a.
11. Alexander AD. Calcium 2-AEP and calcium orotate found essential in the prevention and treatment of osteoporosis. INI Newsletter June 1997b.
12. Ambrose EJ, James AM, Lowick JHB. Differences between the electrical charge carried by normal and homologous tumor cells. Nature 1969;177:576-577.
13. Atema A, Buurman KJ, Noteboom E, Smets LA. Potentiation of DNA adduct formation and cytotoxicity of platinum-containing drugs by low pH. Int J Cancer 1993;54:166–172.
14. Backus BT, Affronti LF. Tumor-associated bacteria capable of producing a human choriogonadotropin-like substance. Infect Immun 1981 Jun;32(3):1211-5.
15. Beal JB. Biosystems liquid crystals & potential effects of natural & artificial electromagnetic fields (EMFs) 1996. Website: http://frontpage.simnet.is/vgv/jim1.htm
16. Bearden TE. AIDS Biological Warfare. Greenville, TX: Tesla Book Company, 1988.
17. Becker RO. The bioelectric factors in amphibian limb regeneration. Journal of Bone and Joint Surgery 1961;43A:643-656.
18. Becker RO. The electrical control of growth processes. Medical Times 1967;95: 657-669.
19. Becker RO, Murray DG. The electrical control system regulating fracture healing in amphibians. Clin Orthop Rel Res 1970;73:169.

20. Becker RO. Stimulation of partial limb regeneration in rats. Nature 1972;235:109-111.
21. Becker RO. The basic biological data transmission and control system influenced by electrical forces. Ann N Y Acad Sci 1974;238: 236-241.
22. Becker RO. Cross Currents. London, England: Bloomsbury Publishing, 1990.
23. Becker RO, Selden G. The Body Electric. New York: W. Morrow and Company Inc, 1985.
24. Becker RO, Bassett CAL, Bachman CH. Bioelectric factors controlling bone structure. In: Bone Biodynamics, ed. H. Frost. New York: Little Brown, 1964.
25. Bender DA. *Introduction to Nutrition and Metabolism, 3rd ed.* New York, New York: Taylor and Francis Inc., 2002.
26. Blad B, Baldetorp B. Impedance spectra of tumour tissue in comparison with normal tissue: A possible clinical application for electrical impedance tomography. Physiological Measurement 17 Suppl 4A:A105-115, 1996.
27. Blank M. Na, K -ATPase function in alternating electric fields, FASEB J 1992;6:2434-2438.
28. Board M, et al. High Km glucose-phosphorylating (glucokinase) activities in a range of tumor cell lines and inhibition of rates of tumor growth by the specific enzyme inhibitor mannoheptulose. Cancer Res 1995 Aug 1;55(15):3278-85.
29. Borgens RB, Robinson KR, Vanable JW, McGinnis ME. *Electric Fields in Vertebrate Repair*. NY: Alan R. Liss, 1989.
30. Brewer AK, Passwater R. Physics of the cell membrane. Mechanisms involved in cancer. Am Lab 1976 April;10;37-45.
31. Brewer AK. *High pH Cancer Therapy with Cesium.* Published by The A. Keith Brewer International Science Library, 325 N. Central Avenue, Richland Center, Wisconsin 53581. Phone # 608-647-6513. email – drbrewer@mwt.net, 1985.
32. Brighton CT, Black J, Pollack SR. *Electrical Properties of Bone and Cartilage.* New York: Grune & Stratton, 1979.
33. Brown G. *The Energy of Life: The Science of What Makes Our Minds and Bodies Work.* New York, NY: The Free Press, 1999.
34. Buist R. *Biological Applications of Orotates: Orotates Mineral Salts of Vitamin B13.* Sydney: Colprint Press, 1972.
35. Buist R. Orotates: *The Ultimate in Mineral Transportation.* Sydney: Colprint Press, 1978.
36. Cantwell AR Jr. *The Cancer Microbe: The Hidden Killer in Cancer, AIDS, and Other Immune Diseases.* Los Angeles: Aries Rising Press, 1990.
37. Charman RA. Electrical Properties of Cells and Tissues. In *Clayton's Electrotherapy 10th edition* (eds. S. Kitchen and S. Bazin), London, UK: WB Saunders Company Ltd., 1996.
38. Cheng N, Van Hoff H, Bockx E, et al. The effect of electric currents on ATP generation protein synthesis, and membrane transport in rat skin. Clin Orthop 1982; 171:264-72.
39. Chou CK, Vora N, Li JR, et al. Development of electrochemical treatment at the City of Hope. In Proceedings of the Fourth International Symposium on Biologically Closed Electric Circuits. Bloomington, MN: International

