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Healing Jnl.1979;2(1).
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The American Revolution in Cellular Biology

By Gar Hildenbrand

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The art and science of medicine throughout the entire modern world is on the edge of a spring-board, about to make a Galilean leap into the future. Cellular biology, which is the root and stem of medicine, will be yanked up and planted over again in fertile soil. There is rising, in medicine, the tide of a great American Revolution in cellular biology which will flood every facet of the biological sciences, eroding the stronghold of international pharmaceutical giants and washing away the credibility of Nobel Prize winning scientist.

The ark of this flood is a Nuclear Magnetic resonance (NMR)* diagnostic machine popularly known as FONAR: **F**ield f**O**casing **N**uclear **M**agnetic **R**esonance. FONAR's futuristic capabilities have been seen only in the television science fiction classic, Star Trek. The ship's physician, "Bones" McCoy, scans the body of a critically ill crewmember, instantly diagnosing bruises, fractures, edema, tumorous growths, schizophrenia-causing chemical changes in the brain, and finally, colonies of an unknown viroid substance in lesions of the nerve sheathes for which "Bones" must create a cure in the ship's lab.

Although NMR uses no nuclear radiation, the "nuclear" in the name gave that impression to many. In the years since this article was written, the name NMR was phased out in favor of MRI (Magnetic Resonance Imaging).

FONAR is to medicine what the telescope was to astronomy, and its creator and inventor, Dr. Raymond Damadian, is confident that it well turn medicine and research upside down. Characterized in the January 6, 1982, Journal of the American Medical Association (JAMA) as the "new wave in medicine", non-toxic FONAR

will replace the controversial CAT scanner and carry with it to scientific acceptance and great respectability the names of Gerson, Sodi-Pallares, Ling, Cope, Hazlewood and their colleagues. It will be the trump card which will force the hand of a scientific community unwilling to accept the work of physiologist Dr. Gilbert N. Ling, who has shown that the commonly accepted model of living forces in the human cell is an impossible model.

The "bible" of the revolution is soon to be published, a book entitled, *In Search of the Physical Basis of Life*, by Ling, whose work inspired, indeed allowed, the invention of FONAR. Gilbert N. Ling may very likely be known by future generations of scientists as the Father of Cellular Biology. He has created the first model (paradigm) of the function of living forces in the cell, and in so doing has challenged the work of every scientist who has used the so-called "sodium pump" model as the first principle in a theory, including scientists who have won the coveted Nobel Prize. Many in the scientific community are actively ignoring Ling's work.

Every great change deserves a prophet who will bellwether the work done by others. This revolution has its prophet in Freeman W. Cope, M.D., a biochemist, researcher, physician and author. He has done more than nay other individual to communicate with readers and listeners the truth of Dr. Ling's work and the great depth of its implications for medicine. Cope has even appeared before the Congress of the United States in an effort to advance this most important cause. He is the man who first called it a revolution.

The Nature of Life

It is understandable that the function of the cell has been so difficult to fathom for it is the very nature of Life itself which eludes our scientists, not merely a set of chemical reactions. It almost requires a sense of the mystical to inquire into the forces which create life, and scientists have attempted perhaps too mechanically to analyze the cell, almost as a tribe of primitives with a newly found radio. We know what it looks like, inside and out, and what it does, although we do not recognize the strange language and music it creates. We have discovered how to manipulate and influence it (turn it on or off, change stations), but we have not succeeded in conceiving how and why it works. It has been totally beyond us, and, as one might imagine, some of the ideas we have conjured up to explain "how" and "why" are purely fantastic.

The British won Nobel Prizes — But not for the "Sodium Pump"

Our cells live in an ocean of salt water (serum) which is very high in sodium and very low in potassium. This salt water passes through each cell at the rate of nearly 100 times the volume of the cell every second. Amazingly, cells themselves contain only 7% as much sodium as the serum, but they have a potassium concentration 342 times greater than that of serum. Researchers had to ask how the cell could gather so much potassium from serum which has a potassium concentration only 3% of that found in the cells. To answer that question, they invented the idea of the "sodium pump" which they suggested might continually pump excess sodium out of the cell

and perhaps carry potassium in.

The major articles in which the concept of the “sodium pump” were set forth occurred in 1941 (1) and 1946 (2), and by 1949 the idea was so popular as a convenient and seemingly practical answer that nobody listened to Ling when he announced that it was impossible. And, even today, few scientists are interested to know that the “sodium pump” is impossible — even though a search of the scientific literature reveals that not one coherent paper has laid out the theory and interpretive value of the “sodium pump” idea. In fact, even third generation advocates of the “sodium pump” at Cambridge University admit that it is not a true scientific theory (3), and it must be kept in mind that the greatest number of Nobel Prizes given for research work based on the truth of the “sodium pump” have been won by scientists at Cambridge. It is sobering to realize, as well, that there has never been a Nobel Prize awarded for work on the “sodium pump” itself, yet many awards have been given work which incorporates it as first principle. Ling has argued persuasively that the “sodium pump” is not a theory or even a hypothesis, but consists of the rephrasing of observations. It has never been identified, it cannot be proved, there are no concrete facts which support its existence, and yet it stands in the way of great progress in research, diagnosis and the practice of medicine.

Debate Refused

Ling and his colleagues have attempted repeatedly to draw the advocates of the “sodium pump” into open debate, but without success. In 1968, the President of the Federation of the American Society of Experimental Biologists suggested an open forum in the form of a closed circuit televised debate. The organizer of the event was Carleton Hazlewood of Baylor University. Six months before the debate was to occur, he invited Ling, who immediately accepted, and many others, including two Nobel Laureates. However, as time for the debate neared, all of the guests except Ling developed other commitments.

Publication Denied

Ling, Cope, Hazlewood and Damadian published continually on the various aspects of the new idea of forces active in the living cell from the mid-sixties when they became aware of one another, and they stirred up great controversy. There was competition, often fierce, and minds clashed over the new idea. Papers were published by “sodium pump” advocates refuting the claims of the small group of scientists. The scientific community was in a turmoil over this issue, and was therefore in a healthy state for the sciences must never become static.

Then the going began to get rough. It became increasingly more difficult for the four to publish, and they endured lengthy arguments from peer review committees who more and more frequently rejected their articles.

Common sense

In a series of articles critical of the “sodium pump”, FreemanW. Cope, M.D., of the Biochemistry Laboratory at the Naval Air Development Centerin Warminster, Pennsylvania, became the Thomas Paine of this revolution. Paine is remembered for

the pamphlet *Common Sense* which inspired many American colonists to rise up against the British.

Cope writes,

In present textbooks of medicine, lengthy explanations of salt and water disturbances in disease are presented that try to explain clinical measurements and why some salt and water therapies are effective and others are not. In fact, present treatments of salt and water disorders in human disease are mostly empirical. Theoretical approaches from physical chemistry have shown themselves to lack predictive value — which is not strange since they have been based on a false model of the cell. (4)

Cope is the primary interpreter of Ling, translating his work from the extremely technical writings of the experimental scientist to the kind of prose most physicians can understand. It is Cope's explanations which make Ling's work accessible to the majority of interested readers in the medical community, where it is likely to have its greatest impact. Each time Cope authors a challenge to the "sodium pump", he details the theories which will replace it (4-6), explaining that in Ling's model of the cell, potassium is held inside by electrostatic forces operating somewhat like magnetism (7). Water in cells is not free liquid, but is "structured" and almost crystalline, more solid than free liquid water but less solid than ice. Cope and Damadian have confirmed the existence of this "structured water" by using Nuclear magnetic Resonance (NMR) measurements. (8-10)

Attacks without Representation

The right to publish is everything to the scientist, bor without that right his work will not live on, and no change can occur. In the early 1970s, that right began to disappear for Ling, Cope, Hazlewood, and Damadian. Frederick Dodge had assumed editorship of the Biophysical Journal, organ of the Biophysical Society of which the four scientists were members (11) and he refused to accept their papers for publication while, at the same time, publishing criticisms of their ideas and unpublished experiments to which he had been privy through their rejected manuscripts.

Dodge, of IBM's Thomas J. Watson Research Center in Yorktown heights, New York City, had made the decision to bar submissions by the "structured water advocates" because, according to him, these papers amounted only to a review of one another's papers.

When scientists cannot publish, prospects for funding are severely limited. Cope decided, in a daring move, to use Representative John B. Conlan's (R-Ariz) Congressional hearings on National Science Foundation funding to do something about the tremendously unfair treatment from Dodge. Cope went before Congress to ask for support for research into the new model of the cell. He explained his research group's difficulties in obtaining grants and in publications. He suggested that the current administrators in the biomedical division of the national Science Foundation be replaced, explaining tersely that the NSF "has been wasting tax money funding research on a scientific hypothesis which has been disproven, and which has not

been and is unlikely ever to be of any practical use to anybody."

