The Quantum Mechanisms of Pyrophosphate and

Their Postulated Role in the Rise of Life

Leo J. Baranski

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FOREWORD:

An unclassified, personal document written on his own time, culminating his life's work, and dedicated to his research and development using the Unified Field Theory, outlined by his mentor Dr. Albert Einstein while at Princeton University and the work of his close friend Dr. Lancelot Law Whyte who had also worked with Einstein at the Planck Institute.

This "White Paper", was written during his employment as Senior Scientist with North American Aviation, Inc., Los Angeles, California from 1962 to 1964, in cooperation with N.A.S.A. the U.S.A.F and U.S. Naval Research Laboratory in his Bio-Physics R. & D. for the "Man in Space Program".

This great work was, Validated and Documented by C. Susskins (ED.) "Proceedings of the 3rd Annual Tri-Service Conference on Biological effects of Microwave Radiating Equipment", New York, Rome Development Center, Griffis Air Force Base, RADC-TR-58-14, August 1959, by Bach, S., Baldwin, M. and Lewis, S.,"Some effects of Ultra-High Frequency Energy on Primate Activity". (see ref. #33).

Dr. James Watson
Los Angeles, CA., USA
01/06/2003

A. Introduction

In 1938, A. I. Oparin published, and subsequently revised in a second and third edition (1953 and 1957, respectively), his now classic book <u>Origin of Life</u>, which forms the basis for currently held views concerning the rise of life on earth (1,2,3).   In these works, Oparin, relating data and theory from astrophysics, geochemistry, geophysics, paleontology, biochemistry, and physical and colloidal chemistry, puts forth the hypothesis that the appearance of life of this planet was preceded by a gradual and long evolution of carbon and nitrogen ionic, atomic, molecular and colloidal complexity which can be traced to its inception on the hottest and, hence, the youngest stars of our galaxy. This view points out that the evolving complexity of carbon and nitrogen led to complex mixtures of amino acids and other organic compounds (which are now accepted as having been present in the primary hydrosphere). Out of these pools of complex mixtures gradually emerged proteins, which evolved into colloids (possessing living properties) with thermal and/or chemical energy as the organizing mechanism.

In 1951, H.F. Blum in his <u>Time's Arrow and Evolution</u> (4) fixed attention on the adenylic acid pyrophosphate system as playing a major role in the rise of life by pointing out that a means of free energy transport (such as mediated exclusively in living systems by ATP) underlay the

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property of reproduction. Blum also pointed out that the nucleic acid structure (of DNA) stemmed originally from that of adenylic acid so that nucleoproteins may have been the first types of protein to be synthesized. Blum would therefore add nucleotides to the amino acids postulated by

Oparin as the basic constituents of life present in the primordial hydrosphere.

The major remaining problems in the elucidation of the mechanisms underlying the rise of life concern the general mechanisms of catabolism and catalysis, and especially those utilized by the first life. That the pyrophosphate system was basically involved in the first catabolism appears to be established beyond doubt. But what else is involved as basic essentials of catabolistic and catalytic systems? Moreover, how did catabolism and catalysis begin and how was the primordial catabolic source continuously maintained?

After a thorough study of the catabolistic system and photosynthesis, this writer has come to the conclusion that only two chemical species are basically involved in catabolism: atomic hydrogen and phosphate. Further, contrary to the almost universal assumption that the first viable entity utilized chemical and/or thermal means to convey free energy to the pyro-phosphate system, this writer maintains that the implications of the catabolic and photosynthesis processes, and especially the quantum char-acteristics of atomic hydrogen and phosphate, make it a more likely possibility that life used electromagnetic energy in its catabolism from the very beginning and long before photosynthesis as we know it today was developed. It is the purpose of this paper to support these views.

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B. Micro-Evolution in the Primary Atmosphere and Hydrosphere (3,5,6)

Utilizing the Harvard classification of stars, Oparin pointed out that in

the hottest stars of the ultraviolet type, with surface temperatures of approximately 50,000° C., the elements carbon, hydrogen and nitrogen are present largely in the ionized state. In the bluish-white or B-type stars, with temperatures from 20,000° to 15,000° C., atomic carbon, atomic hydrogen and atomic nitrogen appear. In the A-type or white stars, with surface temperatures of 8,000° C., di-carbon molecules (C_2), hydrocarbons and cyanogen (CN) are found. In still cooler stars, M and N types, with surface temperatures of 4,000° and 2,000° C., more complex carbon and nitrogen molecules and molecular hydrogen are found. Note the increasing structural complexity—ionic, atomic, and molecular—of carbon, nitrogen and hydrogen with the descending magnitude of thermal energy.

By extrapolating the above structural evolution and meshing it with the widely-held hypothesis that the earth was, in its primordial state, molten throughout and expelling much of its volatile material to form a dense primitive atmosphere, one arrives at the likely hypothesis that the process of structural evolution of carbon, nitrogen and hydrogen continued in the primary atmosphere of the nascent earth—the mechanism again being the progressively descending magnitude of thermal energy. A plausible explanation of the origin of the primary atmosphere then may be that, as the molten earth began to cool, carbon dissolved in the molten interior of the earth (3,000-4,000° C.) and formed metallic carbides such as iron carbides.

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As the earth cooled further, the tremendous heat, pressures, and convection currents engendered by the compression and radioactive processes in the earth's interior caused almost constant eruptions of this

magma to the earth's surface, bringing the metal carbides into contact with the superheated gaseous water of the atmosphere. Hydrocarbons would thus be formed in quantity. At temperatures around 1450° C., $Ca_3(PO_4)_2$ and SiO_2 (erupting to the surface of the earth) formed P_2O_5. The P_2O_5 and the hydrocarbons and the halogen chlorine reacted in the atmosphere to produce PH_3, PCl_3 and a large variety of organophosphorus compounds.   ($PC1_3$ is regarded as the parent compound of all organophosphorous compounds such as found in adenine mononucleotide, AMP, which is the precursor of ADP and ATP.)   At lower temperatures, around $1,000^o$ C., the hydrocarbons would exist as free radicals—e.g., methene (CH) and methylene (CH2)—from which unsaturated hydro-carbons such a acetylene ($C \equiv C$) are formed.

The earth's molten interior likewise contained compounds of nitrogen with iron and other metals, the nitrides. When these nitrides erupted to the surface as part of the magma, they reacted with the gaseous water to form NH_3, which even now (along with methane) is an important constituent of the atmospheres of planets far distant from the sun: Jupiter, Saturn, Uranus, and Neptune[1]. Then the unsaturated hydrocarbons, such as acetylene, reacted with this ammonia to form compounds such as aldehydeammonia, cyanogen ($C\equiv N)_2$, hydrocyanic acid ($HC \equiv N$), and adenine ($C_5N_5H_5$ or 5HCN), the adenine reacting with the organophosphates to form traces of AMP, ADP, ATP, etc.[2]

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With sufficient cooling of the earth's surface, the critical temper-ature of water (374° K.) was subsequently reached.   Above this temperature no amount of pressure could form water vapor from the

gaseous H_2O. At this temperature, however, the tremendous pressures then existent in the earth and in the primary atmosphere (which was firmly held by gravitational attraction) could finally cause the formation of water vapor. This condensation began far out in space and subsequently, with further cooling of the earth's surface, the condensed vapor reached the surface of the earth, deluging it for prolonged periods and leading to the formation of deep primary pools over the earth's volcanic surface. In the primary atmosphere the unsaturated hydrocarbons took on water and formed saturated hydrocarbons. Any residual P_2O_5 in the atmosphere reacted violently with the water vapor to form H_3PO_4.   There was now present in the water-saturated atmosphere, in the rain, and hence, subsequently in primary volcanic pools, a complex solution of free hydrogen, halogens, H_2S and other sulfur compounds, hydrocarbon radicals, unsaturated hydrocarbons, saturated hydrocarbons, organophosphates and H3PO4, ammonia, cyanogen, HCN and other nitrogen-containing compounds, etc.   From these were formed in the primary atmosphere and in the primary volcanic pools—due to electric discharge, solar radiation between 300 and 30,000 Å, and cosmic radiation—alcohols, organic acids, aldehydes, amines, amino acids, and other species of carbon, nitrogen, phosphorous, sulfur, and halogen compounds.[3] (That amino acids are produced from a primary atmosphere of H_2O, CH_4, NH_3, and H_2 by these three separate methods—electric discharge, solar radiation, cosmic radiation—has been experimentally demonstrated.)

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        Subsequently (primarily due to the catalytic presence of water vapor), NH_3, CH_4 and H_2O were photodissociated to N_2, CO_2, more H_2, and

small quantities of O_2—some of which was further dissociated to O3—which combined with residual H_2S and halogens from the primary atmosphere to yield part of the secondary atmosphere. (The H_2 and H in the present atmosphere are due to the continual dissociation of H_2O; the H_2 and H of the primary atmosphere were lost due to their escape from the earth's gravitational field; the O_2 now present in the atmosphere is mainly a by-product of photosynthesis; the CH_4 now present is due to the decay to organic matter.)

The organic solution mentioned is postulated to have been present in the primary volcanic pools, in addition to traces of many metals. Most of the H_2O that was to form the secondary oceans of the present was to come from the gradual degassing of the earth's interior during the course of geologic time, which process also contributed materially to the formation of the secondary atmosphere.[4] On this hypothesis the primary pools of approximately 4.8 billion years ago would have possessed a pH of between 4 and 5, with the acidity decreasing as bases came into solution during the course of geologic erosion (6). The water resulting from the degassing of the earth's interior decomposed rock silicates ($CaSiO_3$) and quartz (SiO_2), which would mean 1) that the concentration of CO_2 in the atmosphere must have remained very low at all times and 2) that deep below in the Mg-Fe igneous crust of the once nascent earth there remains to be discovered a thin layer consisting primarily of organophosphate deposits, the "fossil remains" of primordial life.

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C. The Quantum Mechanisms Underlying the Source of Phosphate's Energy and the Origin of Pyrophosphate's Enzyme Catalyst

The two major problems remaining in accounting for the rise of life on earth are 1) to account for a continuous source of phosphate energy possible under the conditions of a primitive earth and 2) to delineate a plausible mechanism underlying the synthesis of the first polypeptide (enzyme) with catalytic activity. In solutions to the problem of a continuous energy source, the assumption is universally made that the aboriginal living entity was heterotropic and thus utilized chemical and/or thermal energy.   Solutions to the origin of the first polypeptide with catalytic activity, on the other hand, have involved autocatalytic hypotheses, following N. H. Horowitz (9).   For Blum (4), the autocatalytic process was due to spontaneous polymerization of amino acids into long polypeptide chains in dried-up pools which once contained amino acids. Bernal (10) had previously offered essentially the same hypothesis but placed the process on the surface of hydrated clay particles. Pringle (11) has suggested branching chain reactions that produced long chains of peptide-linked amino acids much like the processes that are observed in ordinary inorganic and organic laboratory synthesis. Calvin and others (12) have suggested versions of Langmuir's divergence-convergence crystallization hypothesis to explain the origin of the first enzyme.

The postulate of the present paper is that both the aboriginal energy source and the catalyst of phosphate and pyrophosphate were electromagnetic in nature. In order to set the basic problems under

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consideration in the perspective of the present postulate, consideration must be given to mechanisms of photosynthesis and catabolism, with emphasis on their bioenergetics.

1. Photosynthesis and Catabolism: General Characteristics

In Photosynthesis, energy is stored in carbohydrate in the form of activated hydrogen; in catabolism, it is this activated hydrogen of carbohydrate that is progressively divested of its energy to for pyrophosphate ($\sim PO_4$).

In photosynthesis, chlorophyll a absorbs electromagnetic energy between 4000 and 6800 $\overset{\circ}{A}$; other photons absorbed by various pigments are transferred to chlorophyll a.   When an orbital electron of chlorophyll a absorbs a photon, the acquired energy and momentum of the electron results in its expulsion into, and it attraction by, cytochrome f (13). From the cytochrome system, the energy passes---very likely in the form of electromagnetic energy---to an intermediate carrier system which is likely the pyrophosphate system, acetyl$\sim PO_4$ possibly serving as the initial pyrophosphate carrier. Since photosynthesis and catabolism are highly similar but reverse in their operations, the next step might be the entrance of acetyl$\sim PO_4$, H_2) and CO_2 into a "hydrogen activation" cycle (analogous but reverse to the "hydrogen deactivation" principle of the Krebs cycle). The functions of this cycle would be to split H_2O, to form activated H (designated by H*), and to hydrogenate CO_2 with H*. The end product would be O_2, inorganic phosphate and ATP (the latter also being a by-product of the catalytic activity of the cytochrome system).