Association for Biologically Closed Electric Circuits in Biomedicine, pgs 100-103, October 26-29, 1997.
40. Cone CD. Variation of the transmembrane potential level as a basic mechanism of mitosis control. Oncology 1970;24:438-470.
41. Cone CD. The role of surface electrical transmembrane potential in normal and malignant mitogenesis. Ann NY Acad Sci 1975;238:420-35.
42. Cone CD. *Transmembrane Potentials and Characteristics of Immune and Tumor Cells*. Boca Raton, Florida: CRC Press, 1985.
43. Cope FW. A medical application of the Ling Association-Induction Hypothesis: The high potassium, low sodium diet of the Gerson cancer therapy. Physiol Chem Phys 1978;10(5):465-468.
44. Cure JC. Cancer an electrical phenomenon. Resonant 1991; 1(1).
45. Cure JC. On the electrical characteristics of cancer. Paper presented at the Second International Congress of Electrochemical Treatment of Cancer. Jupiter, Florida: October 1995.
46. Dang CV, Lewis BC, Dolde C, et al. Oncogenes in tumor metabolism, tumorigenesis, and apoptosis. J Bioenerg Biomembr 1997; 29:345–354.
47. Douwes FR, Szasz A. Electrochemical therapy of cancer. A new treatment modality for cancer destruction. Clinical use and experience. Proceedings of the Fourth International Symposium on Biologically Closed Electric Circuits. Bloomington, MN: International Association for Biologically Closed Electric Circuits in Biomedicine, pgs 75-99, October 26-29, 1997.
48. Eckert KA, Kunkel TA. Fidelity of DNA synthesis catalyzed by human DNA polymerase and HIV-1 reverse transcriptase: effect of reaction pH. Nucleic Acids Res 1993;21:5212–5220.
49. Edwards SL. Hypovolaemia: pathophysiology and management options. Nursing in Critical Care 1998;3(2):73-82.
50. Foster KR, Schepps JL. Dielectric properties of tumor and normal tissues at radio through microwave frequencies. J Microwave Power 1981;16:107-119.
51. Fricke H, Morse S. The electric capacity of tumors of the breast. J Cancer Res 1926;10: 340-376.
52. Frohlich H., ed. *Biological Coherence and Response to External Stimuli.* Heidelberg: Springer-Verlag, 1988.
53. Fukada E, Yasuda I. On the piezoelectric effect in bone. J Physiol Soc Japan 1957;12:1198.
54. Fukada E. Piezoelectricity of natural biomaterials. Ferroelectrics 1984;60:285-296.
55. Garnett M. *First Pulse: A Personal Journey in Cancer Research.* New York, NY: First Pulse Projects, 1998.
56. Garnett M. Does DNA have a pulse? Garnett McKeen Laboratory, Inc. 150 Islip Ave. Suite 6, Islip, New York 11751, 2000.
57. Garnett M, Remo JL. DNA Reductase: A Synthetic Enzyme with Opportunistic Clinical Activity Against Radiation Sickness. International Symposium on Applications of Enzymes in Chemical and Biological Defense, Orlando, Florida, May, 2001, p. 41.

