THE GREAT LIVING SYSTEM: THE WORLD AS THE BODY OF GOD

by John Ruskin Clark

We experience the universe from a limited perspective and therefore piecemeal. If we are to make sense out of our fragmentary experiences, we have to ask what the universe is like as a whole. What is reality like taken altogether? What supports and what limiting conditions does the comprehensive environment provide for human life and aspirations? Is the reality we experience itself fragmentary, or is it part of a unified system? Does the environment when perceived as a whole have any implications for how we should live, or are we engaged in just a meaningless dance, hopping around to avoid being crushed in an avalanche of impinging events? Is there anything going for us, or are we on our own in an indifferent world? And if there is anything going for us, does it make any demands upon us, or does it place any limitations on our activity?

In our Western culture, informed by the Judeo-Christian tradition, such questions have been answered by referring to the existence and will of a supernatural living god. In the beginning when "the earth was without form and void," he created the world originally, according to the myths in the first two chapters of Genesis. The laws of creation were laid down by divine fiat, and they had to be obeyed by man at the peril of everlasting damnation. Suffering and death and unrequited evil were justified by the assurance that history moved inevitably toward a grand climax when perfect justice would be established in the complete reign of God's will upon earth. This scheme had the value of making the struggle and ambiguities of life meaningful, and it gave each believer a sense of participating in a significant drama.

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God Is Dead

In order to make the supreme God conceivable, he has always been described by analogies. In our Judeo-Christian Bible, we can trace the development of the concepts of God from a tribal deity to a universal sovereign power; from a warrier god who protects the interests of a particular band of nomads to a god of love and justice who controls the destinies of all nations; from a divinity who inhabits the nearest high place, or may be transported in an ark or housed in a temple, to a divinity who makes his domicile in the heavens; from a being who is understood by analogy with an autocratic tribal leader or king to the metaphor used by Jesus of God as a loving, disciplining, and redeeming Father. Then among the early Christians, Jesus himself became the image of God, and God himself was conceived of as being Christlike, exhibiting merciful, forgiving, and redeeming love for sinners. Belief in Jesus' powers of self-sacrificing love was sufficient to assure redemption.[1] Early Christian theologians, under the influence of Neoplatonic philosophy, described God in terms of Platonic ideals as the unmoved mover, the first cause. Eighteenth-century deists described God the Creator by analogy with a potter at his wheel or by Paley's analogy with a watchmaker.

Such analogies for God as an external creator are dead. Since the theory of evolution has disclosed the continuous process of creativity, we now see the creation and the creator as one. The supernatural creator-god is redundant, and, taking the word redundant in the British sense, God is unemployed, which partly accounts for his demise. Besides, in our expanded universe penetrated by space rockets and the Palomar reflecting telescope, there is no heaven in which God can reside. Unitarians have acknowledged for some time that such a god is dead, and recently radical orthodox theologians have swelled the chorus in a God-is-dead movement.

But has the reality denoted by the name of God changed, or is the total environment just as creating and sustaining as it ever was, if not more so? Martin Buber asks: "What does all mistaken talk about God's being and works . . . matter in comparison with the one truth that all men who have addressed God had God himself in mind?"[2] Man may be better able to cope with reality now that he better understands its structure and dynamics than he did when he implicitly trusted in earlier analogies for god.

In trying to answer the question about the nature of comprehensive reality, we will see whether "the commanding, transforming reality," of which James Luther Adams speaks, or "the ground of our being," of which Paul Tillich speaks, can be conceptualized. In an attempt to fill the credibility gap in religion left by the death of God, I invite you to share a flight of fancy with me and then having heard my argument out, see whether you find from your experience that the model I propose describes something real.