The Battle of '76

In response to a worsening situation in the Biophysical Society, Cope wrote a letter to all members of the organization urging that they vote for Carleton Hazlewood, Professor of Physiology and Physiological Chemistry at Baylor University and a distinguished researcher and colleague, for a position on the council of the Society. The intent was to open the ranks of the council.

After much lobbying and backbiting within the Society, a narrow vote went against the small group of militants as Hazlewood was defeated. Immediately thereafter, Cope wrote another letter to the members of the Society calling for Dodge's resignation on the grounds that Dodge's repeated criticisms which were printed in the Biophysical Journal and his refusal to publish articles by Ling, Cope, Damadian and Hazlewood "was a misuse of editorial power by Dr. Dodge to suppress publication of work which threatened his self-esteem, professional reputation and grants — which depend on maintaining the illusion of validity of old concepts of salt and water biophysics upon which the professional reputations of Dr. Dodge and his friends are built."

At the same time, a volley was fired by Gilbert Ling, known by his colleagues as a quiet thorough experimental scientist, not ever given to such demonstrations. Ling wrote a letter to the members of the council of the Society accusing Dodge of censorship.

Declaration of Independence & birth of a new society

As a summation of their response to underhanded politics of the controlling elements of the Biophysical Society, the scientists formed their own independent organization, the International Society for Supramolecular Biology (ISSB). This bold move was greeted by almost polar reactions, some scientists applauding, some bitterly offended, and many unable to see the merit on either side of what appeared to be a highly charged political issue.

With the formation of the new council, Cope wrote a letter of invitation to all members of the Biophysical Society to join ISSB and to use the Journal sponsored by ISSB, Physiological Chemistry and Physics (PCP). PCP, which was printing long before the revolution reached a head, is now used as a forum for all sorts of issues, obviously not excluding those which "clash" with classical ideas. This was the birth of an important new organization, one that may lead the field of medicine and biophysics in the near future.

What are we fighting for

There now exist two basic models of the cell. The old model is essentially a bag of water with proteins dissolved in the solution. In order to explain high cellular levels of potassium, researchers have had to rely on the idea of a pumping mechanism in the wall of the bag (membrane). This mechanism, supposedly able to carry sodium out and potassium into the cell, has been referred to in the literature as a membrane

pump or, popularly, the “sodium pump”. Without it, the bag of water model does not work. Ling has shown the “sodium pump” to be impossible.

In the new model, proposed by Ling and his colleagues, the cell is honeycombed by a fragile, invisible skeleton consisting of a latticework of interwoven protein and lipid (fat or fat-like) molecules. An electron current may flow through part of all of this “skeleton” which functions almost as one gigantic molecule and resembles a ball of wool or a sponge. As shown by nuclear magnetic resonance, water in the pockets of this sponge-like “skeleton” is structured — water molecules nearest the skeleton are in an orderly arrangement while those at a greater distance are more random. As extra cellular fluid diffuses through the cell, rapid exchange of ions occurs. Ion and water concentrations are controlled by the “skeleton” which chooses potassium over sodium. The structuring of water itself controls ion concentrations to some extent in much the same way that water is purified of foreign substances as it freezes to ice.

These two models are obviously incompatible. It is because acceptance of Ling’s model will completely invalidate the old “bag of water” model, and because Ling has made it a scientific point to disprove the old model’s pivotal “sodium pump”, that the scientific community is divided.

Why the old idea seems right

The “sodium pump” was, in some ways, a logical extension of dilute solution theory (12). Researchers knew that there is a strong tendency of soluble molecules to diffuse as ions in water, so that the concentration of salt in sea water, for example, is nearly the same in all parts of the sea. This rather fundamental observation is easily confirmed by lowering a thimble of salt crystals (sodium chloride) slowly into a glass of water, not disturbing or stirring the water. It will be noticed, as time passes, that the water in the glass has a uniformly salty flavor. This is so because ions of sodium and chlorine have diffused throughout the water.

Scientists had found that fluid surrounding the cells (extra cellular fluid) contains a great deal of sodium, and lesser amounts of chloride and bicarbonate ions. Conversely, they found that the fluid inside cells (intracellular fluid) was very high in potassium and also contained significant quantities of magnesium and phosphate ions.

They also observed that the levels of various ions in the extra-cellular fluid change during different phases of cell activity. In order to explain this, scientists deduced that there must be tiny pores in the cellular membrane (13) through which ions pass freely in and out of the cell.

With the movement of ions established, and with the understanding that the cell membrane was full of tiny, ion-sized holes (8 angstroms) researchers were now faced with the question which is central to our revolution: Given the tendency of ions to diffuse equally into all parts of a solution, and holes in the cellular membrane through which ions may easily move, what is normally keeping 97% of the body’s potassium in the cells and 93% of the sodium out?

In 1941, R.B. Dean conjectured that there may be some sort of pumping mechanism (1) which continually pumps sodium out of the cell and pumps potassium in. this "pump" could supposedly push ions against the gradient into solution with an already high concentration, like stuffing another set of clothing into an already overfilled suitcase, or perhaps like pushing a heavy rock uphill, a function which requires energy. August Krogh wrote about the "sodium pump" next, in 1946 (2). After his writing the idea snowballed.

The current version (unproved) of the "sodium pump", which is prominently featured in all textbooks of medical physiology, goes like this: The pump is thought to be a carrier, possibly a chemical or an enzyme or a protein, present in the membrane of the cell. In order to carry potassium into the cell, literally forcing it, the pump must have energy. This energy is thought to come from the enzyme, adenosine triphosphate (ATP), which is known as the "energy currency" or energy storage battery which provides energy for most functions of the body. Because ATP is so plentiful — at least 99% of all carbohydrates utilized by the body go to the manufacture of ATP — it would be the only possible fuel for such an energy-hungry "sodium pump". (14,15)

The "sodium pump" is a very interesting idea, but has the actual mechanism been identified? No. Has the idea led to observation of fact from which to build a proper scientific theory? No. Gilbert Ling cites mathematician Charles Babbage to describe writers of "sodium pump" literature. Babbage, a 19th century scientist, defined three kinds of fraud in science-writing: fabrication, trimming and cooking. Ling thinks authors of the pump idea are primarily guilty of cooking, eg: choosing only those ingredients which will support one's hypothesis and discarding others. Damadian offers this blunt analysis: "The sciences, like a lot of other … activities where the rewards are not monetary but fame and glory, are ego-driven specialties. That's the root of the problem … The thing is that the British scientific community staked itself out on this "sodium pump" foolishness and got a bunch of Nobel prizes and convinced the whole word that it was so when, in fact, it was an off-hand suggestion in one lousy paper by soeone who didn't consider it very seriously<. (16)

The new paradigm

The historian, Thomas Kuhn, described science in terms of paradigms (17) — pervasive frameworks of scientific thoughts. A poor paradigm promotes fragmentation of scientific logic while a good paradigm promotes unity. The "sodium pump" may be said to be a poor paradigm for reasons mentioned previously. Ling's theory — the Association-Induction (A-I) Hypothesis developed in his new book *In search of the physical basis of life* — is a new paradigm. Ling thinks it can easily replace the "pump" idea. He noted, "The incorrect paradigm cannot bear to look at history, because it has no coherence. History, to it, is merely yesterday's newspaper. The coherent theory sees its roots in history and absolutely depends on and is part of history." Ling has found Thomas Huxley's protoplasm concept, -- an idea which has been extinct for fifty years — to be in full harmony with the A-I hypothesis. Huxley used the descriptive words, "physical basis of life". Ling explains "That is why the title (*In search of the physical basis of life)* is another way of phrasing the A-I Hypothesis in its historic perspective and what it portends for the future. How did we become what we are? How does it happen that at the

peak of our accomplishment in the A-I Hypothesis, we have practically become excommunicated? We have practically no audience at this time among the establishment." (18)

Does Ling deserve what he refers to as excommunication? What are his credentials?

Currently with the Department of Molecular Biology at Pennsylvania Hospital in Philadelphia, Ling is one of the nation's most brilliant and impeccable researchers — able to cite, chapter and verse, the scientific literature on salt and water biophysics from the beginning of the century. He came to the U.S. from China where in the 1940s he distinguished himself as a student of Biology, winning the prestigious Boxer Fellowship in Biology. Based on the highest scores for written examinations, Boxer Fellowships are awareded yearly, one for each major field of science. Contestants are drawn openly from the vast population of China and the competitions are intense.