58. Garnett M, Remo JL, Krishnan CV. Developmental electronic pathways and carcinogenesis. Garnett McKeen Laboratory, Inc. 150 Islip Ave. Suite 6, Islip, New York 11751. http://www.polymva survivors.com/research_articles.html, 2002.
59. Gerweck LE. Modification of cell lethality at elevated temperatures: the pH effect. Radiat Res 1977;70:224–235.
60. Gold J. Proposed treatment of cancer by inhibition of gluconeogenesis. Oncology 1968;22:185-207.
61. Gold J. Inhibition of gluconeogenesis at the phosphoenolpyruvate carboxykinase and pyruvate carboxylase reactions, as a means of cancer chemotherapy. Oncology 1974;29:74-89.
62. Gold J. Anabolic profiles in late-stage cancer patients responsive to hydrazine sulfate. Nutr Cancer 1981;3(1):13-9.
63. Goldin EM, Leeper DB. The effect of low pH on thermotolerance induction using fractionated 45 degrees C hyperthermia. Radiat Res 1981;85:472–479.
64. Graeber TG, Osmanian C, Jacks T, et al. Hypoxia-mediated selection of cells with diminished apoptotic potential in solid tumours. Nature 1999;379:88–91.
65. Gray LH, Conger AD, Ebert M, Hornsey S, Scott OC. Concentration of oxygen dissolved in tissues at the time of irradiation as a factor in radiotherapy. Brit J Radiol 1953;26:638-648.
66. Hakomori SI. Biochemical basis of tumor-associated carbohydrate antigens. Current trends, future perspectives, and clinical applications. Immunol Allergy Clin North Am 1990;10:781–802.
67. Haltiwanger SG. Clinical use of mineral transporters and their effects on cell membrane capacitance: Second International Congress of BioEnergetic Medicine, Institute of Quantum and Molecular Medicine, February 20-22, 1998.
68. Hasan NM, Adams GE, Joiner MC, Marshall JF, Hart IR. Hypoxia facilitates tumour cell detachment by reducing expression of surface adhesion molecules and adhesion to extracellular matrices without loss of cell viability. Br J Cancer 1998;77(11):1799-805.
69. Hazelwood CK, Chang DC, Nichold BJ, Woesner DE. Nuclear magnetic resonance transverse relaxation times of water protons in skeletal muscle. Biophys J 1974;14:583-606.
70. Hille B. *Ionic Channels of Excitable Membranes 2nd ed.* Sunderland, MA: Sinauer Assoc., 1992.
71. Ho MW. Bioenergetics and Biocommunication. In *Computation in Cellular and Molecular Biological Systems* (eds., R Cuthbertson, M Holcombe, R Patton). Singapore: World Scientific pgs. 251-264, 1996.
72. Ho MW. *The Rainbow and the Worm: The Physics of Organisms, 2nd ed.* River Edge, NJ: World Scientific, 1998.
73. Holash J, Maisonpierre PC, Compton D, et al. Vessel cooption, regression, and growth in tumors mediated by angiopoietins and VEGF. Science 1999;283:1994–1998.
74. Ivorra A. Bioimpedance Monitoring for physicians:an overview. July, 2002. Website:http://www.cnm.es/~mtrans/PDF's/Bioimpedance_for_physicians_rev1.PDF