I propose the concept of a living system as a model for the universe. The premise of my speculation is that the process of evolution issues in a continuity of being which implies a unity of all being which, when certain dynamic relations are observed, can be visualized as a great living system rather than as a mere congeries of events. My hypothesis that the continuity of all being concresces in an emergent unified being with a character and self-directedness, which affects us as participant beings, is difficult to conceive. Therefore, I will proceed by using the relatively well-understood concept of a biological cell as an analog for the newer concept of a living system, which through systems analysis of a wide variety of configurations in our environment is becoming increasingly useful in helping us understand aggregates as wholes. Then we will see whether the concept of a living system can be a satisfactory model to help us know reality as a whole.

The image of the universe as a living system has already been proposed in the philosophy of organism, or process philosophy, of Alfred North Whitehead and Charles Hartshorne. Some thirty years ago Hartshorne first gave me a glimpse of this way of looking at things when I heard him say: "The world is the body of God. When man rejoices, God rejoices; when man suffers, God suffers." Then a course with Hartshorne at the University of Chicago introduced me to the organic philosophy of Alfred North Whitehead, particularly through an assigned study of his book *Process and Reality* (1929). The organic philosophy of Whitehead and Hartshorne, now being made more systematic in general systems theory, is providing common ground for the current exciting dialogue between scientists and theologians.

Employing the concept of a living system avoids some of the resistance to using the older organic analogy. Reality presents itself to us with such different qualities from those of living beings that the analogy with an organism seems incredible. Hartshorne himself points out one of the difficulties when he says: "The human body does not, for direct perception, contain distinct individual things, as the world to which God is to be related certainly does. It is a quasi-continuous solid, differentiated, but without clear-cut separateness or independence of parts. Hence it is feared that to interpret the world as though it were God's body would be to deny the reality of individuals as such other than God."[3]

General systems theory is useful in understanding such widely differing systems as industries, public utilities, governments, biological nervous systems, and computers. Ludwig von Bertalanffy, suggested the correlating benefits of general systems theory: "The existence of laws of similar structure in different fields enables the use of systems which are simpler or better known as models for more complicated and less manageable ones."[4]

An elemental example of a living system is a biological cell, an organism whose structure and dynamics may help us understand more general systems. All organisms are by definition living systems, while all systems are not necessarily living in the ordinary sense of the word. Later in this essay we will have to confront the question of the definition of "living" to see how generally it may be applied to systems. First, we will look at an indubitably living system, a cell.

We will not take man as an example of an organism for two reasons. First, man is such an extraordinary emergent in the process of evolution, because of the development of his mind and hands, that he is misleading as a model for other systems. He is so unique an event in the universe, with such unusual capacities for imaginative creativity and for autonomy, that as an analog for living systems he would lead us into confusing complications. And, second, we already have too much of a tendency to read ourselves into the universe. Our anthropomorphisms have already made God incredible as the traditional creative power in the universe. A cell is less complex than man, so we will not inadvertently carry over peculiarly human traits to living systems in general.

Why Is There Not Nothing?

A philosopher has asked the polarizing question, "Why is there not nothing?" Or, at least, why is there not nothing more than an inchoate glob of primeval stuff? What we call the natural order is not natural; it is amazing. For, according to the principle of entropy which, following the Second Law of Thermodynamics, says that closed systems tend to run down and arrive at a state where the available energy is so evenly distributed within the system that the system becomes inert, the natural state of existence should be placid chaos. Entropy is also a measure of disorder. Erwin Schrödinger, German physicist, said: "We now recognize this fundamental law of physics to be just the natural tendency of things to approach the chaotic state (the same tendency that the books of a library or the piles of papers and manuscripts on a desk display) unless we obviate it."[5] What is amazing is that form and order have emerged in spite of entropy, that creation has produced such open systems as organisms which can utilize energy. As Hartshorne suggests: "A creative side of nature there must be, and its local manifestation in planetary life cannot exhaust its reality, or there would have been no cosmos to 'run down' toward the 'heat death.' The presupposed 'running up' or creation cannot be *less* fundamental as a cosmic function, however hidden from us its larger operation may be."[6] In the presence of entropy we are, therefore, trying to account for the natural process of creativity.

