ENERGY AND STRUCTURE IN BIOLOGICAL WATER

A new approach to aging, metabolic inefficiency and cancer

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Biochemistry and even biophysics tend to be ruled by an emphasis on structure, at the expense of energy or function. The popular unit of biological energy is the chemical bond energy of ATP, a concept which has been notoriously unproductive in attempts to understand biological energy transformations such as nerve and muscle function, ameboid movement, cell division, etc. That molecular concept of energy, despite its popularity, is derived from chemical equilibrium studies, and is not really applicable to the non-equilibrium, "steady state" conditions of life. (1) The study of biological energy transmission, transduction, and integration have been shunned, in favour of static models - for example, a famous researcher in "cell motility" has spent thirteen years manipulating wooden blocks representing molecular structures. Nevertheless, there is now enough information on the physics of macromolecules, water, and electrons and their interactions to support some very detailed interpretations of biological functions, including such well known, but hard to understand, interactions as memory and molecules, hormones and desires, emotions and cancer, loss of curiosity and aging, etc.

Prolonged discharge or activation of a cell tends to consume the molecular reservoir of energy, to "lower the energy charge" of the cell. Various physical measurements suggest that this is accompanied by an actual "melting" of the protoplasm. "Melting" does not necessarily mean going from hard to soft, and doesn't require changes in temperature. The general meaning of the concept as it is used here is "a phase transition from relative order to relative disorder". Glass, though very hard, is considered not to be a true solid because of its molecules' random arrangement. Likewise, fluid water can have different degrees of internal order, or structure, depending on its temperature, (2) its "history" (3) (its state during the last several hours) and its distance from a surface.(2) The proton, or hydrogen, component of the water molecule aligns itself with an electromagnetic beam, and so the freedom of water molecules can be measured by determining the nature of its absorption at certain frequencies. Such measurements have revealed that the water in tissue is more highly ordered than ordinary water, and that cancer (4) and fetal (5) tissue and other new growth contain more water but their water is more like ordinary water, or more "melted".

In the presence of oil, or any unwettable surface, water becomes immobilized and ordered; conversely, ordered water will admit oily molecules more readily. Hydrophilic chemicals, such as sugar, will dissolve more easily in ordinary or relatively "melted" water: cancer cells are known to take up more glucose than normal cells do; insulin probably has a similar effect (a melting of the general protoplasm, follows insulin treatment).

Otto Warburg (6) related what he called "structure" to the ability of cells to use oxygen and to the ability of tissue to differentiate. He believed that evolution to the multicell stage depended on the existence of atmospheric oxygen. For several decades he gathered evidence to support his theory that cancer resulted from damaged respiration. However, his concept of "structure" was limited to such cellular components as the mitochondrion. (7) His general theory has withstood every challenge over the last thirty years.

If the cancer process represents a self-stabilizing reversal of evolution to the single cell stage, it can also be considered as a reversal of ontogenesis to a very early stage of

embryonic development. Several theories have been based on the similarities of cancer to the early embryo (metastasis, non-allergenic proteins).

At the blastula stage of development, the embryo suddenly begins to consume large amounts of oxygen. As oxygen consumption increases, the water content decreases, (8) so that what remains is increasingly "surface" dominated, that is, on the average it is closer to macromolecules. Therefore, it must be more highly structured. The excited electronic state of oxygen is stabilized by cell water, just as the excited state of many fluorescent molecules is stabilized by ice, but not by ordinary water. This stabilization of the excited state could facilitate oxidation. Stabilization tends to be mutual; if this is the case, then oxidation might support structure in the water.

The fact that structured water promotes protonic conduction as well as prolonged electronic excitation should extend the range of molecular interaction, possibly even to the extent of intercellular adhesion. This would provide an explanation for cancer cells' loss of adhesiveness which results in secondary cancer growths. Resonant stabilization of one cell by another would similarly account for the "contact inhibition" of normal cells. In the "melted" state cells would be limited to the less efficient anaerobic metabolism, because of the altered solubility and stabilization of oxygen, but they would maintain the primitive function of growth. If hydrostatic pressure can be considered to interfere with cell water structure, * this view would predict the observation of Chumak (9) that high pressure shifts the metabolism of bacteria from oxidation to fermentation. However, very high pressures can also interrupt cell division; growth under such conditions can lead to very long cells.