Ling evidenced his considerable talents shortly after his arrival in the U.S. when — still a graduate student at the university of Chicago — he invented the intracellular microelectrode, a devise so tiny and sensitive that it could be inserted into a single cell. This was a formidable achievement for the pre-microcomponent years of the 1940s and the devise is, importantly, still in common usage in the field of microelectrophysiology. That field is now large enough to support several thousand researchers and generates hundreds of papers each year in the U.S. alone.

Far ahead of the rest of the field, Ling had recognized inconsistencies with the already popular "sodium pump" idea by 1949, and had published critically on that idea by 1952 (19,20). His work was largely ignored. In the course of his experimentation to discover a process which could explain high cellular concentrations of potassium, Ling worked out a procedure which kept muscle alive in vitro (in glass) for a week(!) — maintaining electrical potentials in the cells, all normal functions, and the muscle's ability to contract. This procedure, which is now in common usage, was another first for Ling.

The "sodium pump" was widely thought to be fueled by adenosine triphosphate (ATP) (the only possible source of energy for such a pump). In the early 50s Ling inactivated all energy systems in the cells, including ATP, by poisoning them. In spite of the resulting lack of energy in any form, cells maintained high level of potassium for many hours, with ions of sodium and potassium passing freely in and out of the cells. Ling calculated that a pump operating under these conditions — even a 100% efficient pump — would require from 15 to 30 times the energy available. Thus, the "sodium pump" violated a basic law of physics — the Law of the conservation of Energy — by requiring more energy than was available in the system. (21-23)

Through slow and careful experimentation, Ling deduced the principles of his new theory and developed the Association-Induction (A-I) Hypothesis. He had created what Cope calls "an elegant model of the cell, incorporating the ideas that (a) cell water is structured (b) cell cations are associated mostly with macromolecules and (c) cation pumps do not exist." (6)

Ling decided that the potassium in cells gathers at negatively charged association sites along macromolecules of proteins and lipids (fat or fat-like substances). (7.23.24) Once the potassium atoms are in place, a force of attraction causes water molecules to lineup — their oxygen atoms facing one direction and their hydrogen atoms the other — around the protein/lipid macromolecules. This produces a layer of structured water. By "structured" it is meant that the water molecules are not free or random but exhibit an orderly arrangement as in ice crystals — although cellular structured water is much less solid than ice. (5,6)

Around the initial layer of highly structured water molecules is a second layer, which is less structured because it is farther from the attractive force of the protein/lipid macromolecules. The third layer is less structured than the second, and so on. It is not known exactly how many layers of structured water molecules there are. Water molecules most distant from the macromolecules are most random and most like free liquid water, although even this water is probably somewhat structured.

The protein/lipid macromolecules are interwoven in a latticework which extends throughout the cell to form a skeleton-like structure resembling a sponge. This skeleton itself controls ion concentrations by choosing potassium over other ions and by structuring water. Water which is structured will not readily accept ions or foreign materials. Although much sodium laden extracellular serum diffuses throughout the cell and ions are exchanged between the cell and serum, no energy is required in the form of ATP to maintain high cellular levels of potassium and other ions. In theory, the cell could hold these high concentrations forever without using energy. Only when cells are damaged by trauma or poison do they require energy from ATP. (22,23,25).

Ling solidified this model and in 1962 published the detailed book *A physical Theory of the Living State, the Association-Induction hypothesis.* (7) shortly after the book was published, Cope and Damadian became involved showing with NMR (Nuclear magnetic Resonance) measurements that cell water is not free liquid, but structured, like the ion-exchange resins of a water softener (7,23,26-33).

The introduction to *A Physical Theory of the Living State* was written by Ling's former college roommate and close friend, Chen ning Yang. Yang came to the U.S. with Ling after winning the Boxer Fellowship in Physics the year Ling won in Biology. Yang received the Nobel Prize in Physics in 1957 and is considered one of the worlds foremonst authorities on cooperative phenomena. He was fascinated by Ling's A-I Hypothesis, which was accessible to him through his own work with the Ising model of magnetism. The Ising model forms the basis of modern physics theory of phase transitions (the familiar examples are condensation of steam into water and the freezing of water into ice) and, more generally, of cooperative phenomena. Yang — currently the Einstein Professor of Physics and Director of the Institute of Theoretical Physics of the State University of New York at Stony Brook — worked with Ling to further develop one aspect of the A-I Hypothesis, the idea of near neighbor interaction (cooperativity). Together, they applied the one dimensional Ising model to the biological polymer and, as Ling said, "We have been using that to describe quantitatively the behavior of in vitro (in glass) and in vivo

(living) systems with considerable success." (34)

Science is like a tree

Does isolation from the establishment bother Ling?

Not really, he says, "Those people who are still interested in what we have been pursuing are special kind of people, and fortunately, you don't need that many."

Ling agrees that the sciences have become over-crowded,

Really, we have too many scientists as of this moment … too many people. They will be eventually useful, like genetic engineers and so on, but we haven't reached that stage. The very large mass of people is singularly unsuited to deal with science in the real sense. Forces have become involved which have very little knowledge of what science is.

Science is … like a tree. You can only rush the growth of the tree so much. You have to be an extremely good, capable botanist to make the tree grow faster without destroying its qualities. Yet, what we have been trying to do is hasten the sciences. First we assume that science is all the same and if we put money in we'll get results out, and that is simply not true. In the meanwhile, the business of research has become like any other business. It prospers by the usual routes, forgetting more and more what it is about.

In its rush to get on with things, the scientific community has brushed past Ling and many others. But the day will come soon when it has to backtrack and return to true science.

Implications for medicine

Freeman Cope, M.D., came into the study of structured water in living cells from his extensive work in solid state physics. (33) He has combined his training in medicine and physics to look into the future of medicine and physics to look into the future of medicine from the vantage point of Ling's monumental Association-Induction (A-I) Hypothesis. From the same vantage point he looked into the past, to the work of a medical pioneer from Germany, Dr. Max Gerson. (35,36) Cope's interest in the possible crossover to biological systems of solid state physics led him to read Ling's first book. (7) Shortly after reading it, he contacted Ling to question him. Cope knew that biochemistry was based on the behavior of ions in dilute solution. Small molecules are known to float around in solution, bumping into each other at random and sometimes reacting as they bump. However, Cope had reasoned, things happen differently when large clumps of molecules are present because different forces are active. (30,31) He was excited to see, in Ling's work, a logic which related some of these basic concepts. Becoming much more familiar with Ling's theoretical model of the forces in cells, Cope deliberately tested the mode. Using NMR measurements, he verified the type of water-structuring Ling had described. (21,30)

Cope continued to follow Ling's work, and was eventually inspired to make a prediction of the medical applicability of some treatments suggested by that

research. He predicted that large amounts of potassium could be added to a low sodium diet to the benefit of patients suffering from many disease, and certainly heart disease (Gerson had applied this thinking in cancer and other disease. Sodi-Pallares had done the same in heart disease. Cope was unaware of their work at the time of his prediction).

What Dr. Cope saw — Tissue Damage Syndrome.

In many degenerative processes, cells are swollen with water and sodium. (38) they have lost potassium and no longer function normally. Healthy cells maintain high levels of potassium (K+) as long as they suffer no chemical or physical damage and have sufficient ATP. ATP is used to keep the cell protein in its normal configuration and, in fact, is part of that normal configuration. For every molecule of ATP which joins with a cell protein macromolecule, approximately 20 association sites are formed (24) which exhibit a strong preference for K+. (23,39-42) With a high concentration of K+, the cell's water is structured, some of it (20%) highly structured and all of it more structured than free liquid water. (26,27) this enables the cell to refuse sodium, which cannot dissolve in the structured water.

Writing in Physiological Chemistry and Physics, (4) Dr. Cope suggests,

When cell cation association and cell water structuring are disturbed by damage of any kind, it is probable that the production of ATP by mitochondria (tiny energy factories of the cell) will be adversely affected, which will decrease ATP concentration, which will intensify the disturbances in cation association and water structuring, which will further impair mitochondrial ATP production, and so on, in a cycle of destruction.

Cope calls this "cycle of destruction" the **Tissue Damage Syndrome.** It is capable, he says, of affecting tissues anywhere in the body. Without sufficient ATP, a damaged cell will not be able to return its proteins to the normal configuration, and it will be unable to structure water. Cope writes, "In the damaged configurational state, the cell proteins lose their preference for association with K+ rather than Na+, and the water content of the cell increases (the cell swells)." (38)

Cope has also written that the extent of the damage to the cell proteins and the length of time the mitochondria are exposed to the unfavorable salt and water environment are decisive. In the extreme, the damage to the cell will be irreversible because of damage to the ATP-producing mitochondria. But, in the short run, if the extent of the disturbance to the cell proteins is not too great, Cope predicts, "the configurational state of the proteins and also the induced changes of cation association and water structure are reversible. Medical treatment may therefore partly or completely correct the tissue damage syndrome if it is not too severe or has not existed for too long a time."