Mere chance is not an adequate explanation for the occurrence of creativity, for the emergence of new forms of order. Dutch biologist C. A. van Peursen feels strongly that an infinite number of monkeys pecking randomly at an infinite number of typewriters could not in an infinite number of years produce a Shakespearean sonnet. In the first place, we do not have infinity for the occurrence of such a miracle; we have only about five billion years at our disposal, and yet from a condition "without form and void" such sonnets have been produced. Moreover, as van Peursen pointed out, such an event does not occur all at once; it takes a cumulative development of increasingly complex forms to produce such an artistic creation as a sonnet. Some structures have to have sufficient stability to record each minute gain in capacity; for random variations to occur, there first have to be genes to mutate.

In addition, all that chance explains is that in the restless moving of particles there are a lot of random meetings; chance does not explain the reason that some meetings are an event in which new relations are established, and thus a new form of order originates, while in other random encounters nothing occurs.

For instance, if I take a glass jar and fill it halfway with white sand and top it off with red sand and stir it for a while, the sand will intermingle and become pink. No amount of stirring it in the opposite direction will, probably, sort out the sand again into its pure red and white constituents.[7] Although energy is being added to the jar of sand, no selective principle is at work. Some organizing power is needed to restore the original order. Something more than chance must be operative for antientropic forms of order to occur. Some capacity for establishing selective relations seems to be necessary to creativity.

Life Is Organization

Given a planet such as ours with a source of energy in the sun, under favorable conditions, systems have organized themselves which are capable of capitalizing on the energy. At a point in their development, we identify more complex systems as living. It is open living systems which have succeeded in organizing structures able to use energy in a more efficient way. "Everyone is aware of the fact that life is an antientropic struggle against the dissipative forces of nature," writes A. Katchalsky, who was director of the Polymer Research Laboratory, Weizmann Institute, in Israel. "Since all real processes require, however, a positive production of entropy, life has chosen the least evil—it produces entropy at the lowest rate."[8]

To produce entropy at the lowest rate, living systems have been inadvertently organized by components into bounded structures, capable of cooperation within and of selective interaction with the undifferentiated environment without. Selectivity, says Katchalsky, "is one of the foremost requirements of living organization."[9] For a selective response to the environment to occur, some stable form of ordered relations has to be integrated into a system. J. Bronowski, resident fellow at the Salk Institute for Biological Studies at La Jolla, California, suggests the concept of "stratified stability" for such organizations, and says the natural world "has turned out to be full of preferred configurations and hidden stabilities, even at the most basic and inanimate level of atomic structure."[10]

Life is a process by which order is created out of chaos in the universe. Biologist Edmund W. Sinnott defines life as *"the organized process by which matter is brought together in organized and integrated systems capable of self-perpetuation and of change."*[11] Nonliving aggregates, such as formidable looking mountains, slowly degenerate through entropy; erosion in time, provided other variables remain constant, will reduce all elevations in the landscape to an inert level, But where there is life, there is persistence of form and order. The cells are the smallest units of living matter, or protoplasm, which are capable of metabolism, growth, and reproduction.

Many cells, such as protozoans, various simple algae, and bacteria, are individuals able to live independently and to reproduce their kind. They are large enough to be seen through a microscope. I recall the time I saw amoebae and paramecia, both one-celled animals, darting around in a drop of pond water under a microscope at college; I was amazed to see such tiny creatures quietly and adequately going about their business. They seemed to know what they were doing, and had been at it for a long time, too, I was told.

Other cells gather in symbiotic communities, such as sea sponges, which confer survival benefits upon the still autonomous participants in the aggregation. Still other cells have organized themselves into multicellular organisms, a plant or animal, in which various cells develop specialized functions more efficiently to serve each other's needs in a cooperative division of labor, and achieve a new level of stability. Biological cells, with the same protoplasmic structure, can assume an enormous variety of forms and functions.

