# The Information Pathway

(revised July, 2008)

John A. Gowan
home page

Table of Contents:



(I recommend the reader consult the "preface" or "guide" to this paper, which may be found at "About the Papers: An Introduction" Section VI).

**Abstract**

The Fractal Organization of Nature is seen as an information pathway whereby the Universe becomes self-aware through the spiritual awakening of humanity. The natural hierarchy is modeled as a sort of "Jacob's ladder" whereby *Homo sapiens* ascends to the astrophysical realm, realizing our destiny as galactic citizens, and dispersing Earth-life into the Cosmos.

## Introduction

While the tabular "Information Ladder" is a hierarchy of structure, it is also a hierarchy of information. Viewed in terms of information, the emphasis is less upon the successive layers of structural order and more upon the interactions, connections, and communications which characterize each level of the hierarchy. The information content of each successive layer is greater than that of its predecessor, not only because the layers increase in structural and interactive complexity, but also because they include all the information content of the preceding layers. The hierarchy consists of a series of 12 fundamental units of structural organization - an atom, cell, galaxy, etc. - which in itself consists of a reasonably well-defined, or bounded, internally organized structure, but whose interactive potential (usually with others of its own kind), produces a new fundamental unit at a distinctively higher level of organization. The new ("emergent") unit has its own well-defined and bounded internal organization, in virtue of which it is enabled to repeat the process of fractal "budding", iteration, or system reproduction, and through a new set of interactions proceed to the next step of the hierarchy. Thus atoms produce molecules, which produce working chemical systems, which produce cells, which produce organisms, which produce species, which produce ecosystems, etc. (See: "Nature's Fractal Pathway"; see also: "Teilhard de Chardin: Prophet of the Information Age").

Readers familiar with the theory of "Chaos" may recognize a familiar pattern in the model: beginning with a "linear" or simple input (cell 1), passing to a stage of bifurcation (cell 2), progressing to a stage of greater complexity including secondary bifurcations (cell 3), and finally a "chaotic" stage (cell 4) which predictably settles in the "fractal basin" of a 4x3 (or 4x4) "strange attractor" (the precise physical nature of the attractor, however, is unpredictable). Like a true fractal algorithm, the output of one level becomes the input of the next, the self-feeding iterations producing new self-similar expressions at ever-higher levels of information and system complexity. The model is scale-invariant, not only vertically with each row, but also with respect to the four major realms. (See: "*Chaos: Making a New Science*" by James Gleick, Viking Penguin Inc., 1987)

## Step 1: Elementary Particles

The hierarchy begins with the production of elementary particles in the "Big Bang". While we know the products of the first step, we do not really know how to initiate it. What do we put in the first cell of the matrix as the primordial unit of organization from which all else evolves? We can of course simply put the Big Bang or First Cause in this first cell, claim Divine Intervention, confess our ignorance, and leave it at that. Personally, I am not fundamentally opposed to this solution; we will never know everything and a frank admission of this fact from the outset is intellectually healthy and honest. Nevertheless, in the light of present knowledge, it is possible to fill out the first horizontal row of the hierarchy in sensible, physical terms without presuming that the physical reality is the only reality, that we have done anything more than solve a mechanical puzzle, or that we know, or can know, anything at all about the fundamental origins of free energy (light) itself.

With these apologies, in the first cell I place high-energy light - free electromagnetic radiation - the most symmetric and therefore the most primitive form of energy we know. (This is of course also the "Genesis" or intuitive solution to this problem.) In the second cell of row one, which is the position of the pairing function, I place space-time, the conservation domain of light, created by light's own intrinsic motion or entropy drive, gauged by "velocity c". With spacetime in the second cell is another pairing (also created by light), matter-antimatter. We can view spacetime as the symmetric product of light's wave form, and the matter-antimatter field as the symmetric product of light's particle form. So long as the matter-antimatter field remains symmetric, it will appear as light only; once its symmetry is broken, however, it will manifest as particles. Dualities are fundamental in nature; even light itself has a dual nature in its electric vs magnetic, frequency vs wavelength, and particle vs waveform energy modes.

Spacetime is the conservation domain of light, created by light's own entropy drive (the intrinsic motion of light), and it contains a "metric" or structural order which is the enforcer of spacetime's energy and symmetry conservation role (the source of "inertial" forces). This metric determines or "gauges" the value of c, the velocity of light, and by this means fixes the measured and energetic equivalence between each of the four dimensions. (Without the metric, every photon could be a "law unto itself" with a unique velocity.) Hence light and spacetime themselves, far from being an amorphous waveform of energy, possess an internal structural order (the "metric"), and an entropy drive and symmetry gauge (the intrinsic motion of light at "velocity c") from the very beginning. The purpose of this order is of course simply energy conservation. This order has an alternative form, well defined, and also symmetric, the matter-antimatter particle pairs which populate the "virtual particle sea" of the "vacuum" (spacetime). These particle pairs occur in a relatively small number of quantized forms belonging to the quark and lepton families. The virtual particles (cell 3) become "real" only when the weak force breaks the symmetry of matter-antimatter particle pairs (and the associated symmetry of light and space) during the initial moments of the "Big Bang" (cell 4).

The virtual particle "zoo" is here interpreted as the product of the interaction of light's energy with its own

structural spacetime metric. Thus the "particle metric" bears a structural imprint from the spacetime metric. In the "standard model" of particle physics, the "Higgs boson" or "Higgs field" is the presumed gauge or scalar of elementary particle mass. (See: "The Higgs Boson and the Weak Force IVBs".)

In the the third cell of row 1, which is the "group" cell of interaction (Jaccaci's "sharing of differences", Land's "mutualistic" cell) we can place for simplicity of representation a virtual matter-antimatter "leptoquark" pair, which stands for the interaction between the quark field of the strong force color charge, and the leptonic field of the weak force "identity" charge. In this third cell we usually find an expression of Nature's 4x3 fractal algorithm; in this first row we have 3 quarks bearing 4 charges: electric, color, flavor, spin.

In cell four, interactions among and between the quarks and leptons are mediated by the weak force "Intermediate Vector Bosons" (IVBs), the W+, W-, and Z, while leptoquark decay is mediated by a similar (but hypothetical) much heavier "X" boson (see "The Particle Table"). The product of the asymmetric leptoquark decay is matter, three families of four particles (six leptons and six quarks), which decay to their ground states as proton, electron, and electron neutrino (a leptoquark antineutrino is presumably also produced to balance the proton's "baryon number"). Hence the first horizontal row of the hierarchy simply recapitulates the gross features of the reaction equation for the formation of matter in the "Big Bang".