75. Kim JH, Kim SH, Alferi A, et al. Quercitin an inhibitor of lactate transport and hyperthermic sensitizer of hela cells. Cancer Res 1984;44(1):102-6.
76. Kuin A, Aalders M, Lamfers M, et al. Potentiation of anti-cancer drug activity at low intratumoral pH induced by the mitochondrial inhibitor m-iodobenzylguanidine (MIBG) and its analogue benzylguanidine (BG). Br J Cancer 1999;79:793–801.
77. Lakhovsky G. Apparatus with circuits oscillating under multiple wavelengths. U.S. Patent No. 1,962,565. June 12, 1934.
78. Lakhovsky G. *The Secret of Life: Electricity, Radiation and Your Body.* Translated by M. Clement, London: Heinemann, 1939.
79. Leeper DB, et al. Effect of i.v. glucose versus combined i.v. plus oral glucose on human tumor extracellular pH for potential sensitization to thermoradiotherapy. Int J Hyperthermia 1998 May-Jun;14(3):257-69.
80. Lemmon MJ, van Zijl P, Fox ME, et al. Anaerobic bacteria as a gene delivery system that is controlled by the tumor microenvironment. Gene Ther 1997;4(8):791-6.
81. Leo KC, Dostal WF, Bossen DG, et al. Effect of transcutaneous electrical nerve stimulation characteristics on clinical pain. Physical Therapy 1986; 6:200-205.
82. Li KH, Xin YL, Gu B, et al. Effects of direct electric current on dog liver: possible mechanisms for tumor electrochemical treatment. Bioelectromagnetics 1997;18:2.
83. Li XQ, Yan YJ. Electrical transport through individual DNA molecules. Department of Chemistry, Hong Kong University of Science and Technology, Kowloon, Hong Kong March 30, 2001.
84. Liboff AR. Electric-field ion cyclotron resonance. Bioelectromagnetics 1997;18(1):85-87.
85. Ling GN. The Association-Induction Hypothesis: A theoretical foundation provided for the possible beneficial effects of a low sodium, high potassium diet and other similar regimens in the treatment of patients suffering from debilitating illnesses. Agressologie 1983;24(7):293-302.
86. Ling GN, Ochsenfeld MM. Na+ and K+ levels in living cells: Do they depend on the rate of outward transport of Na+? Physiol Chem Phys 1976;8:389.
87. Ling GN. *Life at the Cell and Below-Cell Level. The Hidden History of a Fundamental Revolution in Biology.* New York: Pacific Press, 2001.
88. Liu DS, Astumian RD, Tsong TY. Activation of Na+ and K+ pumping modes of (Na-K)-ATPase by an oscillating electric field. The Joumal of Biological Chemistry 1990;265(13):7260-7267.
89. Livingston-Wheeler VWC, Livingston AM. Some cultural, immunological, and biochemical properties of Progenitor cryptocides. Trans N Y Acad Sci 1974 Jun;36(6):569-82.
90. Livingston-Wheeler VWC, Wheeler OW: *The Microbiology of Cancer.* San Diego: Livingston Wheeler Medical Clinic Publication, 1977.
91. Livingston-Wheeler VWC, Addeo KG: *The Conquest of Cancer.* New York: FranklinWatts Publisher, 1984.

92. Mahnensmith RL, Aronson PS. The plasma membrane sodium-hydrogen exchanger and its role in physiological and pathophysiological processes. Circ Res 1985;56(6):773-788.
93. Marieb EN. *Human Anatomy and Physiology* Fourth edition. Redwood City: The Benjamin/Cummings Publishing Company, 1998.
94. Melzack R, Wall P. Pain mechanisms: a new theory. Science 1965; 150:971.
95. Mercola JM, Kirsch DL. The basis for micro current electrical therapy in conventional medical practice. Journal of Advancement in Medicine 1995; 8(2).
96. Modica-Napolitano J, Singh KK. Mitochondria as targets for detection and treatment of cancer. [http://www-ermm.cbcu.cam.ac.uk/02004453h.htm] Expert Reviews in Molecular Medicine April 11, 2001.
97. Morel Y, Barouki R. Repression of gene expression by oxidative stress. Biochem J 1999;342:481–496.
98. Moulder JE, Rockwell S. Tumor hypoxia: its impact on cancer therapy. Cancer Metastasis Rev 1987;5:313–341.
99. Nelson WC. Electrical reactance and its correlates in biological systems: electrophysiological reactivity. Budapest, Hungary, 1995.

http://www.energeticmedicine.net/research/xeriod2.doc.