Free electrons in water will stabilize themselves by forming cages of water molecules around themselves, because of the electrically polar nature of water molecules. They are known to be much more stable in ice than in liquid water, and might be similarly stable in cell water. These electrons in solution have a deep blue colour, and are probably responsible for the blue colour of water and ice, which becomes much more intense at high elevations where free electrons are more abundant. If the structure of water in healthy cells is such that it would stabilize solvated electrons, then an abundance of free electrons should tend to stabilize the normal structure of cell water.

These concepts provide a new perspective in which to consider brain function and other processes in which pattern is essential, including tissue development. Instead of a computer with neuronal "wires", the brain can be viewed as a living jelly, in which nerves might have only a nutritive and transport function, with information storage and retrieval and consciousness in general being a hologram-like function of patterned flows of electrons through a very finely structured protein-polysaccharide-lipid-water gel. In this model, an act of consciousness (a structured flow) is simultaneously retrieval and storage, since structure will be modified or intensified according to the form of the flow, yet the flow will also be governed by the structure. Growth of generalized insight is synergic with intensity of experience, according to this model. This simple conception, derived from physical and metabolic studies, (10) is able to explain complex integration and message transduction, but its most outstanding advantage over the computer model is its ability to explain the experience of time in terms of an energy gradient which is known to exist (measured as a positive charge of the anterodorsal surface) and to correlate with changes in subjective states.

Palladin, (11) who demonstrated that innervation governs enzyme activity, has more recently found that efficient use of oxygen for energy production by brain tissue increases with evolutionary level (in reptiles, birds, and mammals) and with the degree of alertness. Level of brain activity and local innervation have been found to be involved in tumor growth, (12) and in the ability of tissue to form a reactive inflammation. These themes

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* (cf. The effects of stasis on the body fluids in Reich's account of cancer)

of enzyme activity changes and efficiency of oxidative metabolism, which are so important to the problems of evolution, consciousness, growth, and cancer, can be seen in the perspective of water structure with very surprising results.

Certain enzymes are inactivated by cold, and reactivated by moderate warmth; other enzymes are activated by the presence of molecules known to structure water, and inactivated by structure breakers, such as the fluoride ion. The enzymes which are activated by the relative disorder of warm water happen to be the enzymes which control a pathway of energy metabolism which becomes active in the growth state. Estrogen, chemical carcinogens, radiation, and lack of oxygen are known to activate this pathway. Normally, the energy produced by these reactions provides for regeneration following injury. Nerves, hormones, physical structures, and oxygen normally intervene and restore the high energy metabolic system necessary for differentiated functioning. If any of these factors is inadequate, the new tissue can stabilize into cancer, with its own "toxohormone", its own peculiar physical environment of abnormal connective tissue, and its own system for "wasting" oxygen, (13) all of which maintain the "melted" state of protoplasm with its primitive metabolic pathways. The other enzymes that are activated by structure, tend to be implicated in the high energy processes, and may suggest new approaches to the treatment of cancer.

Burr, (13) and more recently Becker, (14) have found that organ development is governed by an electric charge gradient in the organism. This gradient declines with age. Individual cells drift toward the inefficient oxygen wasting mode of metabolism with increasing age. Tissue electrical resistance increases with age. Accumulation of material between cells and disorganization of cell water probably contribute to the poor conductivity. It is possible that the high concentration of free electrons at high elevations increases the life span by helping to maintain the high efficiency cell structure. (Vitamin C, a source of fairly high energy electrons, is known to support normal fetal development, even in the presence of powerful drugs which act by blocking respiration.)

Time-spanning is essential to consciousness; insightful perception seems to depend on the ability to directly perceive patterns that extend through time. Time is needed for consciousness to complexify, to have insights. But eventually, this growth function of time is directly subverted by another function of time, which insulates, lowers energy, shortens the time span of perception, and causes tissue degeneration. Possibly the simple interactions of electrons and water, energy and structure, will suggest new approaches to the treatment of senescence and associated diseases.

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