In the first line we have produced from the order and energy inherent in spacetime and light, the order and energy of the particulate realm, passing from an initial symmetric state, which contained only potential information, to a final asymmetric state which expresses that information in manifest, particulate, and ordered form: the baryons and their alternative charge carriers, the leptons. While we do not understand the details of this process, what we do understand is that the energy, order, and information content of light and spacetime has been transformed, extracted, or projected from an atemporal symmetric potential to a temporal asymmetric reality. The energy, order, and information content of particles does not come from nowhere; it comes from the metric of spacetime and the energy of light. (Note: leptoquarks and the X boson (and/or the "Higgs") remain beyond the energy range of our most powerful accelerators, and so are all still hypothetical. I include them because they (or their analogs) should exist if we are to make sense of the other confirmed elements of the theory).

The baryon, whose ground state is the proton, is the essential material product of the Big Bang. Baryons are composed of three quarks, the mass carriers of matter. The existence of matter depends upon the existence and stability of the baryon. The baryon, with its 3 quarks, 4 charges, and 8 interacting gluons (each composed of a color-anticolor charge moving between quarks at the speed of light), is a particle of incredible internal complexity. Within its beating heart of "colored light" lies the mystery of manifestation - the energy and structure of light and space brought to rest and conserved in a temporal form - and upon its stability rests every higher structure of the manifest Universe.

Matter is thought to be produced by the asymmetric weak force decay of electrically neutral leptoquark-antileptoquark pairs, a hypothetical decay mediated by the hypothetical "X" IVB. Electrically charged particle-antiparticle pairs cannot decay asymmetrically - they can only annihilate each other. Because matter can only be produced from the asymmetric decay of an electrically neutral particle, leptoquarks and baryons must be composite particles whose internal components can sum to electric neutrality (like a neutron). This is the fundamental reason for the existence of the sub-elementary quarks and their fractional electric charges. (See: "The Formation of Matter and the Origin of Information").

By a similar logic, matter could also not exist without the essential service provided to baryons by the alternative charge carriers of the leptonic field - massive leptons to carry electric charges (the electron and its kin), massless (or nearly massless) neutrinos to carry identity charges (the electron neutrino and its kin, including the leptoquark neutrino) (mesons also function as alternative charge carriers of quark flavor and

color, facilitating baryon transformations). Without the leptonic field of alternative charge carriers, the quark field would remain trapped as symmetric, mutually annihilating, particle-antiparticle pairs. This is why matter consists of two fields, the sub-elementary mass-carrying quarks, or composite hadrons, and the alternative charge-carrying elementary particles, or leptons (see: "The Weak Force: Identity or Number Charge"). The leptoquark, which is essentially an elementary lepton fractured internally into three parts, is the ancestor of both hadrons and leptons, which is why these two fields interact so seamlessly. Finally, there remains an asymmetry of unknown origin in the interaction of the weak force IVBs with matter vs antimatter, such that, for example, neutral antileptoquarks decay at a slightly faster rate than neutral leptoquarks, producing (during the "Big Bang") the residue of matter which composes our material Universe.

Humans have accessed this first high-energy rung of the information ladder through particle accelerators, producing all 12 members of the 3 particle families, and through the theoretical framework of particle physics, and the cosmology of the "Big Bang". We have not been able, however, to reproduce the actual symmetry-breaking interactions between the weak force and high energy light which initiated the material Universe.

(See: " The Higgs Boson and the Weak Force IVBs", an expansion of row 1 into a 4x4 General Systems model of the "Big Bang".) (See also: "The Origin of Matter and Information".)

## Step Two: Atoms, Elements; Nuclear Fission/Fusion

### The Atomic Nucleus and its Electron Shell

The baryon (proton) is the principle product of the "Big Bang" and the first rung of the structural hierarchy ladder. It is the fundamental unit of step two and is the foundation stone upon which is built the entire realm of matter. Baryons are the class of particles which contain 3 quarks, of which the proton and neutron are familiar examples. The baryon is an absolute marvel of construction, containing within it three quarks bearing "color" charges (red, green, blue - not actual colors, just names of convenience) which are exchanged via an internal field of 8 gluons. Gluons carry color-anticolor charges, are massless, and move at velocity C. Gluons have been compared to "sticky light". The round-robin exchange of color charges between quarks constitutes the basic or quark-level of the strong force, which keeps quarks permanently confined in baryons and whose conserved presence also prevents "proton decay", the complete disintegration of a baryon via a leptonic (weak force) decay, possibly mediated by the "X" IVB.

Quarks occur in six species, or "flavors", of which the u (up) and d (down) quarks are the "ground" or lowest energy states. These flavors can transform one into another if there is sufficient energy, and if a leptonic (and/or meson) charge carrier can be produced by the W. The quark composition of the proton is (uud)+, that of the neutron (udd). Protons and neutrons (the "nucleons") carry a lot of information with their three quarks, two flavors, various spin orientations, multiple color and electric charges, and their internal gluon field. The baryon is a highly energetic, highly organized, permanently bound, extremely stable unit of high internal information content - and it will interact with others of its own kind to produce extremely complex compound nuclei (in Nature, up to 238 nucleons in the uranium atom). This is indeed a very promising foundation particle upon which to build the information pathway.

In the second cell of row 2, for the pairing function of the baryon we have the up, down (u, d) quark pair, and all the gluon pairs; meson pairs, and proton-neutron "nucleon" pairs, belong at this level as well. (Gluons are composed of color-anticolor charges, and carry color charges between quarks. Mesons are composed of quark-antiquark pairs, and (among other services) carry flavor and color charges between quarks, both in the weak force transformations of baryons, and in the nuclear-level strong force, which binds baryons in compound atomic nuclei). At the level of the compound nucleus we have the proton-

neutron "nucleon" pair; at the level of the whole atom, we have the electron-proton charge pair. Within the electron shell, we have the north-south magnetic pairings of the electrons in their shared orbits (spin up/down). The particle level is particularly rich in pairings; we could name more. Perhaps the most important of these many pairings is that between the leptons and hadrons, illustrated here by the electron and proton.

In the proton-electron pair, or hydrogen atom, the negative electron balances the positive electrical charge of the proton. The electron of row 2 is performing the same electrical function for the proton as the antiparticle of row one performed for matter, but of course the electron is not the antiparticle of the proton. This difference emphasizes the essential asymmetry of matter and the role of leptons as alternative charge carriers for the baryons - alternative in that they are not antiparticles but nevertheless carry (some of) the charges of antiparticles. The function of alternative charge carriers is crucial in that they allow the possibility of charge balancing and charge conservation without the annihilation reactions of antiparticles.

In the third cell of row 2 (the "group" function) we have the helium nucleus, the product of the nuclear fusion of 2 protons and 2 neutrons. This is the second element of the periodic table, which because of its extreme stability becomes the preferred building block, or "brick", of the nucleosynthetic pathway in stars. This pathway, with the aid of supernova explosions, builds the remainder of the elements of the periodic table. Because the alpha particle "brick" is the energetically favored building block of nucleosynthesis, elements with even atomic numbers (numbers of protons) are typically more abundant than elements with odd atomic numbers.