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The next major step might be the reduction of TPN by H* forming TPNH*$_2$. TPNH*$_2$ then might enter reactions with 1,3-diphosphoglyceric acid, both taking part in the synthesis of triose into carbohydrate in a manner analogous to, but the reverse of, glycogen catabolism.

In catabolism, H* is first made available by the enzymatic breakdown of glycogen or glucose into triose. In the ~PO_4 producing steps of glycolysis, a triose molecule is first phosphorylated with ortho ("inorganic") phosphate. Triose is then dehydrogenated by DPN. The dehydrogenation process produces quantum potential drops in the H* that are being removed, the electromagnetic energy being transferred to orthophosphate (on the triose molecule) which is transformed into pyrophosphate. The triose is then dephosphorylated, the pyrophosphate being transferred to ADP to form ATP.   ATP in turn is either directly attached to, or situated in the very near vicinity of, the various biochemical transformers in the living organism. After glycolysis, the Krebs tri-carboxylic acid cycle comes into play and produces the greatest proportion of ~PO_4 for ADP.   After the Krebs cycle, the respiratory cytochrome system comes into play which produces more ~PO_4 and which in the process passes spent electrons to H ions; these then combine with inactive O_2 to form water.

In photosynthesis, the basic bioenergetic steps are the splitting of H_2O into and the transfer of high energy quanta from pyrophosphate to H_2 of H_2O to form H*.   In catabolism, the basic bioenergetic steps are the transfer of high-energied quanta from H* to orthophosphate to form pyrophosphate and the synthesis of water.   In both cases, the pyrophosphate system is the carrier of energy to or away from hydrogen.

Thus, the phosphate system is a universal means for transporting quanta to H_2 of H_2O to form carbohydrates and for transporting quanta from H* to form ~PO_4 (14). From this, it would follow that the phosphate Baranski

system and hydrogen most probably were linked together as the basis of catabolism from the earliest beginnings of life on the earth. This link between the phosphate system and H, plus the maintenance of this link

and its elaboration throughout the incredibly long span encompassing the rise of life and the evolution of the species, suggests that H and PO4 must have some primary property in common. This primary common property, if uncovered, might yield a major insight as to how life began in the primary pools of nascent earth. The close relationship between hydrogen and the phosphate system in photosynthesis and catabolism suggests that the property held in common by these two species is a common quantum (photon) wavelength which permitted the two species to exchange photons. If this was an is the case, then pyrophosphate must deliver photons of specific wavelength to H2 of H2) to form H* in photosynthesis and H* must deliver photons of the same specific wavelength to ortho- phosphate to form ~PO4 in catabolism.

2. Principles of Quantum Theory Relevant to Physio- and Bio-chemical Processes (15, 16, 17)

The failure of classical electro-dynamics to account for the spectral distribution of black body radiation on the basis of a "continuous emission of radiation" concept led Max Planck in 1901 to discard this concept and forward instead the hypothesis that black bodies radiate energy not continuously but discontinuously in energy packets, called quanta, given by the relation:

$$E = hv^{-1}, \tag{1}$$

where E is the energy in ergs of the quantum absorbed or emitted (by a resonator electron of an atom or molecule of the black body radiator),

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hv^{-1} is the frequency of the resonator electron and of the resonant quantum absorbed or emitted, and h (Planck's constant, empirically determined), is equal to 6.62517×10^{-27} erg-sec. Equation (1) is the

fundamental relation of the quantum theory of radiation. Planck further postulated that the resonator electron of an atom or a molecule could either absorb or emit energy in the unit quantum:

$$E_1 = h v_1{}^{-1} \qquad\qquad (2)$$

or in whole number multiples, n, thereof:

$$E_n = n h v_1{}^{-1}. \qquad\qquad (3)$$

Planck's success with the quantization of black body radiation led Albert Einstein to generalize the quantum theory on the basis of evidence existing in the newly discovered photoelectric effect. In the photoelectric effect, Einstein pointed out, one quantum of ultraviolet light brings about the ejection of one electron from a radiated surface (due to the phenomenon of resonance absorption by an electron), the exchange of energy taking place in terms of Planck's hv. Einstein then generalized Planck's quantum theory by asserting that all electromagnetic energy of the whole electromagnetic spectrum is quantized, and not only that of black body (infrared) radiation. Thus, electromagnetic energy of all bands of the electromagnetic spectrum is absorbed, emitted, or exchanged by atoms and molecules in terms of Planck's discrete quanta (5).

Another extension of Planck's quantum theory, developed by Bohr and others, was that an atom or molecule has a set of discrete energy states in which an electron possesses a definite and invariable energy content independent of thermal energy. The set of permitted energy states of an electron is usually referred to as "energy levels". The

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energy levels in turn are designated by "n", which may take on any series of value 1, 2, 3, . . ., known as principal quantum numbers. There are three sub-energy levels (which are designated by quantum numbers 1, m and s), due to the fact that the energy of an electron may be spread over

a major orbital, sub-orbital, sub-sub-orbital and taken up in the spin of the electron.   The principal quantum number, n, therefore, represents the major energy level to which an electron of an atom or molecule belongs. An electron thus can be at one or another major energy level within an atom or a molecule, but it may not acquire energy values intermediate to those of the major energy levels.

The means by which an atom or molecule acquires or loses (electronic) energy is by an electron absorbing or emitting a photon. The absorption of a photon forces the electron (and hence the atom or molecule) into one of its higher major energy levels; thus the atom or molecule gains energy. If the electron emits a photon by "relaxing" to one of its lower major energy levels, the atom or molecule loses energy. The energy lost or gained by an atom or molecule thus results from a loss or gain of a photon, which has an energy value represented by the energy difference of the two major energy levels the electron has spanned. Thus, if ΔE represents the gain of energy by an atom or a molecule due to the absorption of a photon which forces one of their electrons from energy level n = 2 to energy level n = 1, the gain in energy may be expressed as follows:

$$\Delta E = n_1 - n_2 = h v^{-1}. \tag{4}$$

The spacing of the major electronic energy levels is equal to $1/n^2$, which means that the energy content of an atom's or molecule's major

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energy levels is proportional to $1/n^2$ and that the energy content of the various major levels will decrease according to the inverse of the square of the principal quantum numbers. Thus, if the energy content is known for

the highest major electronic energy level of an atom or molecule, this would be n = 1. The energy content of the next lower major energy level (n = 2) would be ¼ the energy content of the highest level; the next lower, 1/9 of the energy content at n = 1; etc.

It follows from Pauli's exclusion principle, which states that no two electrons in an atom or molecule may have all four quantum numbers the same, that an atom or molecule will possess one electron that has a higher energy level than any other electron in the particular atom or molecule. When this electron absorbs an additional photon, certain dissociation phenomena must occur. This fact and equations (2) and (3) imply that an atom's or molecule's major energy levels are circumscribed by an upper and lower limiting energy level. Using ATP as an example, the upper limit- ing energy level would be that of the delabilization (dissociation) energy of ATP and the lower limiting energy level would be that energy involved with ATP at its unit frequency. This permits the determination (by calculation) of the energy content of the highest major energy level of an atom or molecule from the observed spectrographic dissociation frequency and, hence, from the dissociation energy (D_s) of an atom or molecule.   The dissociation energy, D_s, in ergs per molecule or atom may be calculated from the dissociation wavelength or frequency by the application of equation (1), where v^{-1} is now the dissociation frequency and E the dissociation energy in ergs per molecule or atom.   If D_s is desired in ca1 mo1-1 of the substance, the formula for an einstein may be employed:

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$$\epsilon \;\; = \;\; \frac{h \times N \times c}{(v \times 10^{-8}) \; (4.186 \times 10^{7})} \; , \qquad\qquad (5)$$

where D_s in ca1 mo1-1^{-1} of the substance is:

$$D_s \text{ ca1 mo1}^{-1} = \epsilon = \frac{h \times N \times c}{(v \times 10^{-8})\ (4.186 \times 10^7)} \quad , \tag{6}$$

where h is Planck's constant, N is Avogadro's number, c is the velocity of light in cms $\sec^{-1}$, v is the wavelength of the absorbed light in cms (and $v \times 10^{-8}$ the same expressed in Angstroms), 4.186×10^7 is the number of ergs in one calorie, ϵ is the quantum energy absorbed in ca1 mo1^{-1} of the substance, and D_s ca1 mo1^{-1} is the dissociation energy of the substance in calories per gram molecular weight of the dissociated substance.[5]

3. Quantum Energy Levels and Photon Energies of Atomic Hydrogen and Phosphate.

The calculated major energy levels in atomic hydrogen and in phosphate and their related photon energies are as follows. For phosphate, the dissociation energy is the delabilization energy of phosphate. In 1950, the delabilization wavelength of the pyrophosphate of ATP was determined as 2600 $\overset{\circ}{\text{A}}$ (18). Pyrophosphate's dissociation frequency (v^{-1}) and dissociation energy (D_s) in ca1 mo1^{-1} follow:

$$v \text{ of } D_{s_{\sim PO_4}}^{\ 6} = 2600\ \overset{\circ}{\text{A}} \ ,$$

$$= 2.6 \times 10\ -5\ \text{cm} \quad , \tag{7}$$

$$v^{-1} \text{ of } D_{s_{\sim PO_4}} = c/v \tag{8}$$

$$= \frac{2.99793 \times 10^{10}}{2.6 \quad \times 10^{-5}}$$

$$= 1.15305 \times 10^{15}\ \text{cps.} \tag{9}$$

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Applying equations (5), (6) and (7):

$$D_s \text{ of } PO_4 = \epsilon = \frac{(6.62517 \times 10^{-27})\ (6.02486 \times 10^{23})\ (2.99793 \times 10^{10})}{(2.6 \times 10^{-5} \times 10^{-8})\ (4.186 \times 10^{7})}$$

$$= 109{,}949 \text{ ca1 mo1}^{-1} \quad . \tag{10}$$

The delabilization of pyrophosphate (and hence of phosphate) as given by equation (10) is $D_s = 109{,}949$ ca1 mo1^{-1}. Thus, for pyrophosphate, at n = 1, the energy content is 109,949 ca1 mo1^{-1}. The energy contents and photon energies for some of the major energy levels of pyrophosphate and phosphate are given in Table I.

Insert Table I here

The dissociation energy for atomic H would be equivalent to its ionization potential. The ionization potential for atomic H is 13,60 ev (20) which is equal to 313,189 ca1 mo1^{-1}. The energy contents and photon energies for some of the major energy levels of atomic H are given in Table II.

Insert Table II here

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Table I. Energy Contents and Photon Energies of Major Energy Levels of
        Pyrophosphate and Phosphate

Molecule	Energy Level	Energy Content (ca1 mo1^{-1})	Energy of Photon Emitted in "Relaxing"		
			Level of Photon	Levels Spanned	Energy of Photon (ca1 mo1-1^{-1})
~PO$_4$	n = 1	109,949	(no higher	level from which to	"relax"
~PO$_4$	n = 2	27,487 (1/4 of n = 1)	hv$_1$$^{-1}$ (energy of	109,949 –27,487 photon "relaxing"	82,462 from n=1 to n=2)
~PO$_4$	n = 3	12,217 7	hv$_2$$^{-1}$	27,487 – 12,217	15,270 7
PO$_4$	n = 4	6,872 8	hv$_3$^{1}	12,217 - 6,872	5,345
PO$_4$	n = 5	4,398	hv$_4$^{1}	6,872 - 4,398	2,474
PO$_4$	n = 6	3,054	hv$_5$$^{-1}$	4,398 - 3,054	1,344
PO$_4$	n = 7	2,444	hv$_6$$^{-1}$	3,054 - 2,244	810
PO$_4$	n = 8	1,718	hv$_7$$^{-1}$	2,244 - 1,718	526
PO$_4$	n = 9	1,357	hv$_8$$^{-1}$	1,718 - 1,357	361
PO$_4$	n = 10	1,100	hv$_9$$^{-1}$	1,357 - 1,100	257
PO$_4$	n = 11	909	hv$_{10}$$^{-1}$	1,100 - 909	191
PO$_4$	n = 12	764	hv$_{11}$$^{-1}$	909 - 764	145
PO$_4$	n = 13	651	hv$_{12}$$^{-1}$	764 - 651	113
PO$_4$	n = 14	561	hv$_{13}$$^{-1}$	651 - 561	90
PO$_4$	n = 15	489	hv$_{14}$$^{-1}$	561 - 489	72
PO$_4$	n = 16	430	hv$_{15}$$^{-1}$	489 - 430	59
PO$_4$	n = 17	381	hv$_{16}$$^{-1}$	430 - 381	49
PO$_4$	n = 18	339	hv$_{17}$$^{-1}$	381 - 339	42
PO$_4$	---	-------	-----	-------	----
PO$_4$	n = 50	44	hv$_{49}$$^{-1}$	46 - 44	2
PO$_4$	---	--------	-----	-------	-----
PO$_4$	n =1733	3.667 x 10^{-2}	hv$_{1732}$$^{-1}$	--------	3.667 x 10^{-2}