100. Newell K, Franchi A, Pouyssegur J, et al. Studies with glycolysis-deficient cells suggest that the production of lactic acid is not the only cause of tumor acidity. Proc Natl Acad Sci 1993;90:1127-31.
101. Nieper H A. Experimental bases and clinical use of electrolyte carrier compounds. Arztl Forsch 1961;15: 510-514.
102. Nieper HA, Blumberger K. Electrolyte transport therapy of cardiovascular disease in: Electrolytes and cardiovascular disease. Ed. Bajusz E. Vol 2: 141-173, Basel/ New York: S. Karger, 1966a.
103. Nieper HA. Experimentation clinque de transporteurs de calcium. 1966b;7(6): 623-639.
104. Nieper HA. Clinical experimentation with calcium transport agents. Calcium DL, L-aspartate and calcium-aminoethyl phosphate, 2 powerful anti-inflammatory and antiallergic agents. Agressologie 1966c Nov;7(6):623-639.
105. Nieper HA. A clinical study of Ca-2-aminoethanolphosphate (2nd communication). Aggressologie 1967a;7(4):4-16.
106. Nieper HA. A clinical study of the calcium transport substances Ca-l, dl-aspartate and Ca-2-aminoethenol phosphate as potent agents against autoimmunity and other anticytologial aggressions. Aggressologie 1967b; 8(4):395-406.
107. Nieper HA. Comparative study of the clinical effect of dl- asparate (calciretard), of ca-2- calcium aminoethanol phosphate (Ca-EAP) and of the cortisones. Aggressologie 1968;9(3):471-475.
108. Nieper HA. The anti-inflammatory and immune-inhibiting effects of calcium orotate on bradythropic tissues. Agressolgie 1969;10(4):349-357.
109. Nieper HA. Recalcification of bone metastases by calcium- diorotate. Aggressologie 1970;11(6):495-503.
110. Nieper HA. Therapeutically effective calcium diorotate US Patent 3,621,024, filed Nov. 13, 1968, pat. Nov. 16, 1971.

111. Nieper HA The clinical effect of calcium- diorotate on cartilaginous tissue, the specific function dependent upon the pentose- metabolism of bradytrophic tissue. Geriatrie 1973; 3(4): 82-89.
112. Nieper HA. Dionaea muscipula (Venus Fly-Trap) Therapy - Excerpt from his lecture at the Health by Choice Conference, Atlanta, Georgia, April 1984.
113. Nieper HA. *Dr. Nieper's Revolution in Technology, Medicine and Society*. Oldenburg, Germany: MIT Verlag, 1985.
114. Nieper HA. The colamine phosphate salts as membrane integrity factor. Raum and Zeit 1988 Aug;35:4-9.
115. Nieper HA. Genetic repair including 'Iridodial' an insect derived genetic repair factor of important antimalignant effect" Raum & Zeit (German Magazine, Space & Time), 1990.
116. Nieper HA. Modern medical cancer therapy following the decline of toxic chemotherapy. Townsend Letter for Doctors & Patients, November 1996.
117. Nieper HA, Alexander AD, Eagle-Ogden GS. The Curious Man: The Life and Works of Dr. Hans Nieper. Garden City Park, NY: Avery Publishing Group; 1999.
118. Nordenström BEW. *Biologically Closed Circuits: Clinical, Experience and Theoretical Evidence for an Additional Circulation*. Stockholm, Sweden: Nordic Medical Publications, 1983.
119. Nuccitelli R. The Involvement of transcellular ion currents and electric fields in pattern formation. In Pattern Formation, (eds. GM Malacinski, SV Bryant), NY: Macmillan Publishing Co., 1984.
120. O'Clock GD. The effects of in vitro electrical stimulation on normal and malignant eukaryotic cells. In Proceedings of the Fourth International Symposium on Biologically Closed Electric Circuits. Bloomington, MN: International Association for Biologically Closed Electric Circuits in Biomedicine, pgs 105-113, October 26-29, 1997.
121. Ojugo A SE, McSheehy PMJ, McIntyre DJO, et al. Measurement of the extracellular pH of solid tumours in mice by magnetic resonance spectroscopy: a comparison of exogenous 19F and 31P probes. NMR Biomed 1999; 12: 495-504.
122. Oschman JL. *Energy Medicine: The Scientific Basis*. Edinburgh, England: Churchill Livingstone, 2000.
123. Osiecki H. *Cancer: A Nutritional/Biochemical Approach*. Eagle Farm, Australia: Bioconcepts publishing, 2002.
124. Pekar R. *Percutaneous Bio-Electrotherapy of Cancerous Tumours: A Documentation of Basic Principles and Experiences with Bio-Electrotherapy*. Munich, Germany: Verlag Wilhelm Maudrich, 1997.
125. Presman AS. *Electromagnetic Fields and Life*. New York, NY: Plenum Press, 1970.
126. Regelson W. The `Grand Conspiracy' against the cancer cure. Journal of the American Medical Association 1980;243(4):337.
127. Reichart LF. Extracellular matrix molecules. In *Guidebook to the Extracellular Matrix, Anchor, and Adhesion Proteins*, (ed. T. Kreis and R. Vale). Oxford, England: Oxford University Press, pgs. 335-344, 1999.