Organization of a Cell

A normal cell is composed of nucleus, containing the genetic information that specifies the general structure and function, surrounded by cytoplasm laced with microsomes containing ribonucleic acid, which carry on protein synthesis, and mitochondria, which with the aid of catalytic enzymes transform nutrients into energy. This schematic description of what is really a very intricate even though tiny system is meant only to indicate that a cell is an amazing organism with a highly ordered behavior pattern and ability selectively to utilize elements from its environment.

This ability to exploit energy from its environment is a function not only of the cell's internal structure but also of its boundary. A membrane encloses the unified diversity of entities and operations. The membrane is permeable, selectively admitting some chemicals from the environment and not others, which makes possible creative processes within the cell that could not take place in the undifferentiated environment. Since the skin of the cell permits selective transactions with the environment, the cell is an open system—which is one of the characteristics of a living system.[12]

The significance of the cell's organization of entities within a boundary is emphasized by A. I. Oparin, associate director of the Biochemical Institute, USSR Academy of Science, in his suggestion as to the possible mode of the precellular organization of matter. He assumes that organic substances in the primordial chemical soup coalesced into "coazervates" (sometimes spelled "coacervate"). He says:

> The formation of coazervates was a most important event in the evolution of the primary organic substances and in the process of autogeneration of life. Before that event organic matter was indissolubly fused with its medium, being diffused throughout the mass of the solvent. But with the formation of coazervates organic matter became concentrated at different points of the aqueous medium and, at the same time, sharp division occurred between the medium and the coazervate.
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> So long as there was no delimitation between the organic substance and its aqueous environment; in other words, so long as it was still dissolved in the waters of the original hydrosphere of the Earth, the evolution of organic substance could be considered only in its entirety. But as soon as organic substance became spatially concentrated into coazervate droplets or bits of semiliquid colloidal gels; as soon as these droplets became separated from the surrounding medium by a more or less definite border, they at once acquired a certain degree of individuality. The future history of coazer-

vate droplets could now follow different courses. Their fate was now dependent not only on external conditions of the medium but also on their own specific physico-chemical structure or organization.[13]

It is the organization into a definite unit which makes it possible for a cell to be creative. Edmund Sinnott is convinced

that the presence of this biological organization is the most distinctive feature of life. Form itself is the visible expression of it. The recent great advances in biochemical genetics have tended to obscure this fact and to focus attention primarily upon the individual genes and their composition. But the organism is more than a collection of genes. It is bound together as a unit. In every cell of an individual there seems to be something that represents the organized system as a whole, for every cell has the potentiality of reproducing the individual if conditions are favorable. This "something" is apparently an inherent norm or pattern to which development, from fertilized egg to adult, tends to move.[14]

The Coalescent Dynamic

In the description of a cell as a bounded organization, we have left an implicit mystery which we now must consider: What dynamics bring the constituent elements together to form a cell? The crucial question is whether there are coalescing powers inherent in some types of matter which impel them toward combination. What starts the process going? Why are some chance meetings the beginning of a beautiful friendship? Is the power of organization primordial in matter itself?

In looking for the forces of cohesion, we need not posit some power external to reality, some supernatural agency imposing order according to some preconceived plan of its own, or some vitalistic phenomenon which adds life to inert matter. The success of the sciences in tracing the continuities of evolution precludes the concept of any extraneous power. Instead, we trace back the dynamics of the evolutionary process itself in creating elementary forms. We presume, as Oparin points out, that "a definite protoplasmic organization and fitness of its inner structure to carry out definite functions could easily be formed in the course of evolution of organic matter just as highly organized animals and plants have come from the simplest living things by a process of evolution."[15] Therefore, in accounting for the emergence of elementary organisms, such as cells, we look to the nature of the components for the rudimentary forces which got them together.