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Table II. Energy Contents and Photon Energies of Major Energy Levels of

Atomic Hydrogen

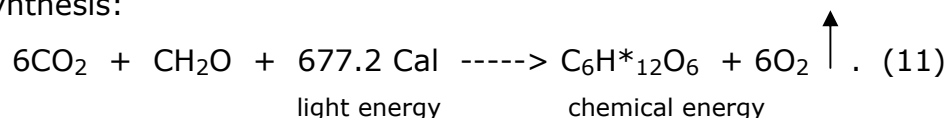| Molecule	Energy Level	Energy Content (cal mol^{-1})		Energy of Photon Emitted in "Relaxing"	
			Level of Photon	Levels Spanned	Energy of Photon (cal mol-1^{-1})
H	n = 1	313,189		(no higher	level from which to	"relax"
H	n = 2	78,297	$h\nu_1^{-1}$	313,189 –78,297	234,892 9
H	n = 3	34,799 7	$h\nu_2^{-1}$	78,297 – 34,799	43,498
H	n = 4	19,574 8	$h\nu_3^{1}$	34,799 - 19,574	15,225
H	n = 5	12,528	$h\nu_4^{1}$	19,574 - 12,528	7,046
H	n = 6	8,700	$h\nu_5^{-1}$	12,528 - 8,700	3,828
H	n = 7	6,392	$h\nu_6^{-1}$	8,700 - 6,392	2,308
H	n = 8	4,894	$h\nu_7^{-1}$	6,392 - 4,894	1,498
H	n = 9	3,867	$h\nu_8^{-1}$	4,894 - 3,867	1,027
H	n = 10	3,132	$h\nu_9^{-1}$	3,867 - 3,132	735
H	n = 11	2,588	$h\nu_{10}^{-1}$	3,132 - 2,588	544
H	n = 12	2,175	$h\nu_{11}^{-1}$	2,588 - 2,175	413
H	n = 13	1,853	$h\nu_{12}^{-1}$	2,175 - 1,853	322
H	n = 14	1,598	$h\nu_{13}^{-1}$	1,853 - 1,598	255
H	n = 15	1,392	$h\nu_{14}^{-1}$	1,598 - 1,392	206
H	n = 16	1,223	$h\nu_{15}^{-1}$	1,392 - 1,223	169
H	n = 17	1,084	$h\nu_{16}^{-1}$	1,223 – 1,084	139
H	---	----	-----	------	----
H	n = 40	195	$h\nu_{39}^{1}$	-------	----
H	---	-----	-----	-------	-----
H	n = 50	125	$h\nu_{49}^{-1}$	-------	----
H	---	-----	------	--------	----
H	n=1514	0.1361	$h\nu_{1513}^{-1}$	--------	0.1361

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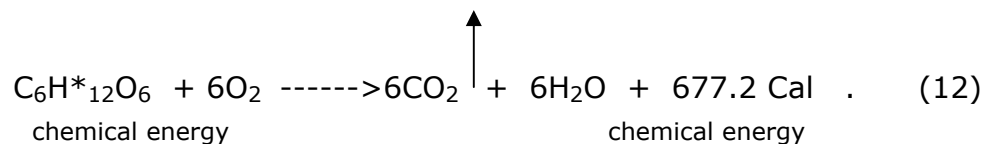3. Photosynthesis and Catabolism: Bioenergetics

The quantum energy levels and photon energies of atomic hydrogen and phosphate permit clarification of the confused picture of photosynthesis and catabolism and indicate that the phosphate system and hydrogen were linked together as the basis of catabolism from the earliest beginning of life on earth.

The extensively quoted overall formulas and bioenergetics of photosynthesis and catabolism (which—by implication of the formulas—are reversible processes) appear as follows (21):
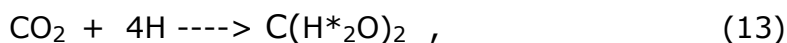
For photosynthesis:

$$6CO_2 \; + \; CH_2O \; + \; 677.2 \; Cal \; \text{-----}> \; C_6H*_{12}O_6 \; + 6O_2 \uparrow . \quad (11)$$

<div align="center">light energy   chemical energy</div>

For respiration:

$$C_6H*_{12}O_6 \; + 6O_2 \; \text{------}>6CO_2 \uparrow + \; 6H_2O \; + \; 677.2 \; Cal \; . \quad\quad (12)$$

<div align="center">chemical energy   chemical energy</div>

From (11) and (12) it is apparent that one mole of glucose has 12 H* and that each H* possesses 677,200/12 or 56,433 ca1 mo1^{-1}.

An eminent authority in photosynthesis states the primary reaction of photosynthesis as follows (22):

$$CO_2 \; + \; 4H \; \text{---->} \; C(H*_2O)_2 \; , \quad\quad\quad\quad\quad (13)$$

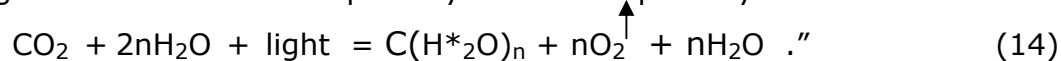and puts forth the following energetics in relation to (13):

"To reduce (hydrogenate) a molecule of carbon dioxide to the 'reduction level' of sugar, four hydrogen atoms must be transferred to the molecule $C(H*_2O)_2$ . . . . .To move these hydrogen atoms 'uphill' from water to carbon dioxide, each of the four atoms must receive a push equivalent to at least one fourth 112 [112.8] kilocalories, or 28 [28.2] kilocalories per gram of hydrogen .[10] These pushes must be supplied by light."

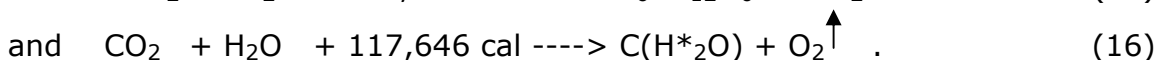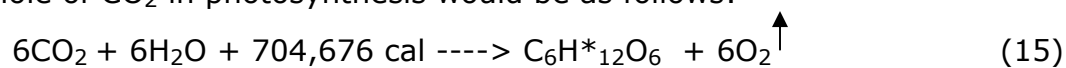That (13) is regarded as the formula for the primary reaction of

photosynthesis can be seen from a second authoritative source (23):
"The general formula for the primary reaction in photosynthesis is:

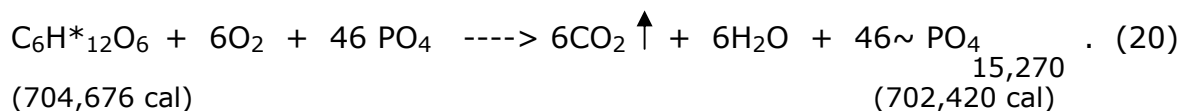$$CO_2 + 2nH_2O + light = C(H*_2O)_n + nO_2{\uparrow} + nH_2O \; ."$$ (14)

According to formula (13) and the quoted discussion, the energy required to move one H atom uphill to CO_2 is 28,200 cal per gram of atomic hydrogen. For the 12 H* in one mole of glucose, this would be a total of 338,400 ca1 mo1^{-1} of glucose. But from formula (11), one mole of glucose had a total caloric content of 677,200 ca1 mo1^{-1}. It thus appears that (13) accounts for only one-half of the calories actually involved. To move one gram atom of hydrogen uphill from H_2O would require, rather, 1/12 of 677,200 or 56,422 cal per gram atom of H. Moreover, according to the relevant cal- culated quantum energy level value for atomic hydrogen (58,723 ca1 mo1^{-1}), it seems that the 56,433 value is also too low, since at least 58,723 ca1 mo1^{-1} are required to lift H* from n = 4 to n = 2. (This would also mean that 58,723 cal are required to move one atom of H uphill from H of H_2O to CO_2.) It follows that the basic minimum energy requirements for photosynthesis would be 58,723 x 12 or 704,676 ca1 mo1^{-1}. The basic minimum energy requirements to hydrogenate one mole of CO_2 to the reduction level of glucose by H* would then be: 58,723 x 2 or 117,446 ca1 mo1^{-1}. Therefore, it appears that the general formulas and energetics involved in the synthesis of one mole of glucose and in the hydrogenation of one mole of CO_2 in photosynthesis would be as follows:

$$6CO_2 + 6H_2O + 704,676 \; cal ----> C_6H*_{12}O_6 + 6O_2{\uparrow}$$ (15)

and $$CO_2 + H_2O + 117,646 \; cal ----> C(H*_2O) + O_2{\uparrow} \; .$$ (16)

In addition, research indicates that the cytochrome system uses at least 8 photons to move H_2 from H_2O to CO_2. Therefore, the cytochrome system must deliver at least 117,446/8 or 14,681 ca1 mo1^{-1} quanta to some inter-mediary system which in turn supplies the energy to H_2 to H_2O to form H*.

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This intermediary system is the pyrophosphate ($\sim PO_4$) system. But in order

for $\sim PO_4$ to carry 14,681 cal to form H*, the pyrophosphate must be given at

least 15,720 ca1 mo1^{-1}, for $\sim PO_4$ requires that many calories to be pushed

from n = 3 to n = 2. Thus, in order to move H_2 from H_2O to CO_2, the $\sim PO_4$

requires 8 of the 15,720 ca1 mo1^{-1} quanta from the cytochrome system. The

quantum exchanges between cytochrome, pyrophosphate, and an activated

unit of glucose would be as follows:

cytochrome---> 8 hv ---> 8$\sim PO_4$ ---> CO_2 + H_2O + 117,466 cal-->
     15,270   15,270
    (122,160 cal) (122,160 cal)

$\uparrow$

$C(H*_2O) + O_2$.
 (117,446 cal)   (17)

Hence, it takes 8$\sim PO_4$ to push two H to 2H* and 4$\sim PO_4$ (61,080 cal)
     415,270   415,270
to move one H to H*.

  We may now return to formulas (15) and (16). The general overall

formula (including carrier) and energetics in photosynthesis from quantum

considerations would be:

 $6CO_2$ + $6H_2O$ + 47$\sim PO_4$ -----> $C_6H*_{12}O_6$ + $6O_2$ $\uparrow$ + 47 PO_4 . (18)
        15,270
      (717,690 cal) (704,676 cal)

(The energetics of formula (18) are to be compared with those of formula

(11).) The primary reaction in which chloroplasts produce H* and O_2 would be:

CO_2 + H_2O + 8$\sim PO_4$ ----> C ($H*_2O$) + O_2 $\uparrow$ + 8 PO_4.   (19)
      415,270
    (122,160 cal) (117,446 cal)

(The energetics of formula (19) are to be compared with the 112,866 cal
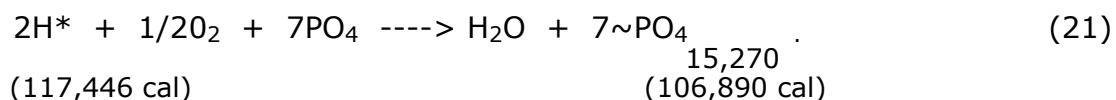
associated with the discussion of formulas (13) and (14).)

The general overall formula and energetics involved in the production of $\sim PO_4$ from one mole of glucose in catabolism would be:

$$C_6H^*{}_{12}O_6 \ + \ 6O_2 \ + \ 46\ PO_4 \ \ ----> \ 6CO_2\uparrow \ + \ 6H_2O \ + \ 46\sim PO_4 \ . \ \ (20)$$
$$\phantom{C_6H^*{}_{12}O_6 \ + \ 6O_2 \ + \ 46\ PO_4 \ \ ----> \ 6CO_2\uparrow \ + \ 6H_2O \ + \ 46\sim PO_4}{\scriptstyle 15,270}$$

(704,676 cal)   (702,420 cal)

(The actual yield of one mole of glucose in catabolism is $39\sim PO_4$. The energetics of formula (20) are to be compared with those of formula (12). It is apparent that photosynthesis and catabolism are not reversible processes.)