Carbon is the second major product of the nucleosynthetic pathway after helium. Both helium and carbon are perfect nuclear resonances of the 4x3 fractal pattern. Helium is composed of 4 nucleons each of 3 quarks; carbon is composed of 3 alpha particles (helium nuclei), each of 4 nucleons. The carbon nucleus is therefore a triple 4x3 resonance (the baron itself is the first resonance), unique among the atoms of the periodic table. The electron shell of carbon contains yet another 4x3 resonance, with four valence electrons in its third shell, the only atom with both a nuclear and an electron shell 4x3 resonance. We will discuss the carbon resonances further in the next two levels.

Protons and neutrons can join together in high-energy fusion reactions in the center of stars, initiating the nucleosynthetic pathway, building the compound nuclei of the heavy elements. As each proton is added to the nucleus, a compensatory electron is added to the electron shell, balancing the overall electric charge of the atom. The heavy, high-energy, stable and "conservative" nucleus holds the atom together, preserving its identity and integrity, while the light, low energy, changeable and "social" electron shell permits temporary interactions with other atoms. It is this special combination of nuclear stability with chemical flexibility that gives our macroscopic world both diversity, solidity, and a certain degree of reliability.

The electron shell provides a low energy pathway for atoms to interact; nuclear interactions are at least a million times more energetic than those of the electron shell, with a correspondingly high energy barrier which must be overcome to initiate them (hence fusion occurs naturally only in the "Big Bang", supernovas, and the interiors of stars). Reducing the energy barrier to interaction is a crucial step toward the higher levels of information building.

The 92 naturally occurring elements of the periodic table are the product of row 2. Of these, at least 25 are known to be required for life, and doubtless every one finds a use somewhere in Nature.

Humans have accessed this atomic rung of the information ladder through the discovery of the Periodic Table of the Elements, and again using the particle accelerator, by producing nearly 2 dozen new elements heavier than uranium, the man-made "transuranic" elements. In addition, we have harnessed the fission reaction to produce electricity and are attempting to do the same with fusion. Fission reactions are widely

used in medicine and in the engine-rooms of warships; both fission and fusion bombs are notoriously overabundant in the weapons arsenals of the U.S. and Russia.

## Step three - Molecules, Chemistry, Organic Polymers, Crystals

Step three is the realm of molecules and chemistry, inorganic and organic; the formation of compounds, crystals, and polymers; and every type of interaction between the electron shells of atoms.

The electron shell develops as a series of (approximately) concentric orbits of complex geometry, and it is typically only the outer orbits which interact with one another. These interactions can take place only if there are vacant positions in the fixed geometric patterns of the outer orbitals which can be filled by sharing electrons with another atom which also has vacant positions. This type of chemical bonding is called "covalent", in reference to the shared orbital relationship, and provides a strong and stable bond, which is featured in the second cell of row 3. Other pairings at this level include the common atomic pairs, such as H2, O2, and N2, and the dipolar electric/magnetic character of chemical bonds generally.

We place molecular carbon in the third cell of row 3. Amazingly, in addition to carbon's triple nuclear 4x3 resonance pattern, it also contains a 4x3 resonance in its electron shell, having 4 bonding sites in the third electron shell (1S2, 2S2, 2P2). Carbon is the only atom in the periodic table with both a nuclear and electron shell 4x3 resonance. Carbon's molecular tetrahedral bonding structure creates yet another 4x3 resonance - a tetrahedron being composed of 4 triangles. Hence carbon contains five full 4x3 resonances, three in its nucleus, one in its electron shell, and one in its molecular bonding pattern (for example, diamond), a most remarkable atom, with a most remarkable potential.

In the fourth cell of row 3 we have crystals, and especially the organic polymers of carbon. It is of course the ability of the carbon atom, with its four bonding sites, to bond with itself in tetrahedra, chains, branching chains, rings, spirals, and many other forms of great length, molecular weight, and apparently infinite variety in their combinations, permutations, reflections, polymers and isomers, that sets the stage for the information explosion of organic or carbon chemistry, the molecular basis of the complex information systems of life. For example, the nuclear fusion of hydrogen with carbon can produce only the element nitrogen with an isotope or two; the chemical combinations between the electron shells of hydrogen and carbon, however, produces the immense class of the hydrocarbons, with billions of chemically distinct isomers. This is an especially striking example of how by lowering the energy level and barrier for interaction, the possibilities for information building are greatly magnified.

Humans have accessed this rung of the information ladder through the sciences of crystallography, inorganic and organic chemistry, and our quantum mechanical theories of the electron shell, its orbitals, energy states, and interactions.

## Step four - Cyclic, functional Chemical Systems; RNA

In row 4 we enter the realm of functional, cyclic chemical systems, prebiotic "organic" chemistry, including the replicating molecule of RNA. Organic chemistry is characterized by covalent bonding ("hard bonds") between carbon atoms which build strong, stable chains or skeletal structures; these chains provide anchor points for functional chemical groups which interact with each other through weaker, ("soft") bonds. "Soft" bonds are more in the nature of attractive and repulsive electrical interactions between molecules rather than orbital bonding. "Soft" bonds include hydrogen bonds, ionic bonds, bonding due to Van der Waals forces, and hydrophilic/hydrophobic interactions. The geometry, shape, size, symmetry, and configuration of molecules is crucially important to their biological properties, and these weak bonding forces are critically important to this level of information building. Again, reducing the energetic threshold of interaction is very

important to the diversity of possible interactions, and hence also to building the information content of systems such interactions may produce. These soft and flexible molecular bonds, crucial to the complex forms of organic and biochemistry, we place in cell 2. Here too, we place the base pairings of the 4 nucleotides of RNA (AU, CG) (adenine, uracil, cytosine, guanine).

Replication is the translation of the ability of carbon atoms to bond with their own kind (including the general phenomenon of crystal formation and growth), into the ability of carbon based macromolecules to bond with plus replicate their own kind. What produces crystal growth on one level produces replication on the next. It is a stage transition to a higher level of both organization and information, and the direct projection of nuclear, electron shell, and crystal bonding patterns into the realm of macro-molecular interaction. The pathway is directly through the 4x3 structure of carbon, which as we have seen, contains a 4x3 resonance in its nucleus, electron shell, and tetrahedral bonding pattern. The covalent bonding of carbon with itself into stable branching chains and cyclic structures provides attachment points for functional groups involving other elements. These in turn can form "soft" hydrogen bonds with each other, producing macro-molecular chains of cyclic or periodic character, leading directly to the 4x3 resonant structure of RNA. Water itself, the "universal solvent", also produces a tetrahedral molecular bond; the combination of water and organic chemistry is literally pregnant with the potential for life.