The tissue damage syndrome is something more and more physicians will come to identify in their patients in the future as the ideas of water structuring and ion-association are ushered in by the use of Damadian's FONAR diagnostics. (43,44) cope postulates, "the (tissue damage) syndrome is likely to be observed in varying degrees in all disease conditions producing tissue damage, mild or severe, acute or

chronic, and arising from any cause. Examples, probably include acute myocardial infarction and chronic hypoxia of the tissues due to chronic heart failure."

A Medical Prediction

By 1976 Ling's careful experimentation had given Cope the fuel he needed to make a successful medical prediction that potassium (K+) could be given in addition to a low-sodium (Na+) diet to correct the tissue damage syndrome:

In the damaged cell, the proteins lose all or part of the preference of their sites for association with K+ rather than Na+. Nevertheless, a competition between K+ and Na+ for these sites still exists. Therefore, if in the environment around the cell the concentration of K+ is increased compared to Na+, the association sites are forced to accept more K+ and less Na+ because of the cooperative interactions between association sites. This tends to restore the normal configuration of the proteins. It follows that treatments to increase tissue K+ concentrations and/or to decrease tissue Na+ concentrations are a logical therapy for the tissue damage syndrome.

Low sodium therapies are widely used and highly effective in acute and chronic heart disease. Methods of treatment include low sodium diets and diuretics to remove sodium already present in the body. Reasons given in textbooks for the observed effectiveness of low sodium therapies are generally superficial and ambiguous. Yet in acute cardiac damage, there is an obvious tissue damage syndrome in the heart. In chronic heart failure, there is probable chronic mild tissue damage syndrome in all tissues due to chronic hypoxia due to inadequate blood flow. Therefore low sodium therapy is a logical approach to both conditions in the light of modern theory.

High potassium therapy either alone or together with low sodium therapy is also a logical method for treatment for the tissue damage syndrome, but has seen little clinical use.

Only six months after making this prediction, Cope found that the ideas had already been broadly applied successfully in the clinic, by Dr. Max Gerson of New York. And within six months of that discovery, Cope found that the ideas had been successfully used in acute myocardial infarction by Dr. Demetrio Sodi-Pallares of Mexico City. (39-41)

The coherent theory sees its roots in history

Cope found in Max Gerson this century's pioneer in low sodium-high potassium therapy. Gerson received his medical training in his native Germany at the turn of the century. His successful yet controversial treatmentof skin, lung and bone tuberculosis was based on a low sodium diet. (48) This diet became the cornerstone of the treatment which Gerson was to later apply successfully to cancer. (49)

Dr. Erich Urbach, a distinguished pioneer dermatologist in the United States, wrote glowingly of Gerson;s successes with tuberculosis in the 1946 text Skin Disease, Nutrition and Metabolism (50):

Much credit is unquestionably due Gerson, as well as Sauerbruch and Herrmannsdorfer, for valuable contributions to the therapy of cutaneous (skin) tuberculosis in the form of diets which bear their names. Although over a hundred years ago Struwe advocated a salt-poor diet for the treatment of tuberculosis, it was Gerson who really introduced dietotherapy for cutaneous (skin) tuberculosis and who methodically studied the clinical course of the disease under the salt-poor, high vitamin dietary he had planned.

This dietary therapy for cutaneous tuberculosis has been extensively tested and approved by the majority of authors (Jesionek, Jesionek and Bernhardt, Bommer, Volk, Wichmann, Jadassohn, Stuempke and Mohrmann, Brunsgaard, Scolari, Dundas-Grant, Stokes, and others). Particularly noteworthy are the investigations which Jacobson and Brill and Gawalowski carried out over a number of years on extensive material. The Russian authors treated 124 patients who were under observation for five years, while the Czechoslovak investigator followed 127 cases. Both groups showed marked improvement.

Gerson did not add additional potassium — which Cope predicted to be valuable — until he became involved in the treatment of cancer. Gerson struggled with the question of the importance of potassium, trying to reconcile his own extensive clinical observations, with the available literature (49):

In a recent article, Barnell and Scribener (51) came to the conclusion that serum potassium (K) concentration can be used as an excellent guide to potassium need. My experiences in a advanced cancer cases and some in chronic diseases contradict these findings. The serum is only a passage channel for support and exchange. Low K-figures may show best healing because the depleted tissues reabsorb K, while high figures may be found in failures because the tissues lose K.

Indeed, it is a simple extrapolation which suggests that cells damaged by tumor toxins might lose the ability to structure water, thereby losing potassium and absorbing sodium and water. The net effect this would have on serum would be the elevation of serum potassium and a drop in serum sodium. This might, unfortunately, prompt the treating physician to administer sodium chloride and prohibit potassium in an effort to cause the serum readings to return to normal. The additional sodium could only make matters worse.

Gerson described the process and literature which led him to administer very large quantities of potassium (K+) to advanced cancer patients:

The decision to apply large K+-doses in a compatible composition immediately (at the beginning of treatment) was finally made after about six years of indecisive clinical experiments, until I saw regularly better and more extensive clinical progress. The laboratory reports about K+ were fluctuating and not in conformity with the clinical picture. The literature presented a different viewpoint; there, almost all tables except the articles of Moravek (52,53) showed an undiminished K+-content in cancer tissues. He found diminished K+ in the beginning and later uncertain ups and downs. The situation was cleared up when Lasnitzki (54) found the ionized K41 “diminished in cancers”. The leading cancer specialists still rely on

the laboratory work in their decision.

Gerson's treatment produced documented successes. Cope wrote (55):

The Gerson cancer therapy is an integrated set of medical treatments which has cured many advanced cases of cancer in man. It was developed empirically by Gerson in the course of 30 years of clinical experimentation. Essentially, he tried many variations and combinations of treatments on cancer patients, always retaining that which was successful and discarding that which was not. Gradually he evolved an integrated pattern of treatment which cured many cases of advanced cancer, 50 of which are described in clinical detail in his book.

Calling the Gerson cancer therapy a logical application of the Ling Association-Induction Hypothesis, Cope wrote:

The high K+, low Na+ diet of the Gerson cancer therapy is a logical strategy for improving the health of the body tissues, of which probably all and certainly the liver are suffering from the tissue damage syndrome, some components of which were observed and recognized by Gerson … Treatment with the Gerson diet to increase tissue K+ concentration and to decrease tissue Na+ concentration is a logical therapy for the tissue damage syndrome in the cancer patient.

In the article entitled, "Pathology of structured water and associated cations in cells (the Tissue Damage Syndrome) and its medical treatment" (4), Cope offered the following table to illustrate changes in tissue content of sodium and water when the tissue became damaged:

	State of Muscle	
	Normal (mM)	*Poisoned (nM)*
Potassium (mM)	105	6
Sodium (nM)	20	120
Percent of Normal Water content	100%	121%

In addition, Dr. Damadian, who has catalogued many nuclear magnetic resonance measurements of cancers, suggests that the water content of a cancer cell may be even higher than that of damaged tissue, much higher. The normal cell is approximately 66% water and 34% other substances. Cancer cells, which tend to be large in comparison with normal cells, are as much as 90% water with greatly elevated sodium levels. (16)

FONAR measurements have shown that both tumors and developing tissues have a high sodium and water content. Cancer cells, which are low in potassium, have lost their ability to structure water. They are swollen, the membranes stretched taut. Research has shown that a high potassium, low sodium environment is unfavorable for tumor activity. (56,49) tumor tissue may said to be like embryonic tissue gone wild, not subject to control. Sodium and potassium NMR readings are alike in embryos and tumors, as shown first by Damadian.

Sodium causes cancer cell mitosis (division)

Interestingly, a possible rationale for the Gerson cancer therapy comes from outside the ranks of the revolutionaries, and itk too, concerns itself with cellular ion concentrations. It has been suggested by William Regelson, M.D., -- of the college of Medicine at the commonwealth University of Virginia in Richmond — that Gerson's cancer therapy possibly achieved its clinical results as "an approach that altered the mitotic regulating effect of intracellular sodium." (57) Regelson, Medical Director of the Fund for Integrative Biomedical Research, based his comment on the work of Clarence Donald Cone, a physiologist who has generated substantial experimental data concerning changes in potassium and sodium levels in cancer cells.