The primary "charging reaction" of catabolism would be:

$$2H^* \ + \ 1/2O_2 \ + \ 7PO_4 \ ----> \ H_2O \ + \ 7\sim PO_4 \ . \hspace{3cm} (21)$$
$${\scriptstyle 15,270}$$

(117,446 cal)   (106,890 cal)

Now, it has recently been experimentally established that ATP can receive quanta directly from gaseous hydrogen via a process called "photo-synthetic phosphorylation" (24). The charging reaction of "photosynthetic phosphorylation" or "ATP-photosynthesis" is:

$$2H^* \ + \ PO_4 \ ----> \ H_2\uparrow \ + \ 2\sim PO_4 \ . \hspace{3cm} (22)$$

Formula (22) is very similar to (21) with the exceptions that the H^* in "ATP-photosynthesis" comes from atomic H (and not from H_2O) and that H is "oxidized" to gaseous H_2, a process not requiring the presence of O_2. (In other words, when ATP is formed in catabolism, it yields a molecule of H_2O. When ATP was formed in the acid medium of the primary pools, it gave up $H_2\uparrow$.) Thus, if H and PO_4 both emitted quanta with a common wavelength, formula (22) could well represent the pyrophosphate's primordial "charging-reaction" which underlay the aboriginal rise of life on earth.

5. Phosphate's Aboriginal Catabolic System

By carefully inspecting the quantum level and quantum (photon) values for atomic hydrogen and pyrophosphate (Tables I and II), one finds that H^* and $\sim PO_4$ emit photons at virtually identical wavelengths. The wavelength (v) and

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frequency (v^{-1}) for H* at 15,225 ca1 mo1^{-1} are calculated as follows.

Previously:

$$\epsilon = \frac{h \times N \times c}{(v \times 10^{-8})\ (4.186 \times 10^7)} \quad . \tag{5}$$

Another way of writing this same equation:

$$v = \frac{h \times N \times c}{(\epsilon)\ (10^{-8})\ (4.186 \times 10^7)} \quad .$$

At H* = 15,225 ca1 mo1^{-1} :

$$v = \frac{(6.62517 \times 10^{-27})\ (6.02486 \times 10^{23})\ (2.99793 \times 10^{10})}{(15,225)\ (10^{-8})\ (4.186 \times 10^7)}$$

$$= \frac{119.66453 \times 10^4}{63.73185}$$

$$= 18,776\ \overset{\circ}{A}\ \text{or}\ 1.8776 \times 10^{-4}\ \text{cm.} \tag{23}$$

From equation (8), we have $v^{-1} = c/v$. Therefore, for the atom under consideration:

$$v^{-1} = \frac{2.99793 \times 10^{10}}{1.8776 \times 10^{-4}}$$

$$v^{-1} = 1.597 \times 10^{14}\ \text{cps.} \tag{24}$$

Similarly, the wavelength and frequency for ~PO_4 at 15,270 ca1 mo1^{-1} are:

$$v = \frac{(6.62517 \times 10^{-27})\ (6.02486 \times 10^{23})\ (2.99793 \times 10^{10})}{(15,270)\ (10^{-8})\ (4.186 \times 10^{-7})}$$

$$= \frac{119.66453 \times 10^4}{63.92022}$$

$$= 18,721\ \overset{\circ}{A}\ \text{or}\ 1.8721 \times 10^{-4}\ \text{cm.} \tag{25}$$

$$v^{-1} = \frac{2.99793 \times 10^{10}}{1.8721 \times 10^{-4}}$$

$$= 1.601 \times 10^{14}\ \text{cps.} \tag{26}$$

The difference in wavelength between the 15,225 and the 15,270 ca1 mo1^{-1} photons absorbed by H and ~ PO_4, respectively, is 18,776 $\overset{\circ}{A}$ – 18,721 $\overset{\circ}{A}$ – 55 $\overset{\circ}{A}$.

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The wavelength of a photon at frequency 1.60×10^{14} cps is:

$$v = \frac{2.99793 \times 10^{10}}{1.60 \times 10^{14}}$$

$$= 1.8737 \times 10^{-4} \text{ cm or } 18,737 \text{ Å}. \hspace{2cm} (27)$$

The difference of 55 Å between the wavelength of $H^*_{18,776}$ Å and that of $\sim PO_4{}_{18,721}$ Å falls well within a single photon vibrating at 1.60×10^{14} cps. The quantum numbers for the 18,721 Å photon within $\sim PO_4$'s second major energy level are n = 2, l = 1, m = 0, s = ½ and for the 18,776 Å photon (emitted by H*) within the same major energy level of $\sim PO_4$, the quantum numbers are n = 2, l = 0, m = 0, s = ½. Thus, as far as quantum mechanisms are concerned, the 15,225 and the 15,270 cal mol^{-1} photons of H* and $\sim PO_4$ have resonant wavelengths, which means both species of chemicals could keep up a continuous exchange of energy. In other words, a 15,225 cal mol^{-1} photon emitted by H* could force $\sim PO_4$ from n = 3 to n = 2. Conversely, a 15, 270 cal mol^{-1} photon emitted by $\sim PO_4$ could force H from n = 4 to n = 3. Thus, the phosphate system could store photons in atomic H or receive photons from atomic H* for the pyrophosphate's subsequent or immediate use.

The significance of the fact of the resonance identity between $H^*_{18,776}$ Å and $\sim PO_4{}_{18,721}$ Å is that the former could reasonably have served as the aboriginal power carrier for the phosphate system as formula (22) suggests. A continuous supply of high free energy for the pyrophosphates of ATP could have come from photons donated by $H^*_{18,776}$ Å which in turn absorbed these photons from the earth's own natural radiation. The following important facts point to the validity of this conclusion. First, atomic H is well know to be a powerful absorber in the near infrared (8). Second, the concept of "ATP-photosynthesis", to which reference has already been made,
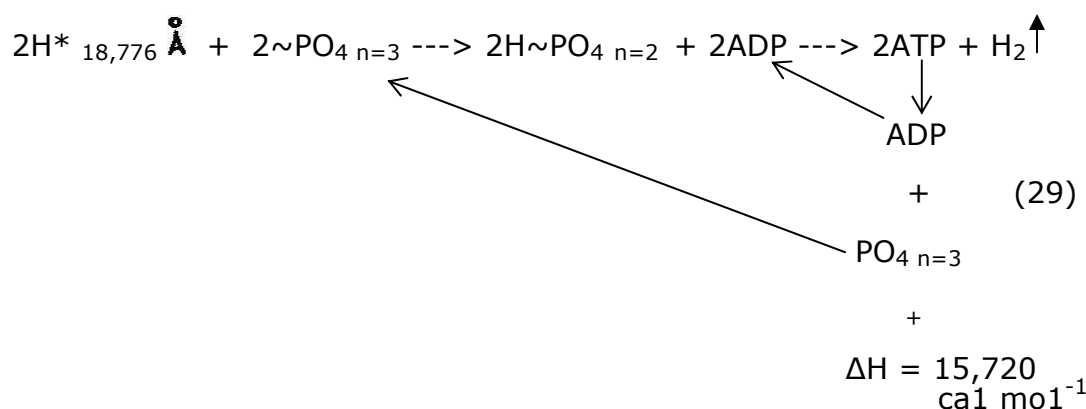
has recently been experimentally established, as the following quote indicates:

"Photosynthetic phosphorylation has provided direct experimental evidence for the view that the key event in photosynthesis, the conversion of light into chemical energy, is independent of the classical manifestation of this process in green plants—oxygen evolution and carbon dioxide reduction. In the light-dependent phosphorylation of cyclic type...CO_2 is not assimilated nor is O_2 evolved ...the only identifiable product of the absorbed light energy is ATP... In the presence of hydrogen gas, the contribution of light...may be limited to formation of ATP (24)." Third, the earth, even today, is a strong emitter of quanta in the near infrared. The earth's total radiation is .06 watts/cm^2, with most of this natural radiation coming from the near infrared (and longer) with its peak at 1×10^5 Å which is not at all far distant in the electromagnetic spectrum from 18,776 Å (8,25). (One can readily assume that the earth was a heavy emitter over the entire infrared frequency band—as well as over the entire radar and radio frequency bands—in the past, especially when the earth was still a nascent planet.)[11]   This factor would have assured the phosphate system, deep in the primary volcanic pools, a continuous supply of quantum energy for a long period.   Fourth, the hydrogen quantum carriers appear to have been present in constant supply.   When the earth's crust was less stabilized chemically than it is now, gaseous atomic hydrogen was available in great abundance (26). This source of supply was abetted by the hydrogen gas stemming from the degassing of the earth's interior and by the supply of H in the primary atmosphere, which was in equilibrium with that present in the primary hydrosphere.

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It is postulated here that the following "charging-reaction" was pyro-phosphate's aboriginal catabolic system:

$$2H^*\ _{18,776}\overset{\circ}{A}\ +\ 2{\sim}PO_{4\ n=3}\ ---->\ H_2\uparrow +\ \ 2{\sim}PO_{4\ n=2}\ .\ \qquad (28)$$

And that formula (28), expressed in terms of the pyrophosphates likely involved:

$$2H^*\ _{18,776}\overset{\circ}{A}\ +\ 2{\sim}PO_{4\ n=3}\ --->\ 2H{\sim}PO_{4\ n=2}\ +\ 2ADP\ --->\ 2ATP\ +\ H_2\uparrow$$

ADP

$$+\qquad (29)$$

$$PO_{4\ n=3}$$

$$+$$

$$\Delta H\ =\ 15,720\ cal\ mol^{-1}$$

This postulated schematic of the pyrophosphate's primordial catabolic system is presented in Figure 1.

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        Insert Fig. 1 about here
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The pyrophosphate system would have been continuously driven by hv $_{18,776}\overset{\circ}{A}$ quanta emanating from the earth and carried to the pyrophosphate system by $H^*_{18,776}\overset{\circ}{A}$. ATP would have been kept constantly present and at a high level of free energy in the pyrophosphate system due to the negative and positive feedback mechanisms of ADP and $PO_{4\ n=3}$, just as is the case of catabolism in modern organisms. Then, if a releasing catalyst having the effect of ATPase was also present, ATP's energy would have been continuously released; environmental fluctuations could have released ATP's potential energy to
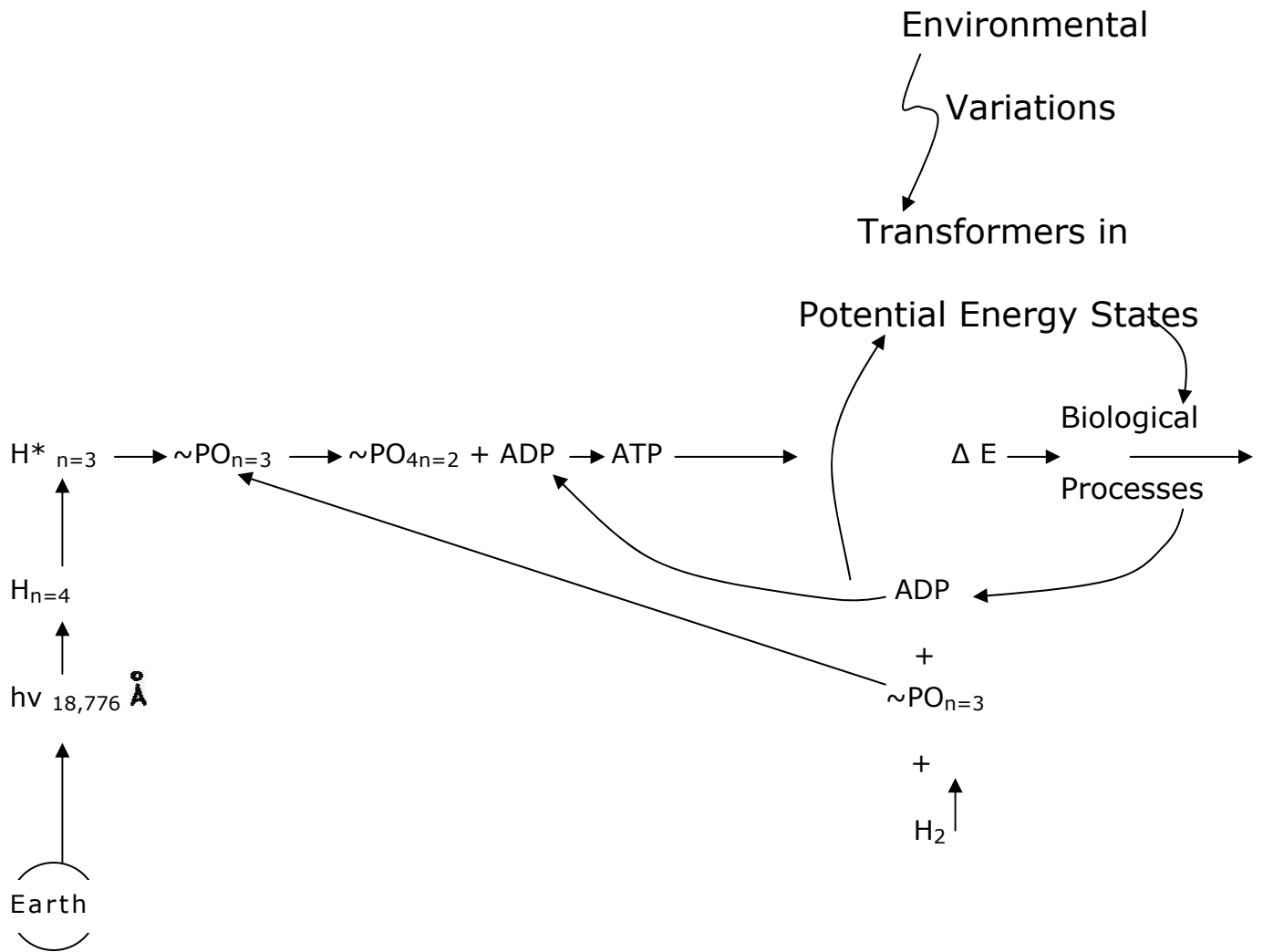
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FIG. 1

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various biochemical transformers (to which ATP had become attached).