In RNA, we again find a structural expression of the 4x3 "metric". RNA consists of 4 nucleotides (adenine, guanine, uracil, cytosine) each composed of 3 functional groups - a nitrogenous base, a sugar, and a phosphate group (in DNA uracil is replaced by thymine). It is this 4x3 structure of RNA which is the centerpiece of row 4, cell 3.

Row four is the chemical threshold of life. Here we find carbon interacting with a variety of other elements to form the complex molecules which are capable of playing a role in future living systems. What is special about these molecules is that they do not simply link up with each other in inert crystalline combinations, they actually perform work of some sort, such as the capture and processing of energy; replication; the formation of defensive perimeters; etc. Why this sort of chemical activity should arise at all is certainly a mystery, but is perhaps more comprehensible if we consider 1) the incredible variety of organic molecules and their possible combinations, permutations, and interactions; 2) the incredible numbers of these molecules in the primitive oceans of the Earth; 3) the immense length of time available for the exploration of possibilities; 4) the steady energy cycles of day and night, the mixing action of wind, waves, and tides, the alternation of wet and dry conditions, the rhythmic cycles of Sun and Moon stirring the reaction vessel of Earth's oceans; 5) the energy inputs of lightning and Earth's magnetic field, and the steady rain of chemical inputs from outer space - under these circumstances the very improbable becomes the very likely. It is as if one person could buy all the tickets to the lottery.

However, there is more order in this system than random chance. This is not analogous to the situation of millions of monkeys typing on typewriters until, just by blind luck, one of them produces a Shakespearian sonnet. The key ingredient of life is the replication of molecular systems. Without the ability to replicate, any advance in the information content of a system is lost, as no matter how sophisticated it may be, it will eventually be degraded and a new beginning will have to be made. With replication, however, information can be stored, retrieved, and through the evolutionary process, advanced. We really do not have to concern ourselves with anything other than the evolution of a replicating molecule which also conserves its own information, since once this is achieved, this molecule will compete with its own copies for resources, and natural selection and evolution (even at the molecular level) will generate all the rest of the complexity. Because the 4x3 structure of carbon is projected into the 4x3 structure of RNA, the generation of this replicating molecule is not a matter of pure chance, and therefore neither is the generation of life. The intersection of the 4x3 universal fractal algorithm with a replicating molecular structure (RNA - DNA) means that life is common in the Universe - a fixed probability of organic chemistry. (See: "Newton and Darwin: the Origin and Abundance of Life in the Cosmos".)

RNA links and catalyzes chemical systems which acquire, store, and degrade energy, systems which may well have evolved in response to the diurnal cycle. The emergent property of "metabolic" RNA is replication. The evolution of a replicative system from a "metabolic" mechanism for energy and enzyme transfer is helpful in terms of understanding the thermodynamic origin of, or pathway to, reproduction: replication may be the accidental byproduct of a 4x3 molecular structure originally involved in energy capture, or a related "metabolic" role - a chemical cycle driven, primed, or "pumped" by abiotic energy sources such as the diurnal cycle of the Sun. The cyclic aspect is important, as it forces the development of an information-conserving "memory" mechanism to bridge the energy gap of nighttime. It is just such a "memory" function which leads to the closely related property of replication, since in a molecule like RNA/DNA, "memory" (information storage and retrieval) and replication are the same thing. The emergence of replicating life is the emergence of an organic (carbon based) 4x3 energy cycle with a memory that can get through the night. The memory mechanism is or becomes the replication mechanism. Once a replicating molecular structure is achieved, all the rest is evolutionary history. We place in cell 4 these cyclic, metabolic, information storing, replicating, prebiotic chemical systems; they will merge their separate abilities to become the coordinated elements of life in level five.

Humans have accessed this rung of the information ladder through the sciences of biochemistry and medicine, and our continuing investigations into the origin of life.

## Step 5: the Cell; DNA

### THE INFORMATION CONTENT OF DNA

When we contemplate the molecular beginnings of life, we are initially at a loss to understand the motivation behind its chemical origins - what force could possibly drive a mixture of chemicals toward the organized, discreet, self-maintaining, self-reproducing, and self-interested (in the sense of individual survival) systems we recognize as living entities? That DNA is a 4x3 fractal resonant molecule, evolved through intense competition from a system originally engaged in an energy cycle, which had the coincidental property of replication (initially functioning as a "memory" to survive the nighttime energy hiatus), answers many of these questions. In DNA, replication and memory are reduced (through the genetic/information code) to the same thing.

In ourselves, we recognize the life force as our desire to eat, driven by hunger; our desire to reproduce, driven by sexual desire; our desire to survive, driven by fear and pain; our desire for knowledge, driven by our need for food, mates, and survival, as well as an inherent and adaptive curiosity. At our level of organization, we have no trouble identifying a number of forces which drive us personally and as a species to participate in the life process. It seems to me that these basic, instinctual, and physiological drives are nothing more than stage transformations of the same forces that drive the chemical system from its very beginning.

For example, DNA is at one and the same time a genetically conserved information system, a metabolic (energy processing) mechanism, and a replicating molecule. When DNA replicates, it "eats" to do so - it must acquire from its environment the "food", or raw materials in the form of appropriate chemicals, to replicate its strands. But DNA's ability to bond to "appropriate chemicals" is also its conserved information and perceptual system. In DNA these three processes are inseparable, all belonging to the same act and molecule. All three are driven by the forces of electrical attraction and repulsion between molecules, requiring also certain bonding strengths and geometric configurations. They simply scale up to our level of organization as the basic feelings, emotions, instincts, and drives which cause us to "want" to eat, reproduce, and perceive - since perception (information) allows us to eat and reproduce and survive more successfully.

In humans, because of our higher level of organization, we have specialized organs which perform these functions separately - stomach, gonads, eyes, brain - so we think of them separately. But the bottom line is we must still eat to think or reproduce. So I think there is less of a mystery here, in terms of the motivational inputs to chemical systems, than we are apt to believe at first. As for the complexity involved, staggering as it is, it is simply the product of evolution over eons of time and oceans of molecules. Similarly, we used to think the eye was too complex for evolution to produce; we know better now - even jellyfish and clams have them.

Once the replicating structure of DNA is achieved, it will compete with itself (its cloned offspring) for the chemical resources to continue to reproduce. Competition within a species, with one's own kind, is the most powerful evolutionary force, and every time DNA replicates it produces a competitor whose needs are identical to its own. We can hardly imagine the ferocity of competition that must have taken place in the early oceans of Earth once this molecule began to replicate. The subsequent evolution of this molecule is simply the history of the most successful eater, reproducer, and retainer of this adaptive behavior and information.