128. Reilly JP. *Applied Bioelectricity: From Electrical Stimulation to Electropathology*. New York: Springer, 1998.
129. Reynolds TY, Rockwell S, Glazer PM. Genetic instability induced by the tumor microenvironment. Cancer Res 1996;56:5754–5757.
130. Revici E. *Research in Pathophysiology as Basis for Guided Chemotherapy, with Special Application to Cancer*. Princeton, NJ: D. Van Nostrand Company, 1961.
131. Rockwell S. Use of hypoxia-directed drugs in the therapy of solid tumors. Semin Oncol 1992;19:29–40.
132. Rofstad EK. Microenvironment-induced cancer metastasis. Int J Radiat Biol 2000;76:589–605.
133. Rossi-Fanelli F, et al. Abnormal substrate metabolism and nutritional strategies in cancer management. JPEN J Parenter Enteral Nutr 1991 Nov-Dec;15(6):680-3.
134. Sartori HE. Cesium therapy in cancer patients. Phar Biochem and Behavior 1984;21(1):11-13.
135. Scharfetter H. Structural modeling for impedance-based non-invasive diagnostic methods. Graz: Thesis for the habilitation at the Faculty of Electrical Engineering Technical University Graz, November 1999.
136. Schaubel MK, Habal MB. Electropotentials of surgical specimens. Arch Pathol 1970;90:411-415.
137. Seeger PG, Wolz S. Successful Biological Control of Cancer: By Combat Against the Causes. Gesamtherstellung: Neuwieder Verlagsgesellschaft mbH, 1990.
138. Semenza GL. Involvement of hypoxia-inducible factor 1 in human cancer. Intern Med 2002;41:79-83.
139. Skarsgard LD, Skwarchuk MW, Vomczan A, et al. The cytotoxicity of melphalan and its relationship to pH, hypoxia and drug uptake. Anticancer Res 1995;15:219–223.
140. Sharp MG, Adams SM, Walker RA, Brammer WJ, Varley JM. Differential expression of the mitochondrial gene cytochrome oxidase II in benign and malignant breast tissue. J Pathol 1992, 168**:**163-168.
141. Smith C, Best S. *Electromagnetic Man*. New York: St. Martin's Press, 1989.
142. Stanish W. The use of electricity in ligament and tendon repair. Physician Sports Med 1985;13:108-116.
143. Stern RG. Carcinogenesis and the plasma membrane. Med Hypotheses 1999 May;52(5):367-372.
144. Straus DC, Lonon MK, Woods DE, Garner CW. Production of an extracellular toxic complex by various strains of Pseudomonas cepacia.. J Med Microbiol 1989 Sep;30(1):17-22.
145. Stipanuk MA. *Biochemical and Physiological Aspects of Human Nutrition.* Philadelphia, Pennsylvania: W. B. Saunders Company, 2000.
146. Stubbs M, Rodrigues L, Howe FA, et al. Metabolic consequences of a reversed pH gradient in rat tumours. Cancer Res 1994;54:4011-4016.