6. The Aboriginal Catalyst of the Pyrophosphate System

If the aboriginal pyrophosphate system was continually supplied with a source of energy, the next major question would be: "How was the free energy of ATP released so that it could energize the biochemical transformers to which ATP became attached?"   A transformer could be an amino acid, a nucleotide, a protein, a nucleic acid, etc.   To posit an answer to this question, we must first understand the operation of what is called "The Biological Energy Cycle" (which is schematized in Figure 2) and then we must consider the apparent determination of ATP's unit frequency.

Insert Fig. 2 about here

The "Biological Energy Cycle"—which the writer prefers to call the ATP-Pyrophosphate Cycle (or simply the pyrophosphate cycle)—is taken from Baldwin's 1953 edition of <u>Dynamic Biochemistry</u> (14) and has been modified to accord with the research of A. Szent-Győrgyi (27).

In the first step [1] of the pyrophosphate cycle, let it be assumed that, to initiate the cycle, the catabolistic system provides the cycle with <u>two</u> molecules of ATP.

In this second step of the cycle, the free energy of one of the ATP molecules is released, passed through a transformer, and appears as the potential energy of the transformer. The second molecule of ATP is linked to the transformer which is in its resting state [2].
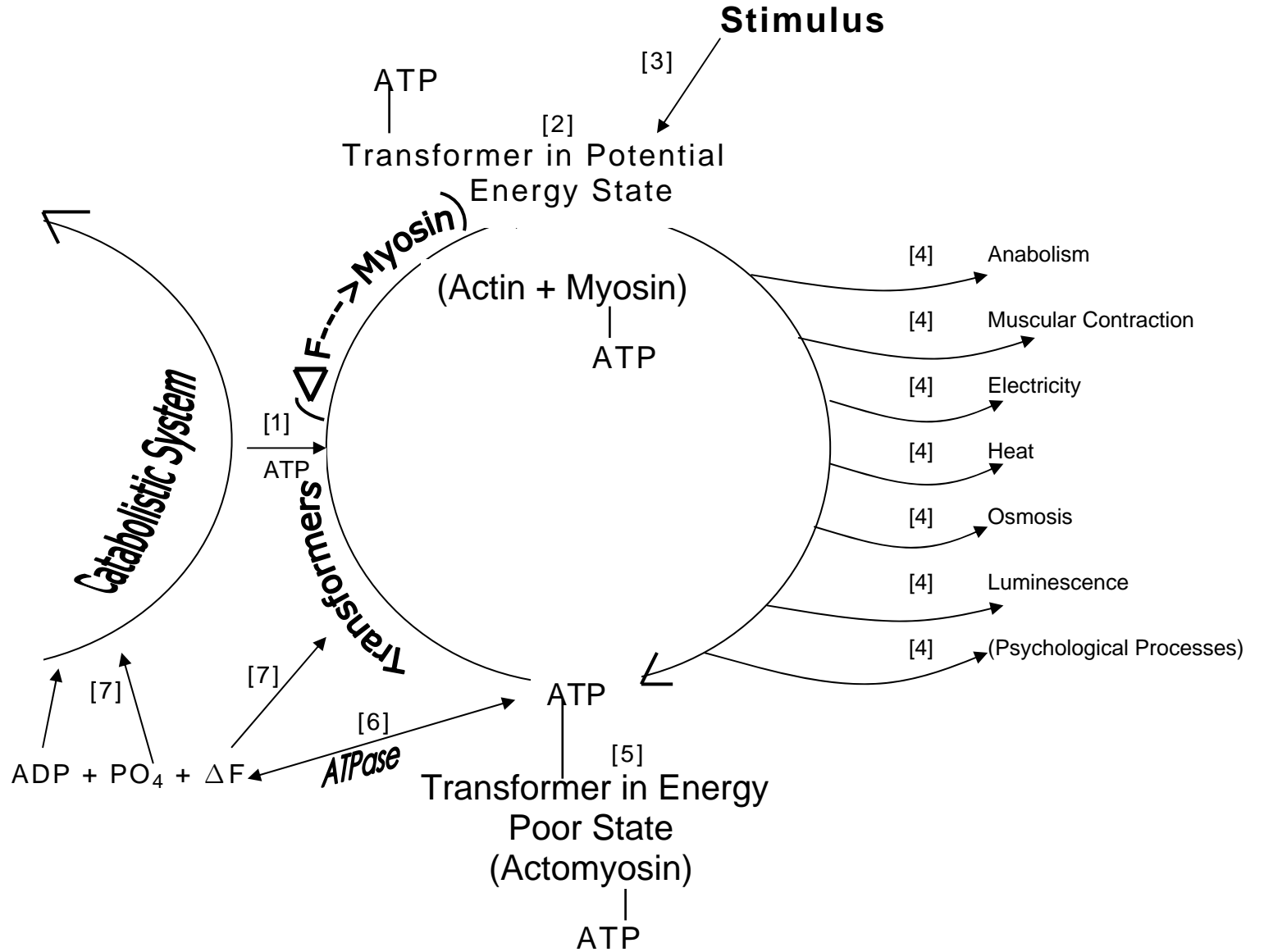
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Stimulus

[3]

ATP

[2]
Transformer in Potential
Energy State

(Actin + Myosin)

ATP

(△F--->Myosin)

Catabolistic System

Transformers

[1]

ATP

[4] Anabolism

[4] Muscular Contraction

[4] Electricity

[4] Heat

[4] Osmosis

[4] Luminescence

[4] (Psychological Processes)

[7]

[7]

[6]

ATP

ADP + PO₄ + △F

ATPase

[5]
Transformer in Energy
Poor State
(Actomyosin)

ATP

FIG. 2

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The third step [3] of the pyrophosphate cycle is the action of the stimulus. The stimulus excites the resting transformer (from its potential energy state) into its kinetic state which causes the transformer to perform its intrinsic function.

The biological functions—step four [4]—known to operate in this manner are listed on the right of Fig. 2.   The writer has added the psycho-logical processes to the list of functions on the basis of his published work (5). Since accounting for the emergence and evolution of the psychological processes necessitates field theory concepts, this problem will be dealt with in a follow-up paper.

In step five [5], the transformer reaches its energy poor state.   Note that the transformer in its resting state [2] had a molecule of ATP attached to it.   Also note that the stimulus [3] and the performance of the transformer's intrinsic function [4] did not involve this ATP molecule.   In this energy poor state [5], the transformer exposes its attached ATP molecule to ATPase.

When the transformer reaches its energy poor state [5], an enzyme—ATPase—breaks ATP down into ADP and PO_4 and releases its free energy, ΔF, step six [6].

In step seven, [7], ADP and PO_4 are fed back into the catabolistic system and simultaneously, the released free energy, ΔF, is driven through the transformer which, in turn, converts the free energy into the chemical, mechanical, or electrical potential energy of the transformer's resting state.

As the transformation process proceeds, the first step [1] of the pyrophosphate cycle again comes into operation; the catabolistic system provides the transformer with <u>one</u> molecule of ATP.   The resting state of

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the transformer is thus now completely restored.   Thus, all biological transformers in their resting (reactive) state have energy in two forms: one is the potential chemical, electrical or chemical energy of the transformer, the other is the free energy which is within the pyrophosphate of the ATP molecule attached to the resting transformer.

A concrete example of muscular contraction has been included in Fig. 2 in parentheses to facilitate the understanding of the pyrophosphate cycle. In its resting (reactive) state, a muscle fiber is composed of units of two separate molecules, actin and myosin.   The potential energy of the muscle fiber consists of the stretched condition of the muscle transformer which is myosin (a protein).   Note that a molecule of ATP is attached to the myosin molecule.   A stimulus (which is step three [3] of the pyrophosphate cycle) causes the mutually repelling, charged ionic groups along the length of myosin (the potential mechanical energy) to be neutralized which in turn forces the actin and myosin units to combine to form actomyosin.   Muscular contraction is the result with the energy of the potential state being mainly utilized in the contraction process with some given off as heat.   Note that, in the energy poor state of actomyosin, the ATP molecule is still attached to the myosin part of actomyosin.   To contract again, the muscle fiber must possess separate actin and myosin molecules and myosin must be restored to its potential energy state.   When, and only when, myosin has run down and actomyosin has been formed, the ATP molecule is exposed, ATPase comes into operation, releasing the free energy from ATP and directing it so that it is driven through the myosin molecule.   The electromagnetic (free) energy driving through the transformer, or myosin, forces the actomyosin to dissociate into actin and myosin and restores the potential mechanical energy state of myosin. During this transformation process, the catabolistic system

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attaches a fresh ATP molecule to myosin.   Thus, the muscle fiber is now reactive and in a position to be self-restorative.   An important point to note is that ATP is the mediate and not the immediate source of energy for muscular contraction.

These principles of the pyrophosphate cycle can now be generalized to point out an important feature.   Note that the catabolistic system initiates the cycle, that it is responsible for the cycle's resting state of potential energy and that it keeps the cycle operating by supplying it with ATP molecules.   Let us call the potential energy of the transformer in its resting state and the free energy in the ATP molecule attached to the transformer, "the norm". Since the catabolistic system has but one function—to synthesize ATP molecules which sustain the potential and free energy level or norm of the pyrophos-phate cycle, the catabolistic system (whatever its origin or nature is) can be called the normalizing process (28). Thus, the normalizing process maintains biological transformers at a high level or energy or norm. Stimuli produce deviations from this norm and evoke functions of the pyrophosphate cycle which eliminate the deviation.   The operation of the catabolistic system can be summarized by stating that the normalizing process facilitates, via the pyrophosphate cycle, the synthesis of structures or performance of functions that maintain its norm (5).   The important point is that there exists an organizing process (catabolism) within living systems which supplies energy to transformers and, hence, to their processes and functions, and which operates to offset stimuli which cause deviation from the high energy norm of the process. (28, 5, 11, 29, 30, 31, 32)

The unit frequency of ATP-pyrophosphate may now be delineated. In 1959, in the course of exploratory hazard microwave research, ATP's unit frequency was discovered accidentally in investigations sponsored by the

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Naval Research Laboratory (33).   In the course of an investigation on the effects of UHF quanta on the brains of monkeys, the experimenters projected 380 to 391 mc quanta (in steps of one mc) down the midline of the monkey's reticular formations.   In 30 sec. the megacycle quanta aroused the monkey from deep anesthesia; the quanta then produced a series of trauma-indicative symptoms which ended in death within two to ten minutes for the ten monkeys so radiated.   Since the power levels used were very low (surface exposure 12.8 mw/cm^2) and since no heat effects were found upon autopsy in the ten primates so radiated, the investigators attributed the UHF effects to resonance within the brain's neurological circuits.