It is this competitive origin of the molecular system of life, natural selection operating within a domain of limited resources, that produces the anomalous "self interest" or "survival instinct" in even the most primitive form of life, and indeed, in the chemical systems which precede them.

I have no intention here of demoting the mystery or sanctity of life, only of understanding its mechanical elements. In my personal view, this mystery is not unique to our particular level of organization, but extends downward into the atoms of which we are composed, and upwards into the galaxies of which we are a part. Among many others, one of the enduring mysteries is the 4x3 organizational "metric" that propagates at every structural level from the Big Bang to the genome of life (see: "The Fractal Organization of Nature"). It is nevertheless true that there are mysteries associated with our own level of organization that are unique to the human experience. I will touch on these later.

## THE CELL

As DNA is the molecular unit of replication and information, so the cell is the organizational unit of life, the quantum of biological systems. The cell is essentially a fortress or shelter erected against an inclement (and competitive) environment in which DNA can safely and efficiently go about its business of eating, reproducing, and storing the information necessary to do so. Within the protective confines of the cell wall, DNA can "get serious" about organizing its activities. In the same sense that "a man's home is his castle", the cell is the castle of DNA and life itself.

A house is not so different from a cell in its functional purpose. If our home is a farm, the analogy is better; if the barn with our symbiont livestock is attached to the house, the analogy is better still. At our organizational level we are the DNA and the house-office-barn is the cell which shelters us from the environment, but which also allows us to interact with it efficiently in ways we need and choose to. The knowledge and expertise we bring to our office, job, or profession is our personal information content which allows us to eat, reproduce, and survive. Communication with, and information gathering from the environment is of course crucial. In the modern house, we will want a mail box, a telephone, newspaper delivery, radio, TV, computer connected to the web, etc. There will be exits for wastes (sewer, garbage, ventilation) and entrances for supplies (water, electricity, antennas, gas, windows, doors, driveways), but even the most primitive shelter must have at minimum an entrance and exit. And like the cell, we are selective about who and what we let in and let out.

We do, of course, very much embody in our persons DNA going about its business of eating and reproducing as our information content allows. So it is really no wonder that our houses have evolved

toward the ideal of the cell; indeed, in the contrast between the self-sufficient structures of the family farm and the interior cubicles of the modern high-rise business office, we see just the difference between the DNA of a free living cell and the DNA of a cell which has lost its independence to the higher organizational level of a social organ of specialized function within a multicellular organism. It is partly from this loss of personal completeness and freedom that the angst of modern life arises. It reprises the difficulty of the evolutionary jump from single, free cells to the subjugation of individuality in the specialized functions of a higher level of social organization, in this case the macro-organism of human society.

In cell 2 of row 5 we place the replication of the double-stranded DNA molecule; in cell 3 we place the cell nucleus and its genetic code. Here the 4 nucleotides of DNA code in triplets to produce the amino acids of proteins, the final molecular expression of the 4x3 organizational metric - the simplest-sufficient or least-energy solution to the information code of biology and genetic heredity.

Here (cell 3) we should point out the role of symbionts in the functioning of the cell; this is the aspect of mutualism, symbiosis, and the "sharing of differences" which characterizes the third column. DNA itself is a collection of information and genes accumulated from many different sources. The role of symbionts in the formation and function of the cell - and in nature generally - has been pioneered and championed by Lynn Margulis and her coworkers. (See: Lynn Margulis and Dorion Sagan, 1997. *Microcosmos: 4 Billion Years of Microbial Evolution*. University of California Press, Berkeley.)

The cell is the first organizational level that we could describe as a complete "system", and the information content of this level is organizational or system information, having mostly to do with the orchestration of a multitude of integrated functions which all serve a single collective purpose: the feeding, defense, and reproduction of the cell. Here a variety of molecular subsystems are subjugated to the central control of the cell, in the form of nuclear DNA, which controls cellular function by means of RNA messengers, and whose genes turn on and off in response to chemical feedback.

Yet, life is a cooperative venture, and within the cell there are at least 2 confirmed symbionts, the chloroplasts and mitochondria, and others are suspected, such as the motile cilia. Chloroplasts and mitochondria (which produce and process energy for the cell) both have their own DNA and reproduce themselves independently within the cell. These are cells which never agreed to relinquish their reproductive options to the larger organizational unit; but they, too, have made a separate peace and taken shelter within the larger group membrane. One advantage of this arrangement is that it relieves the central cell nucleus of the responsibility of reproducing these complex subsystems and carrying the information necessary to do so. They are in the role of specialized "subcontractors" within the overall organizational framework of the cell. It is clear that chloroplasts and mitochondria were originally free living cells, but they have found it more convenient to pursue their specialties within the shelter of a broader authority. Perhaps this allows them to sharpen their special skills, having less to worry about - much as the cook and mechanic on a ship can perform their duties better if they can leave the overall running of the ship to the captain. In turn, the cell and ship benefit from their enhanced, specialized functions.

In short, the cell is a miniature organism or society, complete with a central nuclear authority and specialized subsystems (both molecular and symbiotic) under its regulation. Could we doubt that such a system would eventually take the next organizational step and scale up to multicellular organisms? Nevertheless, life at the level of the single cell (bacteria, algae) is by far the most abundant, diverse, and resilient form of life on Earth.

Humans have accessed this rung of the information ladder by discovering and mapping the genetic code, and by applying this knowledge in genetic engineering, and through the sciences of cell biology and bacteriology.

## Step 6 - Organisms

Multicellular organisms are the next stage beyond cellular systems. Here we find whole cells, rather than symbionts and specialized chemical systems, subjugated to a central authority. In animals this central authority is vested in specialized cells, tissues, and organs such as the brain and hormone-producing glands, which communicate with the body through the vascular and nervous system, while in plants it seems to reside in hormones produced by the growing tips, which communicate with the rest of the plant through the sap. In either case, we find specialized functional cells, tissues and/or organs all synchronized and orchestrated into a harmonious whole.

It is a significant fact that it took nature much longer to evolve multicellular organisms from single cells than it did to evolve living cells from chemicals. One explanation may be that evolution was working with a much smaller number of cells than of organic molecules. Another may be that it is very difficult to subjugate free-living cells to the central authority of an organism, especially to convince them to surrender their own reproduction to the specialized reproductive cells of an organism. In other words, evolution had to work against the resistance of the personal reproductive agendas of single cells, whereas in the earlier instance, molecular systems were not advanced enough to have contrary "personal agendas"; hence the greater difficulty in this second stage of the evolutionary climb toward complexity. To this day, mitochondria and chloroplasts have not relinquished their reproductive rights, and we still suffer cancer when single cells reassert their individual, primitive, reproductive prerogative. Finally, the orchestration of trillions of cells into a synchronized system of integrated specialized functions which grow, differentiate, reproduce, and pass through the different stages of life harmoniously together is clearly a task of extraordinary complexity. The large organisms that have populated the Earth for the last 3/4 billion years, plants as well as animals, are all marvels of systems engineering and systems information, master works of the evolutionary process.