Before organic chemists had synthesized practically all known organic substances in their test tubes, it was inconceivable, says Oparin, that organic substances could have been generated in the long process of natural evolution. But, since we now know the conditions for synthesizing organic substances, we need only to prove the possibility of "such primary syntheses during remote periods of our planet's existence," he says.[16] Analysis of the light from stars by spectroscope reveals that among the elements of the cooler stars, carbon compounds are found. On our planet, carbon dioxide, vital to living organisms, is originally formed in the high temperatures and pressures of the interior of the earth and thrown out in volcanic eruptions.[17] According to Willard F. Libby, twenty years ago at the University of Chicago Dr. Stanley Miller, then a graduate student, with Dr. Harold C. Urey, then professor in the Department of Chemistry, "showed that simple inorganic gases, when mixed and subjected to electric discharges, can produce amino acids, and that these amino acids, which are the building blocks for proteins, can therefore be understood as being present—even in such simple systems—and ready for the magic wand or magic act, the life-giving touch which makes the beginning of life."[18]

Both carbons and proteins have unusual properties for forming combinations, suggesting the dynamics for forming associations. Carbon has a remarkable quality of forming complex compounds because of the ability of its atoms to unite into chains or rings. Some coagulation of the helter-skelter of randomly moving particles is achieved because some of the "particles are already to a certain extent oriented with regard to each other," says Oparin.[19] We also find that proteins, essential constituents of all living cells, have a special proclivity for combination. Oparin states that "Meyer and Mark have shown that owing to their high content of the fat absorbing 'lipophil groups' (phenyl, methyl, etc.) proteins manifest a very strong tendency to form molecular associations,"[20] In summary, Oparin says:

> The carbon atom in the Sun's atmosphere does not represent organic matter, but the exceptional capacity of this element to form long atomic chains and to unite with other elements, such as hydrogen, oxygen and nitrogen, is the hidden spring which under proper conditions of existence has furnished the impetus for the formation of organic compounds. Similarly, protein is by no means living matter, but hidden in its chemical structure is the capacity for further organic evolution which, under certain conditions, may lead to the origin of living things.[21]

Such mutual attractions can account for the formation of organizations. Protein molecules bring us, says Harvard biologist George Wald,

> to the borders of biological structure, for such giant molecules, as also some much smaller molecules such as the phospholipids, have enormous tendencies to spin higher orders of structure, highly organized aggregates that at times are hardly to be told apart from the structures of living cells.

> A notable example is collagen, the principal protein of cartilage. . . . In collagen fibrils we are dealing not with single molecules but with great aggregates of molecules, regularly oriented with regard to one another and regularly spaced as in a crystal. The extraordinary thing is that one can dissolve collagen, so completely randomizing this structure, and then by very simple means precipitate it out of solution, when it reaggregates in this specific, quasi-crystalline condition, hardly to be told apart under the electron microscope from what one finds in the connective tissues of living organisms.[22]

The forces causing the atoms in carbon and protein molecules to combine in their particular patterns are some among the several natural forces known to shape structures and behaviors ranging in size from subatomic particles to galaxies. Kirtley Mather suggested such forces "come as near to being ultimate causes as the mind can grasp. They cannot be directly experienced by sense perception, but their reality is now beyond challenge."[23]

These observations about the dynamics of coalescence, while not exhaustive or conclusive, seem to me to indicate that the cohesive forces which form organisms are functions of qualities of attraction inherent in the constituents, and make it unnecessary to posit additional and extraneous force.

Once elements cluster, what process organizes them into forms? What is the origin of their structure? Morphogenesis, suggests A. Katchalsky, may be a consequence of the ability of chemical processes to structure matter in patterns. Referring to a number of experiments which support this hypothesis, he concludes that "the interaction of diffusional and chemical flows leads to a distribution of substances which might play an important role in the processes of differentiation and morphogenesis."[24] This is a way of envisioning how order emerges from disorder, but still does not account for life.