When this discovery was brought to the attention of this writer, he predicted that the unit frequency of ATP had been accidentally determined and that one of the frequencies between 380 and 391 mcs would subsequently prove to be ATP's actual unit frequency. The rationale is as follows.   In the July 1957 issue of The Scientific American, Phillip Siekevitz, in his article "Powerhouse of the Cell" had the following to say about mitochondria, ATP and transformers:

"It appears that the mitochondria supplies the cell with most of its usable energy: they have been called the power house of the cell... The oxidation of foodstuffs occurs largely in mitochondria at least those cells of liver, kidney, heart and brain cells... Concurrently with all these transfers and oxidations another process is going on. The energy released by oxidation is transferred into the energy rich ATP. Most of the energy required by the cell is provided in this way, and most of it is produced in the mitochondria. Some of the energy of ATP is used in the mitochondrion but most of the ATP is immediately shot out to power the other activities of the cell... This singular function of the mitochondria appears to be reflected by their location within various kinds of cells.   In muscle cells the mitochondria form rings around

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that part of the muscle fiber which actually contracts. In nerve cells they cluster around the junction of one cell and another, where the energy of the nerve impulse in transferred. In sperm cells they accumulate in the 'neck' of the cell, where its head joins its whiplash tail..."

In other words, around every biological transformer there appears to be a concentration of ATP-producing mitochondria.   By 1959, it was apparent that the mid-brain reticular formations was the transformer for all conscious psychological processes (34, 5).   The writer then assumed that the mid-brain reticular formations had a concentration of ATP-producing mitochondria along its length and that the experimenters, by projecting the UHF quanta down the midline of the monkey's reticular formations, were bringing about the break-down of ATP at a very rapid rate.

According to solid state physics, if a molecule with a high energied "free electron" (such that ATP possesses) is subjected to a slight charge from a static electrical field, the energy of the "free electron" "acts as if gravity were directed upward instead of down", for the electronic energy comes streaming out of the molecule.   The writer assumed that the UHF quanta acted in a manner similar to that of the slight static charge and that one of the quantum frequencies employed would prove to be the most critical.   It is postulated that, when ATP absorbs a UHF quantum (in step 2 of Fig. 2), the released electronic energy first excites the resting transformer from its potential into its kinetic state so that the transformer is forced to perform its intrinsic function. Since (from Fig. 2) the transformer cannot go "up" until it has gone all the way "down", the transformer proceeds to its energy poor state. Then, and only then, can the free energy released

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from ATP by the UHF quanta restore the transformer to its potential energy state. The continued presence of the UHF quanta would result in the immediate excitation of the transformer again, with a repetition of the cycle of events. The normalizing process (catabolism), on the other hand, would continue to supply the speeded up cycle with fresh ATP molecules each time the transformer was driven upward.

That one of the frequencies employed by the above experimenters— 385 mc—is the unit frequency of ATP will be seen from the following. The energy level (in ca1 mo1^{-1}) of the unit quantum will be compared with the energy level (in ca1 mo1^{-1}) of the dissociation quantum for both atomic hydrogen and the phosphate system.   If the unit and dissociation quantum in ca1 mo1^{-1} for the 385 mc and the 2600 Å quanta are equivalent, 385 mc is the unit frequency of ATP.   These calculations also afford an independent check for the values calculated in Tables I and II.

According to Planck's development of quantum theory, an atom or molecule can absorb a photon in the unit quantum as expressed by:

$$E_1 = h\ v_1{}^{-1} \tag{2}$$

or in whole number multiples, n, thereof:

$$E_n = nhv_1{}^{-1} = hv_{Ds}{}^{-1} = D_s . \tag{3}$$

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Taking atomic hydrogen as an example, equation (3) states—in relation to the unit and dissociation energy of H—that the energy content of the photon which atomic H absorbs as its unit frequency (hv_1^{-1}), multiplied by the integral number, n, which expresses the ratio of the dissociation frequency of H to the unit frequency of H, will yield the energy content of the dissociation quantum of H (in ergs per H) or E_n.

The unit and dissociation quanta in ca1 mo1^{-1} for atomic H will now be calculated and compared for equivalence, both to serve as an example of the procedure involved and because the dissociation and unit frequencies of atomic H are accurately known.

The unit wavelength, 21 cms, of atomic hydrogen has long been known.

$$v_1 \text{ of H } = 21 \text{ cms.} \tag{30}$$

Then:

$$v_1^{-1} \text{ of H } = c/v_1$$

$$= \frac{2.99793 \times 10^{10}}{21}$$

$$= 1.4276 \times 10^9 \text{ cps .} \tag{31}$$

The ionization potential for atomic H is 13.60 ev which, according to equation (6), yields 313,189 ca1 mo1^{-1} as the dissociation energy for atomic H. The dissociation wavelength, v, of H_{Ds}, also calculated from equation (6), is 9.127666×10^{-6} cm. The dissociation frequency of H is given by:

$$v^{-1} \text{ of } H_{Ds} = \frac{2.99793 \times 10^{10}}{9.127666 \times 10^{-6}}$$

$$= 3.28444 \times 10^{15} \text{ cps .} \tag{32}$$

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The integral multiple, n, that v^{-1} of H_{Ds} (32) is of v_1^{-1} of H (31) follows:

$$n = \frac{v^{-1} H_{Ds}}{v_1^{-1} H} .$$

(33)

Substituting from (31) and (32) into (33):

$$n = \frac{3.28444 \times 10^{15}}{1.4276 \times 10^9}$$

$$= 2{,}300{,}707 .$$

(34)

According to equation (3), the dissociation energy of H should be equal to

$n (h\, v_1^{-1}) \times N/4.186 \times 10^7$ where $N/4.186 \times 10^7$ is brought in to obtain the

results for a gram atomic weight of H in calories. The experimentally deter-

mined association energy of H is:

$$D_s \text{ of H} = 313{,}189 \text{ ca1 mo1}^{-1} .$$

(35)

Therefore, by equation (3):

$$D_s \text{ of H} = n (h\, v_1^{-1}) \times N/4.186 \times 10^7 .$$

(36)

Substituting (35) into (36):

$$313{,}189 \text{ ca1 mo1}^{-1} = \frac{2{,}300{,}707 \,(6.62517 \times 10^{-27} \times 1.4276 \times 10^9) \times 6.02486 \times 10^{23}}{4.186 \times 10^7}$$

$$313{,}189 \text{ ca1 mo1}^{-1} = 313{,}190 \text{ ca1 mo1}^{-1} .$$

(37)

As equation (3) demands, if 1.4726×10^9 cps is the unit frequency of H, the

dissociation energy of H in ca1 mo1^{-1} would be $nh \times 1.4276 \times 10^9$ cps $\times$

$N/4.186 \times 10^7$. As indicated by (37), where 313,189 ca1 mo1^{-1} = 313,190

ca1 mo1^{-1}, the 21 cm quantum is the unit frequency of atomic hydrogen, as

was to be expected.

Let it be assumed that the 385 megacycle frequency is the unit

frequency of ATP and let it be further assumed that the primate subjects met

their fate because the unit frequency of an atom or molecule operates in the

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manner of an electromagnetic catalyst (and a stimulus releaser per the pyro-phosphate cycle) which releases the electronic energy of an atom or molecule possessing a high energied "free electron" such as possessed by ATP. If 385 mc is the unit frequency of ATP, then:

$$v_1^{-1} \text{ of ATP } = 385 \text{ mc } = 3.85 \times 10^8 \text{ cps } . \tag{38}$$

The delabilization frequency of ATP is given by equation (9):

$$v^{-1} \text{ of } \sim PO_{4Ds} \text{ (or ATP) } = 1,15305 \times 10^{15} \text{ cps } . \tag{9}$$

Therefore,

$$n = \frac{v^{-1} \text{ of } \sim PO_{4Ds}}{v_1^{-1} \text{ of } PO_4} . \tag{39}$$

Substituting from (38) and (9) into (39):

$$n = \frac{1.15305 \times 10^{15}}{3.85 \times 10^8} = 2,994,935 . \tag{40}$$

According to equation (3), the delabilization energy of $\sim PO_4$ should be equal to n ($h\, v_1^{-1}$) x N/4.186 x 10^7 . The delibilization energy of ATP, as given by equation (10):

$$D_s \text{ of } PO_4 = 109,949 \text{ ca1 mo1}^{-1} . \tag{10}$$

Therefore:

$$D_s \text{ of } PO_4 = n (h\, v_1^{-1}) \times N/4.186 \times 10^7 . \tag{41}$$

Substituting (10) into (41):

$$109,949 \text{ ca1 mo1}^{-1} = \frac{2,994,935 (6.62517 \times 10^{-27} \times 3.85 \times 10^8) \times 6.02486 \times 10^{23}}{4.186 \times 10^7}$$

$$109,949 \text{ ca1 mo1}^{-1} = 109,949 \text{ ca1 mo1}^{-1} \tag{42}$$

As equation (3) demands, only if the assumption—that 385 mc <u>is</u> the unit frequency of phosphate—is true, would the dissociation energy of ATP in ca1 mo1^{-1} be an exact integral multiple of a mo1^{-1} of 385 quanta (in calories). As indicated by (42), where 109.949 ca1 mo1^{-1} = 109,949 ca1 mo1^{-1}, it may be concluded that 385 is the unit quantum frequency of phosphate.

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The assumption was made that 385 mc quantum produced the profound effects observed in the primates due to the unit frequency of ATP (absorbed by reticular ATP) operating in a manner similar to an electromagnetic catalyst which released the free energy of the reticular ATP.   Referring to Fig. 2, it is apparent that PO^4's unit quantum (385 mc), when absorbed by $\sim PO^4$, takes the place of both the enzyme, ATPase, and the stimulus. In effect, the 385 mc acts as a stimulus forcing the cycle to perform its function, and then acts as ATPase, by driving the cycle upward to restore the transformer's potential energy state. (In actual fact, the 385 mc quantum acts as ATPase in step two of the pyrophosphate cycle. But since the cycle must go "down" before it can go "up", the electronic energy released by the 385 mc quantum is the actual stimulus that forces the cycle to perform its intrinsic function.) Thus, the only possible explanation of the not only drastic but lethal effects of 385 mc quanta on a powerfully buffered living system is that the 385 mc quantum displays properties of an enzyme, ATPase, and of a stimulus-releaser on ATP's two pyrophosphates.   The transmission of a quantum of unit frequency by a catalyst or an enzyme to an atom or molecule or to a substrate may well be a general mechanism of enzymatic and catalytic action.

It is postulated that the 385 mc quantum was the primordial enzyme-catalyst which continuously released the energy of ATP pyrophosphate before organic enzymes appeared. Space research has recently established that the cooler regions of the sun's corona generate quanta of 385 mc which reach the earth's upper atmosphere, but which are now totally reflected due to the ionosphere (8).   It is reasonable to assume that a cooling earth in its primordial state would emit the same critical quantum frequency as the cooler regions of the sun. Although the writer is not aware of any data indicating the emission of 385 mc quanta form the earth at the present time, it is predicted that such emission will be found to occur, perhaps at a very low intensity. If this should prove to be the case, it would seem likely that the earth was an intense radiator of 385 mc quanta in the remote geologic past. It is postulated here that the natural radiation of the earth furnished the primordial pyrophos-
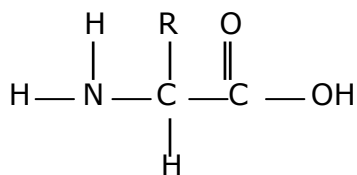
phate system with both its aboriginal catabolic quanta and its aboriginal stimulus-releaser catalyst.

7. Synthesis of the Aboriginal Protein and Nucleic Acid Transformers (35)
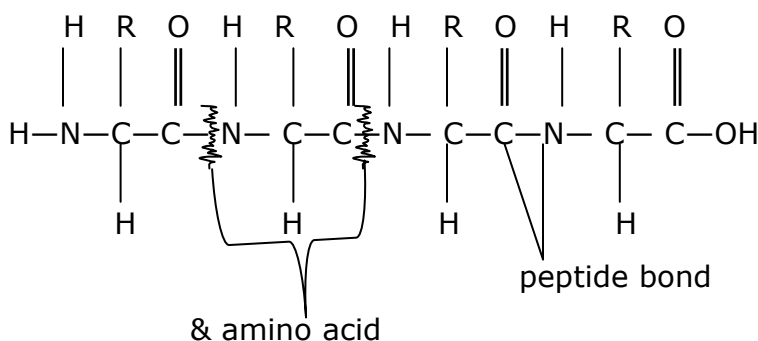
Assuming: that pyrophosphate systems were formed deep in primary volcanic pools approximately 4.8 billion years ago, and that the pyrophosphate systems were in complex reaction mixtures with—among other important chemical components—amino acids (Oparin) and nucleotides (Blum), and that the pyrophosphates were constantly supplied with H* $_{18,776}$ $\overset{\circ}{A}$ quanta, and that ATP's free energy was constantly released by the 385 quanta, and that the pyrophosphate system's normalizing process was constantly operating so as to offset environmental variations (which aboriginally were the 385 mc quanta), a major problem remaining is to account for the aboriginal syntheses of protein and nucleic acid transformers to which ATP could become attached in order to form the system depicted in Figs. 1 and 2. It should be pointed out, in reference to Fig. 2, that the transformers of the pyrophosphate cycle, which are mainly proteins and nucleic acids, account for almost all the attributes of "life" with the exceptions of the psychological processes and an internal organizing process with its intrinsic properties.