Cone has confirmed that the elevated sodium content of cancer cells forces them to continually divide and produce tumors. (56, 58-60) By altering ion levels inside and outside the cells, he has experimentally stopped cancer cell division, and in some cases produced swelling and rupture. Cone is now involved in extensive human trials to validate methods derived from his research with animals.

Although Gerson's highly innovative and controversial treatment has been listed for years by the American Cancer Society as an unproven method, Dr. Regelson has recommended another look at the approach on the strength of Cone's evidence.

If Gerson had known Ling

There are pockets of acceptance for Gerson's ideas and understanding of his results in cancer, but nowhere is the support as unqualified as in the small group of cell biology revolutionaries — for in Gerson's work they see their historical roots. Gerson's incisive reasoning was surprisingly close to home:

Generalizations in cancer are most difficult to formulate. In my opinion, the area wherein they may be possible will be in the biological field of electrical potentials, ionization of minerals and reactivation of enzymes. (49)

Gerson's final years of clinical practice took place during Ling's first years of testing the Association-Induction Hypothesis. Gerson had been combing the literature in search of something, anything, to confirm and offer a rationale for his clinical success. He had written, "we now know that what we have inherited is not a set of chemical substances, but a pattern of dynamic energies." If he had seen Ling's work, he would have recognized it immediately, but the two were destined never to meet. Perhaps, if either Gerson or Ling had been allowed uncensored publication in scientific journals that need not have been the case.

One for the heart

A more fortunate timeline has connected Ling with one of the most innovative cardiologists in the world. Six months after discovering the work of Gerson, Cope was surprised to find that "Sodi-Pallares and co-workers (46,47,61-65) in Mexico have for many years been using high potassium in diet and intravenous fluids together with low sodium for successful therapy of both chronic heart failure and

acute myocardial infarction. Dr. Sodi-Pallares is one of the most widely respected cardiologists of Latin America." (66)

Indeed, Dr. Demetrio Sodi-Pallaris career has been illustrious. A past president of Mexico's National Academy of Medicine, an organization analogous to the American Medical Association, he is author of over 300 scientific publications, more than a dozen of them books. He is recipient of a formidable collection of degrees, honorary degrees, and memberships in many professional organizations around the world.

Sodi-Pallares, in his 1976 book *Ischaemic Heart Disease and Polarizing Treatment — New Metabolic and Thermodynamic Bases* (65) cites the work of Hans Selye as showing potassium salts to have a protective effect in the heart under conditions which would have otherwise produced cardiac degeneration. (67,68) His decision to use a low sodium, high potassium diet in heart disease resulted from a very personal experience as his own mother suffered from the condition. Reasoning that diuretics were intended to lower sodium in the heart patient, Sodi-Pallares set about to construct for her a very low sodium diet which proved successful. Through years of clinical observations and research, he arrived at the conclusion, "Angina pectoris and myocardial infarction are not conditions that derive from coronary disease. They originate from changes in the metabolism of myocardial fibres which begin with a thermodynamic disturbance many years before the coronary arteries are affected." (65)

The "disturbances" he describes are very much in accord with Cope's description of the tissue damage syndrome. According to Sodi-Pallares, "The consequences of these thermodynamic changes are immediate. They include sodium retention, potassium loss and increase of lactic acid at myocardial fibre level; concentrations of blood cholesterol and triglycerides increase (hyperlipidaemias) and, later on, there is coronary damage. This explains the poor results of (standard) treatment and preventive measures in the so-called Coronary Disease." (65)

Sodi-Pallares gives a diet strikingly low in sodium to acute heart disease patients. No other practitioner, surely, has come close to these phenomenally low sodium levels in any sodium restricted diet for blood pressure or any other disease. He recommends a total daily intake of only 300-360 milligrams, which is less than the patient normally excretes in the urine. He insures adequate urine flow and sodium excretion by insisting on ample fluid intake. The diet is given in the presence of heart failure, recent myocardial infarction, severe angina pectoris, severe ventricular arrhythmias and hypertension with diastolic figures above 110. In less severe conditions or as patients respond, the diet may be relaxed to include 500-1000 milligrams of sodium. In recovered cases this figure may be raised to the maximum of 1500 milligrams, which is reduced with return of any symptoms. Even at the highest levels allowed, his patients receive only from 2% to, at the outside, a whopping 6% of what the U.S. National Academy of Sciences estimated to be the average American's daily intake.

In severe cases, Sodi-Pallares uses what he calls "polarizing solutions," his own idea, inspired in part by work for which he has expressed gratitude to French scientist, Henri Laborit. (69) He writes, "The Polarizing Treatment is also essentially

dynamic and sufficiently flexible to allow inclusion of all the other measures and medications which protect the myocardial fibres. The Polarizing Treatment originated with the hyposodium and hyperpotassium diets (polarizing diet) which are still its cornerstone; the polarizing solutions came later, reducing the infarction size and — when prescribed correctly and with the proper diet — replacing with great advantage digitalis and diuretics … Polarizing solutions with glucose, potassium and insulin (GKI) … increase ATP formulation. (70,71)

Sodi-Pallares says the new treatment removes pain by correcting the underlying problem — unlike coronary by-pass surgery which often relieves pain at the expense of structural damage. "It controls the contractile failure of the myocardium, improving ATP production, without driving the heart (digitalis), and without worsening an already handicapped metabolism (diuretics)."

One might infer that the increased production of ATP — as seen in heart patients using the Polarizing Treatment — is due to increased potassium concentration in damaged cells correcting abnormal sodium and water content to allow water structuring, thus permitting the mitochondria to produce ATP normally. When Cope became aware of Sodi-Pallares's work, he wrote him a letter immediately, describing the findings of Ling, Damadian, Cope, Hazlewood, et al. (72) Sodi-Pallares responded enthusiastically, inviting participation in a symposium in Mexico City, which Ling attended. The newly united scientists are making up for lost time with Sodi-Pallares requesting a paper from Ling to be translated into Spanish and French. Both authors are writing new major texts, each making prominent mention of the other's work.

Sodi-Pallares presented results in 1969 to the New York Academy of Sciences (73) and has published widely in U.S. medical journals. His work promises a major breakthrough in treatment of cardiac disorders, and his assertions are very optimistic:

A low sodium and high potassium diet gives electrocardiographic and clinical results which are far better than those produced by a low cholesterol diet. Sodium restriction is particularly beneficial for anginal and hypertensive patients and patients with heart failure. [The now famous *Dietary Goals for the United States* by the McGovern Commission's Select Committee on Nutrition and Human Needs reported, "Drs. Meneely and Battarbee (authors of *Present Knowledge in Nutrition*, 1976), who also describe salt as 'noxious *per se*', report observations of possible connections between high sodium intake and heart disease. Researchers have found that increases in sodium from 4 grams to 24 grams a day in humans altered the ability to clear intravenously administered fat from the bloodstream." (74)]

Possibly the most far-reaching reaction to correct treatment of salt and water disorders — and possibly the greatest resistance — will be seen in the world's pharmaceutical manufacturing industry. Sodi-Pallares has written, "The doctor must also refrain from prescribing medication with entropic or depolarizing effects except in well defined circumstances and, even here, he must try to avoid the depolarizing and entropic effects of these medicaments (75,76) … The majority of the medicines we use in cardiology are capable of producing undesirable side-effects and may depolarize the myocardium and it is for this reason that we have removed from our

armamentarium many of them such as: diuretics (77,78) … digitalis (79-82) .. antiarrhythmics…" (64) These drugs are big business items and there can be no doubt that pharmaceutical industries would feel deeply any substantial reduction in their use by physicians who wrote 23 million prescriptions for digitalis in 1980 in the U.S. alone, one brand of which, Lanoxin, is the number 7 best selling drug in the U.S. (84)

These cardiac preparations may represent only the ground floor of the skyscraper according to Gerson, a keen observer of vast clinical experience, who raised three key points concerning administration of drugs to patients receiving the low sodium diet he constructed. Writing in his 1934 book *Diattherapie der Lungentuberkulose* (Diet Therapy for Lung tuberculosis), he suggested 1) minute doses of drugs may be effective 2) at the same time even tiny doses of drugs might be harmful, and 3) drugs which have not previously worked may be useful in this context. Gerson wrote, "It very quickly became evident that the inability of the patient to tolerate drugs increases with the length of time on the diet therapy. So that, in many cases 1/5 and perhaps even smaller fractions of the usual recommended doses of these treatments can be damaging, regardless of whether they are ultraviolet, X-ray, gold, tuberculin, morphine derivatives, or salicylic acid (aspirin). This side effect of the diet therapy promises the future likelihood of promoting healing with very minute quantities of even drugs which, when prescribed with a normal diet and in high doses, do not obtain results. On these grounds, this book cannot overemphasize and must warn that at the present time our experiences are such that ever-so-small doses of medications or other therapies may not be so harmless. Attempts to combine drugs and other modalities with the Gerson Diet can have very negative results." (48)