The Magic

The magic, or what Libby previously called "the life-giving touch," in an organism is the interaction of its parts. If when entities were brought together there were no interactions, there would be no life. The process of creativity begins when the entities which have formed an organization enter into cooperative relations through which the activities of each supplies the needs of others. The entities behave differently when interacting in a cell than when swimming freely, and new capacities emerge. Von Bertalanffy comments: "If you take any realm of biological phenomena, whether embryonic development, metabolism, growth, activity of the nervous system, biocoenosis, etc., you will always find that the behavior of an element is different within the system from what it is in isolation."[25] And Oparin points out that "Rubinstein has shown that such properties as heat coagulation, surface precipitation, permeability, electrical properties, etc., cannot be explained on the basis of the properties of some one protoplasmic component, like the proteins, lipids, etc., but are the resultant of correlation and reciprocal action of different colloidal systems, which make up the protoplasm."[26] Sinnott concludes: "There appear to be no specific living *substances* at all; but life inheres, rather, in the way these various things are related and built into a precise system."[27] Thus, it seems to me, the living quality of a cell is a function of the interaction of its parts within an organization, from which new powers emerge. Such new creative powers are the magic of life.

Living processes could not occur within a system without the input of energy. Thus, cells or any living organisms are what Katchalsky calls dissipative flow structures—"they survive only on energy input which is dissipated in the maintenance of structure."[28] The requirement of input and conversion of energy distinguishes living systems from "equilibrium structures" (such as a chair) which do not require energy investment but maintain their structures by strong bonds.

Metabolism transforms energy within a cell. It rearranges chemicals from the environment into forms usable for the vital processes, a conversion facilitated by enzymes which are powerful catalytic agents when their reactions are properly and mutually coordinated.

Mutuality

Who directs the operations within the cell? The answer seems to be that no one does; the constituents mutually influence one another. Who does what seems to be a function of both relative position and the sequence of operations of the constituents. Jacques Monod, director of the Pasteur Institute in Paris, says the operations within a cell form a coherent system through "microscopic cybernetics." As the coordination of cells in a whole body is provided by the nervous and endocrine systems, "we now know that within each cell a cybernetic network hardly less (if not still more) complex guarantees the functional coherence of the intracellular chemical machinery."[29] Control operations are handled by specialized proteins acting as detectors and transducers of chemical information. The regulatory patterns by which functions are coordinated are "feedback inhibition," when the product of an enzyme catalysis inhibits further production and thus governs its own rate of synthesis; "feedback activation," when the product of degradation of a compound activates an enzyme to produce more of the compound, thus maintaining the necessary compound at an optimum level; "parallel activation," when parallel sequences of metabolism activate each other to produce balanced amounts of metabolites for assembly into larger molecules; and activation of an enzyme by the material on which it acts.[30] Thus, there is no higher authority which directs the operations according to a preconceived plan.

Oparin suggests that the type of products of an interaction within a cell are dependent upon both the structure of the relationships and the sequence of operations. He says: "Alteration of the inner physico-chemical structure also changes the sequence in which one reaction follows the other and, therefore, changes the character of the entire biochemical process. It is in this manner that organization determines the course of vital phenomena."[31]

For instance, in the process of fermentation, the products of one reaction are immediately subjected to the next reaction, and if the sequence of reactions is somewhat altered, an altogether different end product is formed.[32]

Sinnott makes it clear that the pattern of relations in a cell affects the nature of their interaction when he says: "The fate of every particle is the result of its position in the whole."[33]

The interactions within a cell are coordinated by the exchange of chemical and electrical messages, a communications system with feedback which makes it possible for one constituent to alter its messages when another entity begins to behave differently. Activities going on within a cell seem to be a dynamic system of checks and balances.