147. Szent-Gyorgyi A. Bioelectronics. A Study in Cellular Regulations, Defense, and Cancer. London: Academic Press, 1968.
148. Teicher BA. Hypoxia and drug resistance. Cancer Metastasis Rev 1994;13:139–168.
149. Triozzi PL, Stevens VC. Human chorionic gonadotropin as a target for cancer vaccines [review]. Oncology Rep 1999;6:7–17.
150. Tsong TY. Deciphering the language of cells. Trends in Biochemical Sciences 1989;14:89-92
151. Van der Merwe SA, Van den Berg AP, Kroon BB, et al. Modification of human tumour and normal tissue pH during hyperthermic and normothermic antiblastic regional isolation perfusion for malignant melanoma: a pilot study. Int J Hyperthermia 1993;9:205–217.
152. Van der Zee J, Van der Berg APBroekmeyer-Reurink MP. Temperature and pH during hyperthermic perfusion (meeting abstract). Thirty-seventh Annual Meeting of the Radiation Research Society. Seattle, Washington, 1989 March 18-23: page 105.
153. Van Rinsum J, Smets LA, Van Rooy H, Van Den Eunden DH. Specific inhibition of human natural killer cell-mediated cytotoxicity by sialic acid and sialo-oligosaccharides . Int J Cancer 1986; 38:915-22.
154. Van Winkle LJ. *Biomembrane Transport.* San Diego, California: Academic Press, 1999.
155. Vaupel P, Schlenger K, Knoop C, Hockel M. Oxygenation of human tumors: evaluation of tissue oxygen distribution in breast cancers by computerized O2 tension measurements. Cancer Res 1991;51(12):3316-22.
156. Vodovnik L, Karba R. Treatment of chronic wounds by means of electric and electromagnetic fields. A literature review. Med Bio Engineer Compute 1992; 30:257-266.
157. Volk T, et al. pH in human tumor xenografts: effect of intravenous administration of glucose. Br J Cancer 1993 Sep;68(3):492-500.
158. Von Ardenne M. Principles and concept 1993 of the Systemic Cancer Multistep Therapy (SCMT). Extreme whole-body hyperthermia using the infrared-A technique IRATHERM 2000 -- selective thermosensitisation by hyperglycemia -- circulatory back-up by adapted hyperoxemia. Strahlenther Onkol 1994 Oct;170(10):581-9.
159. Warburg O. The metabolism of tumors. London, England: Constable, 1930.
160. Warburg O. On the origin of cancer cells. Science 1956 Feb;123:309-14.
161. Warren L, Fuhrer JP, Buck CA. Surface glycoproteins of normal and transformed cells: a difference determined by sialic acid and a growth-dependent sialyl transferase. Proc Natl Acad Sci USA 1972;69:1838–1842.
162. Wolfe SL. *Molecular and Cellular Biology.* Belmont, California: Wadsworth Publishing Company, 1993.
163. Webb SD, Sherratt JA, Fish RG. Mathematical modelling of tumour acidity: regulation of intracellular pH. J Theor Biol 1999;196:237-250.
164. Weinhouse S. The Warburg hypothesis fifty years later. Z Krebsforsch Klin Onkol Cancer Res Clin Oncol 1976;87:115–126.

165. Wike-Hooley JL, Haveman J, Reinhold HS. The relevance of tumour pH to the treatment of malignant disease. Radiother Oncol 1984;2:343–366.
166. Wing T. Modern low voltage microcurrent stimulation: A comprehensive overview. Chiropractic Economics 1989;37:265-271.
167. Van Winkle LJ. *Biomembrane Transport.* San Diego, CA: Academic Press, 1995.
168. Yu-Ling X. Indications of the application of electrochemical therapy. In Proceedings of the Fourth International Symposium on Biologically Closed Electric Circuits. Bloomington, MN: International Association for Biologically Closed Electric Circuits in Biomedicine, pgs 52-58, October 26-29, 1997.
169. Yuan J, Glazer PM. Mutagenesis induced by the tumor microenvironment. Mutat Res 1998;400:439–446.
170. Yuan J, Narayanan L, Rockwell S, Glazer PM. Diminished DNA repair and elevated mutagenesis in mammalian cells exposed to hypoxia and low pH. Cancer Res 2000;60:4372–4376.

I hope you will have found this monograph useful and thought provoking. At this time this material is a work in progress and I would appreciate feedback and corrections.

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