In the second position of row 6 we place cell division, and in the third, their differentiated product, the specialized organ systems of the multicellular form. Of particular interest in this regard are the specialized organs of perception and their integration into a central processing center, the brain. The brain emerges as the central controlling authority, while perceptual organs function to gather information from the environment. Information can now be stored in the brain as memory rather than as genetic molecular codes.

Perceptual information is of central importance to all levels of life; in higher organisms it can be stored in memory as "software", rather than encoded into the "hardware" of the genome. Memory perishes with the death of the organism. Memory's utility is personal rather than general, and is a means of allowing an organism more flexibility in its behavior than is possible from its genome alone. Hence memory functions as a personal information set built up from the unique experience of the individual, which is in addition to its genetic information, the latter being approximately the same for all organism of a given type. Memory is therefore a highly flexible and individually adaptive information set which adds greatly to the organism's chances of survival in a diverse and unpredictable environment. Memory itself (the capacity for memory) becomes translated into genetic hardware through its contribution to the reproductive success of an organism. Individual memories can of course be transmitted to other organisms through the process of "learning", or by other cultural, social, or parental communication channels.

Humans have accessed this developmental level of organization through cloning and the propagation of stem cells and other embryonic tissues (umbilical cells); the surgical transplantation of donor organs is another example. Cloning has been practiced for centuries, and very successfully, with our domestic plants.

## Step 7 - Species

Species are defined by sexual reproduction and their closed genomes or exclusive gene pools. Cats and dogs cannot reproduce with each other, their gene pools are incompatible and exclude each other. The species level is our own level of organization. This is the level of individuals, male and female, typically associated with the higher plants and animals, and of populations and social organization. While each individual contains a huge library of genetic information stored in the DNA of every cell, we see the emergence at this level of a new type of information carried in abstract as well as social form. Below this level, information is carried in molecular form, in genes and hormones, and as electrical signals in nerve tissue.

At the species level we find information emerging in abstract form as signals, behavior, sounds, light, language - forms of information that have broken free of molecular carriers and are directed toward the specialized perceptual organs of sight and hearing. Smell, taste, and touch remain as more primitive but eminently useful molecular information senses. While plants, lacking nervous systems, use only chemical communication, almost all animals, vertebrate and invertebrate, use some form of abstract communication. The songs of insects and the flashing lights of fireflies are familiar, and invertebrates also use behavioral signals. Frogs croak, birds sing, bats and dolphins use sonar, the list is endless. The great whales are thought to be able to communicate by sound over enormous distances in the oceans.

Social organizations and communication allow personal memory to be shared and to persist from one generation to another. In humans, memory becomes encoded in written language and books stored in libraries, an information transformation which produces "social knowledge". In humans, the grammatical structure of language has raised the information content of speech to a new level of precision, abstraction, and beauty, and set in motion the explosion of abstract, human information systems which are the glory of our species, a completely new, tangential evolutionary development (a fractal "bud", the initiation of a new fractal iteration) within the information ladder.

The development of human abstract information systems has created an information explosion which is comparable only to the proliferation of organic compounds in the microphysical realm. Again, this information eruption is the result of a lower energy threshold for interaction: abstract perceptual systems (sight, sound, thought) vs molecular codes. Will there be a third resonance of this information explosion in the astrophysical realm at a still lower energy threshold (Super-cooled quantum computers? Psychic phenomena (ESP)? Communication with aliens?)

Most higher species are divided into male and female, an arrangement necessary to maintain the diversity of their otherwise closed gene pools. We also find social behavior at this level, which presages the emergence of a higher organization level, the social organism, fully developed among the invertebrates (corals, termites, ants, bees) and (thankfully) developed to a considerably lesser degree of perfection in the political, religious, economic, and military organizations of humans. There is strength and safety in numbers, and efficiency and opportunity in specialization, provided all is well organized.

In cell two of level 7 we place sexual reproduction, male and female, and in cell three social organization, in which a population of individuals (a subset of the whole species), is organized into groups with specialized functions all coordinated by a central authority. In humans, this authority is formalized as government, a mixture of empowered individuals and abstract organizational codes, system rules, or "laws".

The purpose of social organization is to enhance individual survival and reproductive success through coordinated group action and the efficiency of functional specialization. Human society can advance rapidly through the contributions of its most talented individuals because the society can capture their personal experience and insights in writing, and incorporate their personal expertise into social memory, knowledge, and function. An additional benefit of social life is access to social products which no individual could produce alone. In humans this has come to include the high technology and vast cities of the current era.

Our control of this level is expressed in many ways: by our social organizations; by the domestication and selective breeding of plants and animals; through our scientific control over the evolutionary process; by our development of abstract information systems, grammatical language, writing, and mathematics; as the social storage of information in libraries rather than genes; by the development of artificial adaptations (tools and technology) rather than genetic adaptations; and finally through the social discovery and application of Natural Law (science and technology), defining a new and universal trans-biological niche for humanity, distinguishing us emphatically from all other animals, and liberating us from the gravitational bonds of our native planet.

## Step 8 - Gaia

The final biophysical level of information is that of the ecosystem of the entire planet, approximately the holistic concept of "Gaia" advanced by J. E. Lovelock. At this level, species are but the units in a broader classification of herbivores, predators, parasites, producers (plants), consumers (animals), scavengers and detritivores (agents of decay), etc., in aquatic and terrestrial habitats, distributed over the surface of the globe in response to climatic cycles, continental drift, and evolutionary pressures over geologic time (biogeography). The Gaian hypothesis is simply that life modifies the physical environment of Earth on a global scale in ways that are conducive to life's continuation - the Earth has been and continues to be "terraformed" by life to create a more suitable and stable habitat for itself.

These effects are most notable in the chemical composition of the atmosphere, oceans, and soils of the planet, and the temperature, rainfall, and perhaps even the climatic cycles of the Earth. The fact that the chemical composition of Earth's atmosphere, its temperature, and even the salinity of the oceans, has remained stable over geologic time is evidence of the homeostatic, self-serving activity of Gaia.