Edmund Sinnott provides a good summary of what we have been discovering about the organization of cells so far:

> A living thing is not a collection of parts and traits but an *organized system*, well called an organism. In this no part or process is an independent event but each is related to the others. . . . They are not aggregates but *integrates*. This process of *biological* organization is the unique feature of living things. If anything distinguishes them from purely physical mechanisms, this, I believe, is it. Life is more than a series of lifeless chemical processes. These are part of it, but it transcends them and pulls them all together. I can best define life as *the process by which matter is brought together in organized and integrated systems capable of self-perpetuation and of change.*[34]

The New Being

The cell as an integrated system is a new being. The evolutionary process has produced a novelty, the emergence of a new form, a new gestalt. Michael Polanyi says the process is "a self transformation that achieves a higher existence, and its structure is akin to that of a creative act by which man can achieve a higher existence."[35]

The new form comes into being because an integrated system manifests qualities not found in the components. Oparin points out that even a mixture of chemicals takes on the nature of new chemical compounds because electrostatic and electromagnetic fields of force of the separate components may act upon each other, whereby new means of attraction are produced. "Thus," he says, "on mixing different substances new properties appear which were absent in the component parts of the mixture."[36]

When the elements mixed are not chemicals but complex chemical entities, and when the mixed entities assume patterned relationships, even more startling qualities emerge. This emergent novelty, says Alfred E. Emerson, the University of Chicago professor emeritus of zoology, answers the very important question of how new beings are created, or how life comes from the nonliving, or even how mind evolves from premental life. "The hierarchy of organization," he says, " . . . illustrates the process by which simpler units or entities become parts of larger whole systems, and these larger wholes have new characteristics emerging from the synthesis of the new system."[37]

Edmund W. Sinnott comments: "We should remember Lloyd Morgan's conception of 'emergent evolution' which maintains that as evolution progresses new traits and properties emerge which are radically different from anything that has gone before. Thus life may be emergent from lifeless matter, and the human attributes of mind, reason and spirit may have appeared successively, as living things reached higher evolutionary levels."[38]

Samuel Alexander is quoted as saying that life is "an emergent quality taken on by a complex of physico-chemical processes belonging to the material level, these processes taking place in a structure of a certain order of complexity, of which the processes are the functions." Alfred Stiernotte comments on the quote from Alexander that a physicochemical process becomes living "because of an additional mode of motion supervening upon the more primitive physical and chemical processes which are involved in living forms. Life is not some factor which intervenes *ab extra,* but something which supervenes at a certain degree of complexity of physico-chemical motions and is born of these motions."[39]

In the continuity of the evolutionary process, new beings and functions emerge from integrated relationships. To account for the mystery of new beings, we need not look beyond the evolutionary process; it is all here in the process which spawns new beings at each level of complexity. We need posit no dualism of extraneous forces to move the process; they inhere in the process. We live in not a multiverse but a universe.

Self-Direction

Here we come to another critical point in this line of reasoning. We have noted that the entities which constitute a cell actively determine their relationship to one another in forming an organization. The question is whether a cell, or any living system, actively determines its relation to other entities in its external environment. Does a cell have an attitude which causes it to respond selectively to events around it?

We have already noted that cells are not preformed or preordained; they constitute themselves. It is the same process as that described by George Wald when he raises the question of who winds the helices:

> Deoxyribonucleic acid, DNA, which forms the stuff of genes, characteristically forms a right-handed double helix, in which two nucleic acid chains form a spiral ladder, the rungs of which are made of complementary pairs of nucleotides. . . . Proteins again take characteristically the form of a spiral or helix, this time single and very tightly wound.
>
> There was a time when all this was first becoming plain, when I asked myself—and I hope you will forgive the wording, which was just shorthand for what I really meant—Who winds the helices? The answer was not long in coming: The helices wind themselves. The most stable and hence the most probable condition for a nucleic acid or protein molecule, or an artificial analogue of either, is to collapse into this characteristic geometry.[40]

The question is whether the "characteristic geometry" of a helix or of a cell then has its own sense of direction in forming larger associations or in communicating with the elements in the exterior environment? Jerome Letvin suggested that neurons have a "point of view," selecting more of this and less of that kind of stimuli to transmit.[41] Whitehead calls the act of selecting "prehension," which is an exercise of preference, accepting from the environment what is consistent with an entity's form, rejecting what is not, according to its inherent appetites.[42]

That a cell manifests a sense of self-direction is generally recognized. But there seems to be a problem in the use of words to describe it, a hang-up which obscures the significance of the self-orientation of living systems. The confusion seems to come from the implications of words we normally use for a sense of direction; traditionally we speak of purpose or goal, which implies externality of the orienting principle. A goal, especially, implies an objective which has been preformed or preordained by some other authority. In our reaction to externally posited goals, we obscure the fact that cells have internal "subjective" intentions.