Gerson's observations are echoed by Sodi-Pallares, "We rarely prescribe diuretics nowadays since the diet has shown that they are unnecessary in the great majority of cases. The same can be said of beta-blockers, steroids, and other drugs: the low sodium and high potassium diet considerably reduces the doses of these medications while maintaining their efficiency and avoiding complications of their administration." (65)

While he avoids their use in most patients, Sodi-Pallares has found that doses of defibrillating drugs reduced in the fashion of Gerson are effective. He writes, "If a patient requires digitalis to control his heart or a fast ventricular rhythm produced by atrial fibrillation, the polarizing diet reduces the effective dose of digitalis to one-third or one-fourth of the dose needed without the diet — even though the diet was not specifically indicated for this condition." (65)

It may likely be of extraordinary significance to the manufacturers of diuretics — very popular drugs — that so simple an approach is as effective as those drugs and without side effects. The most frequently treated disease in the U.S. is hypertension, commonly treated with diuretics which Sodi-Pallares feels are harmful: "After a long period of observing the effect that the diet has in maintaining equilibrium in very advanced cardiovascular conditions — particularly on the size of the heart — we were convinced that the progress of the disease and the ever-increasing cardiac enlargement are mainly due to the iatrogenic (doctor caused) effect of the medicines used. These alter the patient's metabolic-thermodynamic condition perhaps even

more than the disease itself."

The Future: "Beam me up, Scotty"

One can't help but get the feeling that he is being "beamed up" and aboard Star Trek's hyper-space-age ship as he speaks to Raymond Damadian about the incredible capabilities of a machine named GED 80 — for the Latin, "*Quod Erat Demonstrandum*," or "That which was demonstrated for the 80s". Although Damadian is not the captain of a star ship, he is the president of FONAR Corporation which is manufacturing QED 80, the only currently available NMR (nuclear magnetic resonance) diagnostic device which can scan the entire body.

Working in the lab of A.K. Solomon who is widely cited for work and writings on the "sodium pump" and related theories (14,15), Damadian became aware through a series of events that the "pump" idea was not going to work out (85-87). He began to look in directions which led him to Ling, whose A-I Hypothesis immediately made sense. Damadian visited Ling in Philadelphia to learn more of this new and compelling theory of ion-association and water structuring. Subsequently — working independently and having been greatly influenced by Ling — Damadian developed his own model of the cell as an ion-exchange resin granule, a concept which Ling had considered by discarded. (85,86,87) In Damadian's Ion-Exchange Resin Theory, cellular ions are accumulated and selected much the way they are in an ion exchange resin bead, by attachment of the ions to fixed charges of opposite sign anchored to the matrix of the bead. Water selects one ion over another. Contractile proteins (29) within the cell, fueled by metabolism, control cellular water content.

Damadian worked with Cope to confirm cell water structuring by NMR and did additional experiments independently (88,90,91) satisfying himself that water structuring occurred. He also gathered significant data concerning differences in water structuring from one type of tissue to another. Then he made a conceptual leap which would make him famous. He reasoned that malignant cells — because of known differences from normal cells — would have water structuring distinguishable from normal cells and their NMR readings would be different. And he proved it. (43)

Other researchers have followed his lead (92-99) and have confirmed the delectability of cancers with NMR. While not all researchers have the frame of reference shared by Ling, Cope, Hazlewood and Damadian, it is commonly accepted that the water in cancer cells is considerably less structured than in normal cells. It is now accepted that these cells contain abnormally high levels of water and sodium.

Damadian moved swiftly to develop and patent the NMR whole body diagnostic technique which he calls FONAR (100,101) and he is currently the unquestioned leader in the field with a several year jump on competitors who are scrambling to catch up. (102-104) Although other machines have been introduced by competitors, FONAR's AED 80 is unique. Its dual-mode scanner is capable of imaging a detailed, high resolution picture of a cross section of any part of the patient's body on a computer television screen. Competitors also have scanners which can image. However, the QED 80s dual-mode scanner is able to perform direct quantitative

tissue chemistries — and no one else has a machine that can do that. (105) It is this capability to do tissue chemical analyses — without removing tissue from the body — that promises to transform medicine into a genuinely quantitative science.

FONAR and other NMR diagnostic machines in the works are able to measure the cell's ability to structure water, and in so doing are able to see things that the four year old, highly controversial full body CAT scanner misses. NMR — which uses no harmful X-rays — was reported by a four institution team to have detected nearly 700% more multiple sclerosis lesions than the CAT scanner (103) — which uses X-rays to measure tissue density. NMR has also detected tumors so small they were missed by radionuclide scan. It is more sesitive than either radionuclide scan or ultrasound in identifying cirrhosis of the liver. (103)

Replacing computerized axial tomography (CAT or CT Scans)

It has been predicted that the NMR scanners will replace CAT scanners (103) which have not shown themselves to be useful enough to routinely expose patients to the cost and the risk. (106) While the CAT scanner can show tissue abnormalities, it cannot see changes in the chemistry of those tissues. Luis Todd, of the University of Nuevo Leon in Monterrey, Mexico, has reported that the FONAR machine he uses has demonstrated a chemistry analysis capability to differentiate between manic depressive patients and those with similar symptoms but different illnesses. (107)

On a historical note of comparison, Technology Review magazine, July, 1981, reported: "Dr. Ronald Ross, a Cleveland radiologist and director of his own $4-million diagnosis center, is the only American physician so far to acquire an NMR scanner unit [a FONAR QED 80] … Since NMR is still experimental, Dr. Ross does not charge patients for scans but considers his outlay an 'investment for the future'. (Dr. Ross has an instinct for these things — he was the first private physician to purchase a whole-body CT scanner in 1978 and has since performed 5,000 scans yearly." (102) Ross reported NMR screenings of human breasts — "difficult to evaluate clinically because it normally contains so many cysts and lumps of fibrous materials" — showed abnormalities not uncovered by other tests such as mammography or CT. NMR avoids the necessity in such cases of the removal and biopsy of actual breast tissue.

Unlike the CAT scanner, the NMR scanner is safe — with one possible exception. According to Peter L. Davis, M.D., Assistant Professor of Radiology at the University of California School of Medicine, San Francisco, "We have detected one definite hazard of the NMR imaging system: to your credit rating. People walking by our imager have had the magnetic field creep into their wallet and erase the magnetic strip on the back of their credit cards and bank withdrawal cards." (103) Aside from this complaint, however, no significant risks can be cited which warrant investigation. The U.S. Food and Drug Administration has produced guidelines, all of which have been easily met by FONAR. QED 80s have been placed in Italy and Japan in addition to the ones in the U.S. and Mexico. (105)

We need an interpreter

Pointing to the great strength of NMR, A. Everette James, Jr., M.D., J.D., Chairman

of the Department of Radiology and Radiological Sciences at Vanderbilt University School of Medicine, Nashville, suggests, "… logically, preceding structural change, there has to be a functional change involving fairly complex chemistry. At the very least, NMR offers us what probably will be an opportunity to evaluate this derranged chemistry." (103) And this is exactly to the point. This is the area in which the revolution of cellular biology will be won, for NMR will show us what is happening to the chemistry of the tissues themselves.

It is difficult to imagine, but "sodium pump" advocates have answers even for the vast data being generated by NMR the world over. Only 1% of cell water, they insist is structured … very highly structured, and the rest is not, not even a little bit. According to Science magazine, "Many investigators, including advocates of pumps, agree that cell water may have some ordered structure that makes it different from liquid water. Water molecules are known to line up against charged surfaces of macromolecules, and NMR relaxation times of water molecules in cells are different from those of liquid water. These relaxation times provide a measure of the environment of water molecules and, specifically, how much freedom of motion they have. Most investigators, then, no not question that cell water is likely to be structured but ask to what extent it is structured and what the physiological importance of this structure is." (11)

It is a common tactic of the research community to publish critical doubletalk such as that appearing in the Science article:

As I have previously pointed out (12,108), the pump view evolves directly from dilute solution theory. In Kolata's article (11) we are told that "many investigators, including advocates of pumps, agree that cell water may have some ordered structure that makes it different from liquid water." If this is so, then the proponents of pumps are stating that the fundamental premise (that is, dilute solution theory) that gave rise to their concept is incorrect. (109)

While some members of the revolution feel that victory may still be far off, Damadian is more optimistic:

I think that it is going to go fairly rapidly because of my machine. What is going to happen when these machines get into use is, the physicians are going to have to interpret the data. And, they're going to have to interpret the data according to the ion-association model because the other [the "sodium pump"] is just a useless morass. (16)

Ling knows he is correct, "This polarized water is not a fantasy. We can actually create a condition and make this water, and with the components which are present in all cells." (34) His case is airtight. NMR is only one of a number of approaches which can be used to verify the cellular structure Ling has so carefully labored to understand.