The grand symbiosis between plants and animals with respect to the atmospheric gases oxygen, carbon dioxide, and the availability of nitrogen are part of this interplay between the physical and biotic environment, as are biogeochemical cycles involving the formation of petroleum, gas, and coal deposits, limestone and salt beds, etc. The positive feedback between plants and rainfall, the greenhouse effect on climate ($CO_2$, methane), etc., are other examples of the linkage between living systems and the abiotic environment. Genetic diversity, heritability, and the competition for limited resources, continues to generate new species over evolutionary time which exploit the environment in new and/or more efficient ways, and each new species is itself a new resource for some other species. Natural checks and balances, such as predators, parasites, and disease organisms, competition, the harshness, limitations, diversity, and unpredictability of the environment, ensure that no one species oversteps the boundaries of a balanced system, at least not for long. Symbiotic relationships are favored over exploitive relationships in the long run. Thus the extinction of the horse by early hunters in North America may be contrasted with its domestication in Asia, to the great benefit in the latter continent of both species. Similarly, agriculture as a symbiotic relationship is greatly favored over hunting and gathering as a method of obtaining food.

The glacial cycles of the recent geologic history of Earth show that extreme climatic shifts can occur even within the context of a fully formed, abundant, and diverse biota, and yet the natural system contains some type of internal buffer or negative feedback that causes the glaciers to retreat more rapidly than they advanced. We would have to suspect that these glacial cycles also have both a biotic and a physical cause.

Humans have begun to have possibly profound and destructive effects at the global level, due to their worldwide distribution, overabundant numbers, agricultural and industrial pollution, consumption of natural resources, etc. Global warming, the ozone hole, acid rain, erosion, overgrazing and the spread of deserts, overfishing, the extinction of species and the destruction of forests, wetlands, coral reefs and other ecosystems, are effects of global significance that are already at dangerous levels, to say nothing of the threat of nuclear holocaust. But humans (potentially) also have a unique and constructive role to play

among the diverse evolutionary productions of Gaia, as we shall see below.

## THE BIOLOGICAL ROLE OF HUMANITY

But for the peculiar appearance of man amongst the myriad species of Gaian life forms, this would be the end of our story - the planet Earth, overflowing with life but isolated in the vastness of space, a magnificent experiment in the building of information systems of incredible diversity and complexity, all doomed to die with the inevitable exhaustion of our Sun. But Gaia has not gone to all this trouble for nothing, for in Man she has planned her escape from the dying Sun, or catastrophic asteroid impact. Man the space traveler will carry Gaian life into the galaxy in every direction as far as he can reach, spreading like bacteria upon an agar plate until he encounters occupied ground and the counter-thrust of a similarly spreading alien life form.

Gaia is in her reproductive phase, and we are her seeds, pawns of her reproductive purposes. She has created us as dispersal agents for herself. The vision of Noah's ark is a vision of the future, not the past. This simple fact explains all of human evolution, every capacity of Man, and all the abundance of resources which Gaia has stored over the eons for our use, so that we may accomplish her great reproductive goal. Like every other life form, Gaia has her season of flowering, reproduction, and dispersal to new territory. This is the special biological meaning of Man and the special significance of the time in which we live. The new millennium will be the age of space travel and discovery, just as the last has been the age of ocean travel and discovery upon the Earth.

We think the space program is our program; it is not. Humanity and the space program have both been produced by Gaia.

We have already entered upon the threshold of step 9, the exploration and colonization of the Solar System. This will be the work of the next century and beyond. We cannot tell when the next stages will occur - they depend upon too many unknowns at our current stage of development. But we see where the information pathway leads, and our art - in the form of science fiction - is already at the stage of galactic exploration and interaction with aliens, who are understandably busy doing just what we will be doing - grabbing as much suitable territory for their planet's life form as possible. We can only hope these future interactions will be symbiotic. Hence intelligent life is a way for planets to interact across the vastness of space, just as atomic nuclei interact at great relative distances through the electron shell, and cells communicate with each other through the vascular systems of organisms, which in turn communicate externally through the signals and sounds of specialized transmitting and receiving perceptual systems.

Gaia is the first level in the table of organization which is above our own level, and we there encounter forces and purposes which are greater than our own, which we may study and come to understand but never control, and to which we are in many ways subservient. It is obvious, for example, that at the planetary level we will never control the forces of the Solar System - the evolution of the Sun, or the orbits and rotation of the moon or other planets. What is perhaps not so obvious is that this same lack of control exists at the level of Gaia, the natural forces of the Earth herself. We will never control plate tectonics, volcanism, or earthquakes, nor, it is likely, the weather or the cycles of climate. It furthermore appears that we are not even in control of our own destiny, in the sense that we are but the agents of Gaia's reproductive intent. Hopefully, what is good for Gaia is also good for us, but we are used to thinking of ourselves as the masters of the Earth, not the pawns of her schemes.

It is certainly possible that Gaia will be significantly weakened by her reproductive effort; that humans will be forced off the planet to escape their own competitive instincts, pollution, and overpopulation. In this case the expulsion from the Garden of Eden, like the story of Noah's Ark, will also come to be seen as a vision of the future rather than the past.

In a purely biological sense, and from a Gaian perspective, we have found the answer to the great question of human existence - why are we here, who are we, and what should we do? We are the seeds of Gaia and we exist to create rocket ships, space programs, and colonize the galaxy with her life forms - exactly as our science fiction writers have long intuitively recognized. That is why Gaia has brought forth humanity upon the Earth.

## The Astrophysical Realm

While the Astrophysical Realm has been critically important to humanity in terms of our metaphysical thought, inspiration, and development, and seems destined to play the major role in our future (if we have a future), we can also enumerate the physical contributions the Astrophysical Realm makes to the current human condition.

At the level of the Solar System, there is the obvious contribution of solar energy and gravitational order; the moon with its tidal effects and stabilization of Earth's tilt and climate; the 4x3 march of the seasons (4 solar seasons each of 3 lunar months); the composition of planet Earth in terms of air, water, minerals, all derived from the original solar nebula; the Earth's rotation and its magnetic field; the impacts of meteors, asteroids, and comets; and other solar system effects, past, present, and future (for example, the water in our oceans was apparently delivered by comets). A major 4x3 expression at this level are Kepler's 3 laws of planetary motion, set in the 4 dimensions of spacetime. Humans are currently physically accessing this level through the space programs of various nations. The effect of the other planets upon the Earth has been profound in the formative past, including influences upon her orbit, composition, and history of extra-terrestrial impacts; their influence will be profound in the future as well, as they provide the stepping stones and practice arena for humanities' exploration and dispersal into the galaxy.

At the galactic level, we require the nucleosynthesis of the stars, including several generations of supernovas, to provide us with the 92 elements of the periodic table, among them the atomic constituents of life. A possible 4 x3 formulation at this level is "3 supernova generations within 4 spiral galactic arms" - but the nucleosynthetic pathway, governed by the 4x3 alpha particle, and the 4 third-order equations of Einstein's gravitational tensor geometry are even more fundamental expressions of the universal fractal algorithm at the galactic level. Humans access this level through their science fiction - "Star Trek", etc. Interstellar travel is being actively researched, and Einstein has shown us in his equations of special relativity that interstellar travel within our own galaxy is actually possible (at least in theory).