The problem that remains is to delineate a plausible mechanism underlying the aboriginal synthesis both of amino acids into polypeptides (proteins) and of nucleotides into polynucleotides (nucleic acids).

The basic structural unit of proteins is the alpha-amino acid. The general formula for these acids is:
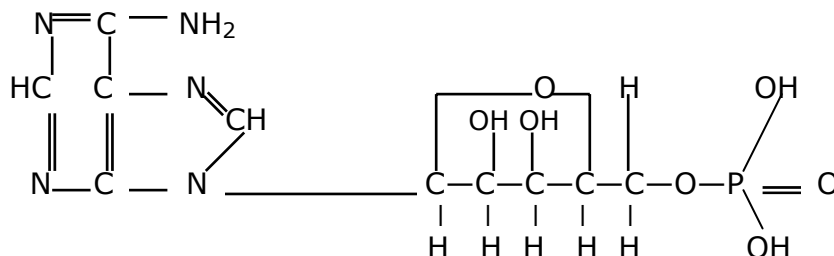
$$H - N - C - C - OH$$

where R represents a great variety of structures which differentiate the alpha-amino acids from one another. Proteins are polymers which contain varying numbers of 23 types of alpha-amino acids. The basic structural linkage of proteins is an acid amide type of bond called a peptide linkage. An example of a tetrapeptide in which four amino acids are united by a peptide linkage is shown:

peptide bond

& amino acid

The atoms of the backbone of the chain, -N-C-C-, are repeated over and over again; one protein may contain hundreds or thousands of these alpha-amino acids in peptide linkage. The formation of the peptide linkage between any two amino acids takes 3,000+ calories; the source of the energy is ATP (36).
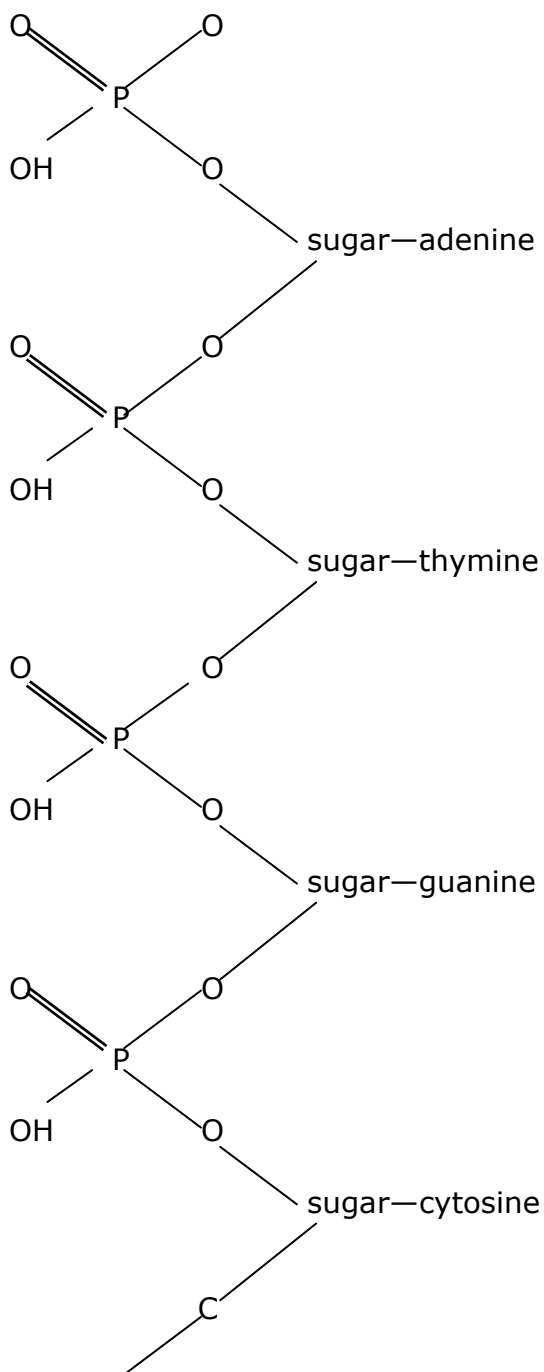
The basic structural unit of DNA and RNA is the nucleotide. Adenine nucleotide (adenylic acid or AMP) is shown:

DNA and RNA are substituted sugar molecules which are polymerized through passage through phosphate linkages. In DNA the sugar is desoxyribose; in RNA it is ribose. Both have 5-carbon rings. The substituted groups on the

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sugar molecule are four bases which are: adenine, guanine, cytosine, and thymine (in DNA) or uracil (in RNA). The nucleic acids are linked through phosphate and sugar groups as follows:

One phosphate-sugar linkage between nucleotides in a nucleic acid also takes 3,000+ calories, the energy also coming from ATP (36).

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By again carefully inspecting the quantum level and quantum (photon) energy values for atomic hydrogen and pyrophosphate (Tables I and II), one finds that H and PO_4 have a second photon wavelength in common which is almost exactly that required for peptide and nucleotide synthesis.   A close inspection of Table I shows that phosphate, when relaxing from n = 5 to n = 9, emits a photon of energy content (per mole): 4,894 − 1,853 = 3,041 calories. An inspection of Table II shows that atomic hydrogen, when relaxing from n = 8 to n = 13, emits a photon of energy content (per mole): 4,398 − 1,357 = 3, 041 calories.   Both H and PO_4 here emit identical photons (which they can also absorb and hence, exchange) whose energy level or content is 3,041 ca1 mo1^{-1} . Applying equation (5), a photon, whose energy content is 3,041 ca1 mo1^{-1} , has a wavelength of 9.427 x 10^4 Å.
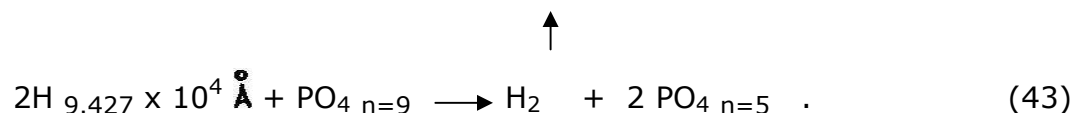
It is postulated that an energy content of 3,041 ca1 mo1^{-1} is the actual energy requirement for the 3000+ ca1 mo1^{-1} synthesis of amino acids and nucleotide linkages cited above.   The human organism, by the way, radiates infrared quanta at wavelength 9,440 x 10^{-4} Å cms which, in Angstroms, is 9.440 x 10^4 Å (37).   A radiation of 9.440 x 10^4 Å has a mole energy content of 3,029 calories. Human radiation is known to stem from catabolic breakdown of protein and nucleoproteins in the digestive process. The 3,041 and 3,029 ca1 mo1^{-1} quanta are no doubt resonant photons.

A radiation of 9.427 x 10^4 Å corresponds almost exactly with the present peak of the earth's natural radiation (1 x 10^5 Å) so it may readily be assumed that 9.427 x 10^4 Å quanta were more heavily radiated by the nascent earth. It is postulated that H$_{9.427}$ x 10^4 Å and PO$_4$ $_{9.427}$ x 10^4 Å constituted a contemporary and concurrent power system (for the phosphate system) to that of the H*$_{18,776}$ Å and ~PO$_4$ $_{18,776}$ Å system outlined in Fig. 1.
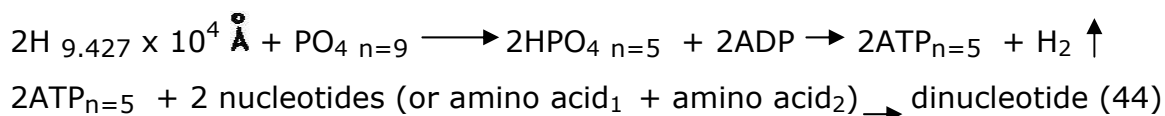
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It is postulated that the $H_{9.427 \times 10^4 \text{Å}}$ and $PO_{4\ 9.427 \times 10^4 \text{Å}}$ quanta were the power system that underlay the synthesis of the aboriginal proteins and nucleic acids.

The primary reaction which underlay polypeptide and polynucleotide syntheses would be:
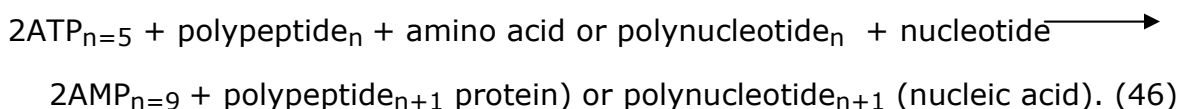
$$2H_{9.427 \times 10^4 \text{Å}} + PO_{4\ n=9} \longrightarrow H_2 \uparrow + 2\ PO_{4\ n=5} \ . \qquad (43)$$

Formula (43) expressed in terms of the syntheses involved:

$$2H_{9.427 \times 10^4 \text{Å}} + PO_{4\ n=9} \longrightarrow 2HPO_{4\ n=5} + 2ADP \rightarrow 2ATP_{n=5} + H_2 \uparrow$$

$$2ATP_{n=5} + 2 \text{ nucleotides (or amino acid}_1 + \text{amino acid}_2) \rightarrow \text{dinucleotide} \quad (44)$$

or,

$$AMP_{\overline{n=5}} \text{ amino acid}_1 + AMP_{\overline{n=5}} \text{ amino acid}_2 \longrightarrow 2AMP_{n=9} + \text{dipeptide.} \quad (45)$$

Then:

$$2ATP_{n=5} + \text{polypeptide}_n + \text{amino acid or polynucleotide}_n + \text{nucleotide} \longrightarrow$$

$$2AMP_{n=9} + \text{polypeptide}_{n+1} \text{ protein) or polynucleotide}_{n+1} \text{ (nucleic acid).} \quad (46)$$

The energy of $PO_{4\ n=5}$, released by the 385 mc quanta, polymerized amino acids and nucleotides into proteins and nucleic acids. The proteins marked the origin of the first organic enzymes and protein transformers. The polynucleotides marked the origin of the first nucleic acid transformers. The proteins and nucleic acids polymerized into nucleoproteins through simple condensation.

The proteins, nucleic acids, nucleoproteins and organic enzymes were synthesized independently of the pyrophosphate system. The next step the pyrophosphate system linked to these transformers through ATP.[12] The pyrophosphate system could then utilize the properties of these various

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transformers which furthered the evolutionary development of the entire system.   In the course of evolutionary time, the 385 mc catalyst either disappeared or was rendered ineffective with the organic catalysts and environmental variations taking its place. The primordial catabolistic system also was supplanted, in most cases by solar photosynthesis.

Conclusion:

Given the solution postulated to exist in the primary hydrosphere by Oparin and Blum and given the natural radiations of the nascent earth, it was inevitable that the pyrophosphate system appeared on the earth approximately 4.8 billion years ago.   From its earliest beginnings in the vicinity of submarine volcanoes deep in the primary pools, it is concluded that the pyrophosphate was constantly channeled a supply of 18,776 $\overset{\circ}{\text{A}}$ quanta and was constantly subjected to the 385 mc quanta which continuously released the pyrophosphate cycle's energy. The pyrophosphate system and these natural radiations from the earth constituted the primordial system of catabolism and catalysis.   Accompanying this primordial system of catabolism and catalysis were the concurrent and independent syntheses of protein, nucleic acids, nucleoproteins, transformers and organic enzymes which were synthesized by the $9.427 \times 10^4 \overset{\circ}{\text{A}}$ natural radiation from the earth and by the agency of the primordial 385 mc catalyst. The pyrophosphate system, the transformers, and the organic catalysts subsequently interlinked to provide the essentials for the rise of life upon the earth.

If the following radiations are constantly maintained: 385 mc, $9.427 \times 10^4 \overset{\circ}{\text{A}}$ and 18,776 $\overset{\circ}{\text{A}}$; and if the following conditions are maintained: pH of 4 to 5, several atmospheres of pressure, a temperature of 160º to 180º C (subsequently lowered to no higher than 60º C); if the pressure, temperature, pH, gravitation, chemical concentration and content, and other electromagnetic radiations are systematically varied; if the following constituents are

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placed into sterile H_2O: Ca^{++}, Mc^{++}, Cu^{++}, Fe^{+++}, H, NH_3, amino acids, nucleotides, organophosphate, halogens, H_2S; then it is predicted primitive living entities would be synthesized in the laboratory.