Damadian's confidence is bracing,

How much longer can scientists endure a theory in the interpretation of their experiments that leads nowhere? When there is a theory at hand that easily interprets

old experiments and forecasts new ones, such as the “nuclear resonance effect in cancer”, with prophetic accuracy, it does not seem as though the end of the pump theory can be far off. Good scientists do not knowingly toil in vain.”(109) He humorously adds, “Even should the end of the pump come, all is not lost for its supporters. It will not pass unceremoniously into obscurity. It has made its mark in history as a concept that ranks with the geocentric solar system and the ether medium of light transmission as a type of latter-day phlogiston.

The Earth is not the center of the universe

Although it seems silly to us now that not so long ago the Earth was considered to be the center of the universe, an astronomer named Copernicus ruined his career by challenging this “geocentric solar system” idea. But even more incredibly nearly sixty years later Galileo — inventor of the telescope and an advocate of Copernicus’s conviction that the Sun was the center of the solar system — ruined his career, too. And Galileo had proof of the ideas of Copernicus in the telescope. Those ideas could be observed, measured and confirmed by using this new and incredibly useful instrument.

But, at this point, Galileo bumped into a wall of scientific vested interests — professors who had been teaching and writing about the geocentric universe. The learned professors pretended not to know about the telescope, or refused to look through it, or lied about what they saw when they did look. And they prosecuted Galileo for heresy.

Dr. Ling is forgiving in nature. He explains that there is no real villain, “they are all nice people.” Perhaps Copernicus understood opposition to the sun-centered universe in somewhat the same way.

And what about Damadian, our “Galileo”? In summary, he says,

I think the real reason for the delay in acceptance is that most of the people doing this kind of work are biologists. The kind of stuff we’re talking about gets into the depths of physical chemistry. Now, an old-line organic chemist or an organic biochemist who’s not a terribly quantitative fellow — if he attempts to follow the trail — instantly runs into this quantitative barrier that he’s completely unfamiliar with. Whereas the concept of the “sodium pump” is sort of qualitative and vitalistic, it doesn’t force him to confront the complexities of physical chemistry which are a little bit pithy. He just veers away from it and says it’s nonsense and says it’s the sodium pump and doesn’t deal with the other things.

The opposition is the whole establishment

Damadian continues, “And ‘he’ is the whole establishment. He’s the geneticist, the molecular biologist, the biochemist, and on and on and on.”

What is keeping the establishment from understanding these new ideas? Damadian explains, “I wouldnt call it lack of ability, but it is a discomfort with this level of quantitative physics.”

He agrees that quantitative physics is a new level to which the whole field of cellular biology is rising: “And of course, one of the things that’s taking it there is this machine I’m using, because the machine has the power to get in there and unravel that stuff, whereas by using ‘wet chemistry’ it would be hopeless.”

The Journal of the American Medical Association (JAMA) quotes William S. Moore, Ph.D., reader in experimental physics at the University of Nottingham, England, as saying NMR may represent “the last possible window into the body.” Damadian is quick to agree. “I think what NMR is going to do -- by its power to do tissue chemistry entirely by electronics — is so completely turn the world upside down, the old shibboleths are not even going to be worth talking about. The whole language, the whole basis of medicine is going to be transformed infinitely.” (16)

The distinguished research physicist, Fritjof Capra, of the University of California, Berkeley, speaks of a new view of living systems:

Most of contemporary biology and medicine adheres to a mechanistic view of life and tries to reduce the functioning of living organisms to well-defined cellular and molecular mechanisms. The mechanistic view is justified to some extent because living organisms do act, in part, like machines. They have developed a wide variety of machinelike parts and mechanism — like bones, muscle action, blood circulation, and so on — probably because machinelike functioning was advantageous in their evolution. This does not mean that living organisms are machines. Biological mechanisms are merely special cases of much broader principles of organization: in fact, no operation of any organism consists entirely of such mechanism. A fuller understanding of life will be achieved only by developing a “systems biology”, a biology that sees an organism as a living system rather than a machine. (110)

Ling’s new model of the forces of life which operate in every living cell is very close to Capra’s enlightened view, emphasizing “basic principles of organization” rather than basic building blocks or basic substances.

Ling ahs seen the effects of forces which are represented by basic principles, and his work is the bottom rung of a marvelous new marriage of the sciences of biology and physics. This is the type of work for which Nobel prizes are intended. With the seemingly inevitable acceptance of his work, does Ling think about the Nobel Prize? No, he says, “It was more a dream when I was young and somehow you begin to realize that it is the kind of thing that has destroyed so many people. It is not the aim. The aim of science is very much an introverted affair. You really have an unrelenting, an absolutely ruthless judge, and that is Truth. It has nothing to do with popularity or approval. You only have one thing, and that is a unique set of truths .. and that is what one contends with. And the reward for occasionally coming into contact with it, and hopefully more and more, is beyond the usual sense of gratification.” (18)

And, Dr. Sodi-Pallares, whose involvement with these events grew from his years in the clinic and at the bedside, offers a fitting summary of the great importance of science:

Science, a human creation, emerged by necessity and it is by necessity that it must

be humanistic to fulfill its purpose. We are not of those scientists who proclaim science for the sake of science itself and declare that they follow pure research — without the consideration of its applications which man has the right to expect. To us, the temporal objective of science is man, and its aim is to benefit mankind. (65)

References

1. R.B. Dean: Biol.Symp. Vol. 3, 331 (1941).
2. A. Krogh: Proc.Royal Soc., London, Ser.3, V. 133, 140 (1946).
3. I.M. Gwynn, Karlish: Ann.Rev.Physiol. Cambridge (1975).
4. F.W. Cope: PhysiolChem.Phys. 9,6,547 (1977).
5. ------: Physiol.Chem.Phys. 8,5, 479 (1976).
6. ------: Physiol.Chem.Phys. 8,6,569 (1976).
7. G.N. Ling: *A Physical Theory of the living State* (Blaisdell, N.Y. 1955).
8. F.W. Cope: Proc.Nat.Acad.Sci. 54,225 (1965).
9. -----: J.Gen.Physiol. 50,1353 (1967).
10. -----: Biophys.J. 10,843 (1970)
11. G.B. Kolata: Science 192,1221 (1976)
12. C.F. Hazlewood: Science 177, 815 (1972).
13. A.K. Solomon: Sci.Amer. 203,6,146 (1960).
14. -----: Sci.Amer. 207,2,100 (1962).
15. R.L. Post, C.R. Merritt, C.R. Kinsolving, C.D. Albright: J.Biol.Chem. 235,1796 (1960).
16. R. Damadian: Pers.Comm. (2/4/1982).
17. T. Kuhn: *The Structure of Scientific Revolutions* (U. of Chicago Press, 1962).
18. G.N. Ling: Am.J.Phys.Med. 34,89 (1955).
19. W.D. McElroy, B. Glass, Eds.: *Phosphorus Metabolism* (Johns Hopkins Press, Baltimore, 1952.
20. G.N. Ling: Am.J.Phys.Med. 34,89 (1955)
21. ------: C.L. Walton: Physiol.Chem.Phys. 7,50 (1975).
22. -----: Am.J.Phys.Med. 4,89 (1955).
23. -----: Int.Rev.Cytol. 26,1 (1969).
24. J. Gulati, M.M. Occhsenfeld, G.N. Ling: Biophys.J. 11,973 (1971).
25. L. Minkoff, R. Damadian: Biophys.J. 13, 167 (1973).
26. C.F. Hazlewood, B.L. Nichols, N.F. Chamberlain: Nature, 222,747 (1969).
27. F.W. Cope: Biophys.J. 9,303 (1969).
28. R. Damadian, F.W. Cope: Physiol.Chem.Phys. 8,349 (1976).
29. L. Minkoff, R. Damadian: Physiol.Chem.Phys. 8,349 (1976).
30. F.W. Cope: Bull.Math.Biophys. 27,99 (1965).
31. -----: bull.Math.Biophys. 29,691 (1967).
32. -----: Adv.Biol.Med.Phys. 13,1 (1970).
33. -----: J.Biol.Phys. 3,1 (1970).
34. G.N. Ling: Pers.Comm. (2/4/1982).
35. M. Gerson: Physiol.Chem.Phys. 10,449 (1978).
36. F.W. Cope: Physiol.Chem.Phys. 10,465 (1978).
37. C.F. Hazlewood, D.C. Chang, B.L. Nichols, D.E. Woessner: Biophys.J. 14,583 (1974).
38. G.N. Ling, M.M. Ochsenfelf: Physiol.Chem.Phys. 8,389 (1976).