At the level of the Universe we find the time and space scale necessary for the slow evolution of life; it has required billions of years to produce humanity, a time and space scale available only at the Universe level. A 4 x3 expression at the Universe level includes not only those found at level one, in the convergence of cosmology with particle physics ("the dragon bites its tail"), but also the 4x3 structure of the Unified Field Theory, the four forces and three energy states of electromagnetic energy (light, matter, charge). Humans access this level in theoretical cosmology, and directly through deep space telescopic observations.

Finally, at the level of the multiverse, we find our particular Universe, out of perhaps infinitely many, whose unique physical constants and natural laws favor and allow the development of our unique life form. In the pairing cell of row 12 we find the "Big Bang" (the annihilation of the primordial Universe-Antiuniverse pair); in the group position (3rd cell) we find a subset of the Multiverse - all possible electromagnetic universes. This is the level and cell of "given" physical constants. This subset will all be 4x3 universes with a fractal algorithm like our own, and all will convert free energy (light) into bound energy (mass) (since otherwise they simply remain as light). This electromagnetic subset will vary at least in size, and possibly in the asymmetry parameter of the weak force, and possibly again in the value of the Higgs constant. We just don't know what variations are possible within the physical limits of the electromagnetic energy type. Here too (cell 3), we find the origin of the 4x3 "Tetrahedron Model", the fractal algorithm of 4 conservation laws

connected in triplets.

In the 4th Multiverse cell of level 12, we find all possible universes of all possible energy types, of which our Universe is one (life friendly) member of the electromagnetic subset. This is also the cell of natural law associated with (inherent in) each energy type. We have no idea what other energy types may be included in the complete inventory of the Multiverse. For those who wish to personify a Deity, Creative Principle, or First Cause, we can say that if God is the "King" of our Universe, he is moreover the "Emperor" of the Multiverse. Humans access this level only through cosmological theory, mythology, and religion. 4x3 representations at the Multiverse level include metaphysical symbols for the Deity (the Holy Trinity and the 4 Living Creatures), and religious or metaphysical notions of a Cosmic Deity dispensing universal or natural law.

In brief, human life needs the Solar System for the Earth and the Sun; we need the Galaxy for its heavy elements; we need the Universe for its space and time; and we need the Multiverse to provide our physical constants, and our "life friendly" electromagnetic universe. See also: "The Fractal Organization of Nature"; "The Human Connection".

## Metaphysics

For many, a biological interpretation of human purpose will seem impoverished of meaning. What about the human soul, spirituality, religion? Does this Gaian perspective represent a return to paganism, the worship of natural rather than spiritual forces? Is our creator Gaia rather than a universal God? In the grand structure of the Cosmos, the Earth is but one planet among trillions. Even supposing our local creator is Gaia (Mother Earth), there is obviously a vastly greater creative power working in the Universe at large. We are the Universe experiencing and exploring itself through living systems - a more universal rationale for human life, intelligence, and perceptual capacity, which nevertheless does not deny Gaia her local jurisdiction and agenda.

Just as atoms have found a way to communicate with each other through the extension of their nuclear information and order into the far-flung electron shell and the infinite range of electromagnetic forces, so planets are finding a way to communicate with each other through the extensions they produce in intelligent life forms, and the infinite range of their communications and curiosity. We can only suppose that this process in the very far future will encompass entire galaxies, perhaps even the entire Universe. But this is simply the physical expression of the spiritual notion of universal At-One-Ment, a convergence of physical and spiritual universal communication, interaction, and community.

All this was foreseen by Teilhard de Chardin in his great book "The Phenomenon of Man", in which he names the collective information systems of planet Earth the "Noosphere", and the far-off goal of universal evolutionary convergence the "Omega Point". See: "Chardin: Prophet of the Information Age".

**Links:**

**The Fractal Organization of Nature**

Section 3: Introduction to Fractals
The Fractal Organization of Nature (table)
Part 1: Microphysical Realm
Part 2: Biophysical Realm
Part 3: Astrophysical Realm
Part 4: Metaphysical Realm - Intuitive Mode
Part 5: Metaphysical Realm - Rational Mode

Part6: The Fractal Organization of Nature (summary) (text)
Newton and Darwin: The Evolution and Abundance of Life in the Cosmos
Commentary on the Metaphysical Realm (rational mode)
The Human Connection

**Information**

Section 6: Introduction to Information
The Information Pathway (text)
Chardin: Prophet of the Information Age
Causality vs Information
Nature's Fractal Pathway

Misc. Diagrams and Tables

The Tetrahedron Model (simple form)
The Tetrahedron Model (complete form)
The "Life" Tetrahedron
The Unified Field Theory in a 4x4 Matrix Form
The Unified Field Table: Short Form

**General Systems and Metaphysics**

Section 8: Introduction to General Systems
A General Systems Approach to the Unified Field Theory: Part 1
A General Systems Approach to the Unified Field Theory: Part 2
Synopsis of the "Tetrahedron Model" of the Unified Field Theory
The Tetrahedron Model in the Context of a Complete Conservation Cycle (text)
"Trance, Art, Creativity" An Investigation of the Numinous Element and the Metaphysical Realm. A Book by Prof. John C. Gowan, Sr.
Stewart C. Dodd's 4x4 Mathematical General System Matrix
Spiritual and Scientific Principles of the Tetrahedron Cosmic Energy Model
Postscript: Causality, Information, Karma
The Grail and Hourglass Diagrams
A General Systems Analysis of the Creative Process in Nature
Is There Life After Death?
A Rationale for Love in the Cosmos
Human Development and Life Stages General Systems Models
DeBroglie Matter Waves and the Evolution of Consciousness
The "Tetrahedron Model" vs the "Standard Model" of Physics: A Comparison
Identity Charge and the Weak Force
Is There Life After Death?

home page

**References**

Books by Prof. J. C. Gowan, Sr. "Trance, Art, Creativity" and "Operations of Increasing Order"
Pierre Teilhard de Chardin : *The Phenomenon of Man*. French: Editions du Seuil, Paris, 1955. English: Harper and Row, New York, 1959
Lynn Margulis and Dorion Sagan, 1997. Microcosmos: 4 Billion Years of Microbial Evolution.

University of California Press, Berkeley
James Gleick "*Chaos: Making a New Science*", Viking Penguin Inc., 1987.

See also: "A Simpler Origin for Life" by Robert Shapiro. *Scientific American,* June, 2007, pages 46-53 (and on www.sciam.com).
See also: "The Origin of Life" by James Trefil et. al. *American Scientist* May-June 2009 Vol. 97 No. 3 pages 206-213.

path.html