Acknowledgment:

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References

1. Oparin, A. I. The origin of life.   New York: Macmillan, 1938.

2. Oparin, A. I. The origin of life (2nd ed.).   Annotations by Sergius Morgulis. New York: Dover, 1953.

3. Oparin, A. I. The origin of life on the earth (3rd ed.). London: Oliver and Boyd, 1957.

4. Blum, H. F. Time's arrow and evolution.   Princeton: Princeton Univ. Press, 1951.

5. Baranski, L. J. Scientific basis for world civilization: unitary field theory. Boston: The Christopher Publishing House, 1960.

6. Rubey, W. W. "Development of the Hydrosphere and Atmosphere, with Special Reference to Probable Composition of the Early Atmosphere."   Crust of the earth.   (A symposium.) A. Poldervaart (Ed.) New York: The Geological Society of America, 1955.

7. Spector, W. S. (Ed.) Handbook of biological data.   Philadelphia: Saunders, 1956.

8. Slager, U. T. Space medicine. New York: Prentice-Hall, 1962.

9. Horowitz, N. H.   "On the evolution of biochemical syntheses." Proc. Nat. Acad. Sci., 31, 237, pp. 153-157, 1945.

10. Bernal, J. D. "The physical basis of life." Proc. Physical Soc., 62, pp. 537-558, 1949.

11. Pringle, J. W. S.   The origin of life. Evolution Symposium VIII of the Society for Experimental Biology (Great Britain), Cambridge University Press, 1953.

12. Calvin, M. "Chemical evolution and the origin of life." American Scientist, 44, 3: pp. 248-263, 1956.

13. Calvin, M. and Androes, G. M. "Primary quantum conversion in photosynthesis." Science, 138, 3543: pp. 867-873, 1962.

14. Baldwin, E. Dynamic aspects of biochemistry, (2nd ed.)   Cambridge: Cambridge University Press, 1952.

15. Heisenberg, W. The physical principles of the quantum theory. Chicago: Univ. of Chicago Press, 1930.

16. Prutton, C. F. and Maron, S. H. Fundamental principles of physical chemistry. New York: Macmillan, 1947.

17. Eastman, E. D. and Rollefson, G. ZK. Physical chemistry. New York: McGraw-Hill, 1947.

18. Carter, C. E. "The decomposition of diphosphopyridinenucleotide (DPN) and adenosinetriphosphate (ATP) by ultraviolet light." J. Amer. Chem. Soc., 72, 4: pp. 1835-1838, 1950.

19. Meyerhof, O. "Energy relationships in glycolysis and phosphorylation."   Ann. New York Acad.Sci., 45, 377, 1944.

20. Hausman, E. and Slack, E. P. Physics. New York: D. Van Nostrand, 1947.

21. West, E. S. and Todd, W. E. Textbook of biochemistry. New York: Macmillan, 1951.

Baranski

22. Rabinowitch, E. I. "Photosynthesis" <u>Scientific American Reader.</u> New York: Simon and Schuster, 1953.

23. McElroy, W, D. and Glass, B. (Eds.) <u>A symposium on light and life</u>. Baltimore: Johns Hopkins Press, 1961.

24. Losada, M.; Trebst, A. J.; Ogata, S. and Arnon, D. I. "Equivalence of light and adenosine triphosphate in bacterial photosynthesis". <u>Nature</u>, <u>186</u>, 4727: pp. 753-760, 1960.

25. Monell, L. "Frequency spectrum" (data chart). Los Angeles: Aerospace Electrical Society, 1962.

26. Bertin, L. (Ed.) <u>Larousse encyclopedia of the earth</u>. (Trans. from the French). New York: Prometheus Press, 1961.

27. Szent-Györgyi, A. <u>Introduction to a submolecular biology</u>.New York: Academic Press,1960.

28. Whyte, L. L. <u>The unitary principle in physics and biology</u>.   New York: Holt, 1949.

29. Selye, H. "The general-adaptation-syndrome in its relationships to neurology, psychology and psychopathology." in <u>Contributions toward medical psychology</u>, v. 1. A. Weider, Ed. New York: Ronald Press, 1953.

30. Helson, H. "Adaptation-level as a basis for a quantitative theory of frames of reference." <u>Psychol. Review</u>, <u>55</u>: pp. 297-313, 1948.

31. Osgood, C. <u>Method and theory in experimental psychology</u>. New York: Oxford Univ. Press, 1953.

32. Allport, F. <u>Theories of perception and the concept of structure</u>. New York, Wiley, 1955.

33. Bach, S.; Baldwin, M. and Lewis, S. "Some effects of ultra-high frequency energy on primate cerebral activity". In C. Susskins (Ed.), <u>Proceedings of Third Annual tri-service conference on biological effects of microwave radiating equipment</u>. New York: Rome Air Development Center, Griffiss Air Force Base. RADC TR-59-140, August 1959.

34. Magoun, H. <u>The waking brain</u>. Springfield, Ill.: Charles C. Thomas, 1958.

35. Harper, H. <u>Review of physiological chemistry</u>, (6th ed.). Los Altos, Calif.: Lange Medical Publications, 1957.

36. Tanford, C. <u>Physical chemistry of macromolecules</u>. New York: John Wiley, 1961.

37. Best, C. and Taylor, N. <u>The physiological basis of medical practice</u>, (5th ed.). Baltimore: Williams and Wilkins, 1950.

38. Crick, F. H. C., Barnett, L., Prenner, S., and Watts-Tobin, R. J., <u>Nature</u>, <u>192</u>, 1227 (1961).

39. Zubay, G., and Quastler, H., <u>Proc. Nat. Acad, Sci.</u>, <u>48</u>, 461 (1962).

40. Speyer, J. F., Lengyel, P., Basilio, C., and Ochoa, S., <u>Proc.Nat.Acad.Sci.</u>, <u>48</u>, 441(1962).

41. Fox, S. "Origin of Life." Lecture #2 in Origin and Evolution of Life Series. Sponsored by the Science and History Alliance of the County Museum of Science & Industry, Los Angeles, California. April 2, 1963.

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Footnotes

1. Since the intensity of electromagnetic radiation varies inversely with the square of the distance from the sun, it is apparent that solar photo-dissociating ultraviolet rays reach these remote planets in only insignificant quantities, which permits them to retain their primary atmosphere of NH_3 and CH_4 to the present.

2. Adenine, AMP, ADP, and ATP were probably present in only trace amounts because they were likely photodissociated almost as rapidly as they were formed.

3. The Oparin view maintains that the primary source of energy for the synthesis of amino acids was solar ultraviolet radiation of $2000\overset{\circ}{A}$. However, if a 2000 to 3000 $\overset{\circ}{A}$ solar radiation band continued to be present long after the primary volcanic pools were formed, ATP and DNA could not have been formed in significant quantities expect deep in these pools. This is because solar radiation of $2537 \overset{\circ}{A}$ dissociates adenine and adenosine into their primary components and at the same time depolymerizes DNA (7). Under current conditions, the atmosphere absorbs all solar radiation shorter than $2900 \overset{\circ}{A}$ (8). It can be shown by quantum mechanics that this $2900 \overset{\circ}{A}$ cutoff characteristic of the atmosphere is due largely to the absorption characteristics of O_3 and to the resonance absorption activation of N_2. Without this secondary atmosphere, however, the earth would be intensely radiated with quanta between $2900 \overset{\circ}{A}$ and $1700 \overset{\circ}{A}$, which would destroy all components of the adenylic acid system in the surface layers of the sea and on the surface of the earth. Accepting the hypothesis that the amino acids, subsequently incorporated into the first proteins, were formed by $2000 \overset{\circ}{A}$ radiation, it must be assumed that ATP was formed either deep in the primary pools or after the secondary atmosphere was developed.

4. After the initial mass expulsion of volatiles to form the primary atmosphere while the earth was still in the molten state, the earth continued to expel these volatile substances at a steady rate, these accretions accounting for the major characteristics of the present secondary atmosphere and hydrosphere. This sequence of atmospheric and hydrosphere development appears not only to be in accord with geo-chemical and astro-physical considerations but also is in accord with the view that ATP early adopted hydrogen as its basic energy source.   The latter signifies that free hydrogen was present in the primary volcanic pools and hence present in

abundance in the primary atmosphere, which in turn signifies that the primary atmosphere must have contained predominantly CH_4, NH_3, H_2, H and some H_2S and halogens, rather than mainly CO_2 and N_2.

5. The standard values of h, N and c are: h = (6.62517 ± 0.00023) x 10^{-27} erg-sec; N = (6.02486 ± 0.00016) x 10^{23} molecules g-mo1^{-1}; c = 299,793 ± 0.3 km sec^{-1}.

6. To be read: wavelength of dissociation energy of pyrophosphate.

7. The 12,217 value is virtually identical to the value for ATP of $\triangle$F = -12,000 ca1 mo1^{-1} determined by O. Meyerhof (19) which is still extensively quoted.   Other $\triangle$F values of ~PO_4 quoted in Baldwin (14) appear as follows:

   $\triangle$F of 1,3-diphosphoglyceric acid = -16,250; $\triangle$F of phospho-enol-pyruvic acid = -15,900; $\triangle$F of acetyl-phosphate = -14,500. From the viewpoint of quantum theory, the $\triangle$H values of all four foregoing molecules are 15,720 ca1 mo1^{-1}.

8. A pyrophosphate (~PO_4) has, by definition, 9000 + cal mo1^{-1}. Therefore, at this point where PO_4 has 6,872 cal, it is no longer a pyrophosphate.

9. Excited hydrogen atoms (H*) emit radiation at 1216 Å. The 1216 Å radiation in ca1 mo1^{-1} is 235,092; the corresponding theoretical value is 234,892 ca1 mo1^{-1}.

10. The quantities in brackets are those of the present writer.

11. The 21 cm unit wavelength of atomic hydrogen which is picked up by radio telescopes is believed to come from stars and planets in the early periods of their formation.

12. Based on current evidence that an RNA molecule is formed by condensation around the two-stranded DNA as a third party (38), it is possible that the first nucleotides to form (that were to have future biologic significance) were those of RNA. The RNA nucleotides may have linked to form, among other structures, triplet nucleotide linkages. Triplet RNA nucleotides are known to absorb specific amino acids. The RNA triplet nucleotide thus absorbed a specific amino acid and this, in turn, may have determined the next RNA triplet nucleotide to link into the chain.   This polymerizing RNA triplet nucleotide-polyamino acid chain then

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absorbed specific DNA nucleotides onto the chain so that in time a double stranded DNA molecule had also been formed. Upon the subsequent splitting of this quadruplet chain, the resulting dual DNA chain also splits into two separate strands. One of the DNA strands then linked with the pyrophosphate system which hereafter utilized the properties of DNA as its transformer.   In other words, this aboriginal DNA which linked to the pyrophosphate system may have been the first DNA molecule to reproduce and then to split, with one strand forming "messenger" and "acceptor" RNA, and the "acceptor" of RNA in turn absorbing specific amino acids and forming a peptide linkage. In this or a somewhat similar manner, the pyrophosphate system acquired a transformer which could be utilized as transformers and organic enzymes. The foregoing postulated sequence of primordial syntheses suggest that the –N-C-C- backbone chain of the alpha-amino acids aboriginally determined the triplet coding scheme of genetic DNA and not the reverse. The chain of DNA triplet nucleotides now control the string of amino acids which form protein through RNA but, aboriginally, it may be been the amino acid backbone chain that imposed its triplet feature on DNA.

The recently published works of Zubay et al and Ochoa et al (39, 40) have established a tentative triplet coding scheme of RNA for twenty amino acids of proteins. In the light of this and accepting Blum's hypothesis that the structure of DNA originally stemmed from that of adenylic acid (AMP), it may be that the first RNA triplet nucleotides to form were UCA and UUA.   RNA's UCA and UUA triplets correspond to ACT and ATT in DNA. Thus, the triplet coding scheme of DNA might begin with either ACT or ATT. In modern living systems, ACT and ATT of DNA code RNA's "messenger" and "acceptor" UCA and UUA which selectively absorb aspartic acid and glutamic acid (after Zubay et al). Aspartic and glutamic acids are two of the most widely occurring amino acids in proteins;   S. Fox and others have suggested that these two amino acids are involved in the syntheses of perhaps all proteins (41).   Glutamic or aspartic acid may have been the initial amino acid in the polypeptide that formed the first protein.