39. -----: J.Gen.Physiol. 49,819 (1966).
40. -----, G. Bohr: Biophys.J. 10,519 (1970).
41. I.L. Reisin, J. Gulati: Science, 176,1137 (1972).
42. J. Gulati, I.L. Reisin: Science, 176,1139 (1972).
43. R. Damadian: Science, 171,1151 (1971).
44. -----, K. Zaner, D. Hor, T. DiMaio: Proc.Natl.Acad.Sci., USA, 71,1471 (1974).
45. E.T. Angelakos, B.D. Polis, R. Riley: Circulation 49-50, Suppl. III (1947).
46. D. Sodi-Pallares, A. Bisteni, B.A. Medrano, M.R. Testrelli, A. DeMicheli: dis.Chest. 43,424 (1963).
47. -----: Ann.N.Y.Acad.Sci. 156,603 (1969).
48. M. Gerson: *Diattherapie der Lungentuberkulose* (Leipzig und Wien, Franz Deuticke 1934).
49. -----: *A Cancer Therapy — Results of Fifty Cases*, 3rd Ed. (Totatilty Books, Del Mar, California, 1979).
50. E. Urbach: *Skin Disease, Nutrition and Metabolism* (Grune & Stratton, N.Y, 1946).
51. Barnell, Scribener: J.Am.Med.Assn. 164,9,959 (J 29, 1957).
52. V. Moravek: Acta.Radiol, et Canc, Boh.Slov. 2,70 (1939).
53. -----: Zeitschr.f.Krebsforschung, 35,492,509 (1952).
54. Lasnitzki, L.K. Brewer: Can.Res. 2,494 (1942).
55. F.W. Cope: PhysiolChem.Phys. 10,465 (1978).
56. C.D. Cone: N.Y.Acad.Sci. Ser.II, V.31, N.4, 404-427 (Ap 1969).
57. W. Regelson: J.Am.Med.Assn. 243,4,338 (Jan. 26, 1980).
58. C.D. Cone: J.Theor.Biol. 30,151 (1971).
59. -----: J.Theor.Biol. 30,183 (1971).
60. -----: J.Cell.Physiol. 82,3 (Dec. 1973).
61. E. Calva, A. Mujica, R. Nunez, K. Aoki, A. Bisteni, D. Sodi-Pallares: AmJ.Phsiol. 211,71 (1966).
62. D. Sodi-Pallares: Am.J.Cardiol. 24,607 (1969).
63. D. Aviza-Herrara, D. Sodi-Pallares, L. Saenz-Arroyo, F. Cisneros, A. Bisteni, J. Vazquez del mercado: Stroke, 3,76 (1971).
64. D. Sodi-Pallares, A. Bisteni, J. Ponce de Leon, D. Aviza, m. Gonzlez Ahumada G.A. Medrano: Agressologie, 13,391 (1972).
65. D. Sodi-Pallares, J. Ponce de Leon: Ischaemic heart Disease and Polarizing Treatment (Tampa Tracings, Box 1245, Tarpon Springs, Florida, 1976).
66. F.W. Cope: PhysiolChem.Phys. 11,93 (1979).
67. H. Selye: *Experimental Cardiovascular Diseases* (Springer Verlag, N.Y. & Heidelberg & Berlin, 1970).
68. -----: Ann.N.Y.Acad.Sci. V. 156, I. 195-206 (1969).
69. Sodi-Pallares, et al: Electrocardiografia Polimetrica. Ediciones del Inst.Nal.de.Cardiol.deMexico. Mexico, D.F. (1971).
70. E. Calva, A. Mujica, A. Bisteni, D. Sodi-Pallares: Am.J.Physiol. 209,371 (Aug. 1965).
71. H. Laroti: Agressologie 15,11 (1974).
72. F.W. Cope: Pers.comm. (2/2/1982).
73. D. Sodi-Pallares: Ann.N.Y.Acad.Sci. 156, 603 (1969).
74. Select Committee on Nutrition and Human Needs of the United States Senate: *Dietary Goals for the United States* (U.S. Gov't Printing Office, Washington, 1977 Stock no. 050-070-03913-2, Catalog No. Y 4. N95:D 63/3).

75. S. Gubjarnason: Cardiol. 57, 35-46 (1972).
76. D. Sodi-Pallares, J. Ponce de Leon, F. Cisneros, A. Bisteni, G.A. Medrano: Geriatrics, 21, 138 (1966).
77. -----: Gaceta Medica de Mexico, 104,407 (1972).
78. H.d. Ariza, M. Ahumada Gonzalez, J. Figueroa, D. Sodi-Pallares, A. Bisteni, F. Cisneros: Memorias deol VIII Congreso Nacional de Cardiologia, p.2 (1973) Mexico.
79. J. Ponce de Leon, H.J.A. Gonzalez, E. Comoglio, C.H. Linares, D. Sodi-Pallares: memorias dol VI Congreso nacioal de Cardiologia, p. 80 (1969) Mexico.
80. J. Ponce de Leon, M. Gonzalez-Ahumada, D. Sodi-Pallares: II Congreso Medico Estatal de Baja Calaifornai, Tijuana, B.C. (June, 1971).
81. J.J. Ponce de Leon, A. Bisteni, G.A. Medrano, D. Ariza, J. Ribeiro Nogueira, D. sodi-Pallares: Resumenes del IV Congreso Nacional de Cardiologia, p.36 (1965) Monterrey, Mexico.
82. P.R. Maroko, e. Braunwald: Ann.Int.Med. 79,720 (1973).
83. Y. Shinohara: Jap.Circ.J. 32, 1269 (1968).
84. Associated press, San Diego Union (3/25/1982).
85. R. Damadian: Biophys.J. 11,773 (1971).
86. -----: Ann.N.Y.Acad.Sci. 204,211 (1973).
87. -----: C.R.C. Crit.Rev.Microbiol. 377 (March 1973).
88. F.W. Cope, R. Damadian: Physiol.Chem.Phys. 6,17 (1974).
89. L. Minkoff, R. Damadian: J.Bacteriol. 125,353 (1976)
90. F.W. Cope, R. Damadian: Nature, 228,76 (1970).
91. R. Damadian, F.W. Cope: Physiol.Chem.Phys. 5,511 (1973).
92. -----, K. Zaner, D. Hor, T. DiMaio: PhysiolChem.Phys. 5,381 (1973).
93. C.F. Hazlewood: J.Natl.Cancer Inst. 52,625 (1974).
94. -----, G. Cleveland, D. Medina: J.Natl.Cancer.Inst. 52,1849 (1974).
95. D.C. Chang, C.F. Hazlewood: J. Magn.Reson. 18,550 (1975).
96. P.T. Beall, C.F. Hazleood, P.N. Rao: Science 192,904 (1976).
97. P.C. Lauterbur: Nature, 242,190 (1973).
98. P. Manfield, A.A. Maudsley: Br.J.Radiol. 50,188 (1977).
99. W.S. Hinshaw: J.Appl.Phys. 47,3709 (1976).
100. R. Damadian, L.Minkoff, M. Goldsmith, M. Stanford, Koutcher: Physiol.Chem.Phys. 8,61 (1976).
101. -----: “Apparatus and method for detecting cancer in tissue”, U.S. Patent 3,789,832, filed March 17, 1972.
102. E.R. Shell: Tech.Rev. 27 (July 1981).
103. P. Gunby: J.Am.Med.Assn. 247,2 (Jan. 8, 1982).
104. J.L. Marx: Science 213, 24 (July 1981).
105. R. Tellalian, FONAR Corp.: Pers.Comm. (3/25/1982).
106. E.R. Shell: Tech.Rev. 23 (July 1981).
107. United press International: “New Body Scan Process Shown, Called Potentially More Useful, Safer than X-Rays” (Nov. 20, 1981).
108. C.F. Hazlewood: Cardiovasc.Dis.Bull.Tex.Heart.Inst. 2,83 (1975).
109. R. Damadian, G.N. Ling, C.F. Hazlewood, F.W. Cope: Science 193, 532 (Aug. 13, 1976).
110. F. Capra: *The Turning Point* (Simon & Schuster, 1982).