Some people who speak of a "regulatory system" generally mean self-direction, even when they also use the words purpose or goal. For instance, Sinnott says: "Protoplasm is not a *substance* but a *system*.

We must regard protoplasm, I think, as possessing a pattern which so regulates the course of changes that go on within it that a specific form or activity tends to result. This pattern is the 'purpose' which leads to the achievement of the 'goal'—the form or activity produced."[43] By making pattern and purpose synonymous, Sinnott has opened the way to getting past the hang-up caused by implicit notions of predetermination in such words as purpose and goal. But in order to avoid the mental block to recognizing the factor of subjective intention or inner-directedness in nonhuman beings, we had better eschew the use of such anthropomorphic terms as "purpose" and "goal," as well as teleology.

Consciously to hold a purpose or goal is a peculiarly human capability which is misapplied to other forms of beings without highly developed brains. "True purposiveness is characteristic of human behavior, and it is connected with the evolution of the symbolism of language and concepts," says von Bertalanffy.[44] A being's inner intentions can be oriented toward an externalized goal only when the sense of direction can be objectified in symbols or words. Therefore, by definition only language-using human beings can speak of purpose. Ralph S. Lillie has said:

> Conscious purpose, as it exists in ourselves, is to be regarded as a highly evolved derivative of a more widely diffused natural condition or property, which we may called "directiveness." . . . In the characteristic unification of the organism an integrative principle or property is acting which is similar in its essential nature to that of which we are conscious in mental life. . . . Conscious purpose is to be regarded as only one form of biological integration; the integration shown in embryonic development is apparently unconscious, and the same appears to be true of most physiological relations. Such biological facts point to the existence of a more general integrative property or activity of a fundamental kind which is universally present in living organisms, from amoeba to man.[45]

Nonhuman living systems without conscious purpose thus have a capability for orienting themselves in, and organizing elements from, their environment. "When dead matter, random and fortuitous in its distribution, enters a living organism," says Sinnott, "it comes under the control of a regulatory system which molds this hitherto disorganized system into a complex organic pattern of a very precise sort."[46] This self-regulatory system is clearly manifest in the way an injured organism restores itself; he points out:

> The precise form an organism assumes is a visible expression of its organization, and the orderly development march is the means by which this comes to being. . . . If normal development is disturbed, there at once begins a series of processes which tend to restore it. Injuries are healed. Missing parts

are regenerated. Altered patterns are reconstituted so that a whole and typical individual tends to be produced. The *self-regulating* capacity of organisms is often shown more dramatically in these modifications of their development progress than in the normal development itself. . . . Organization is regulatory process.[47]

The self-regulatory process in nonhuman organisms is apparently different in degree from that in human beings, but not in kind. When an organism builds itself according to a plan of its own, this "plan is experienced subjectively as a purpose, the beginning of mind," says Sinnott. This self-designing, he continues, "is the vital difference between a lifeless mechanism and a living one."[48] Bergson points out that when a chick pecks its way out of its shell, a new instinct has not taken over, but the behavior is the continuance of the pattern which has brought its embryonic life thus far. In the same way mind has emerged as an extension of the self-regulatory pattern. In support of this view, Sinnott quotes from J. C. Smuts, "Mind is a continuation, on a much higher plane, of the system of organic regulation and coordination which characterises Holism in organism," and concludes, "Mind is thus the direct descendent of organic regulation and carries forward the same task."[49] Mind is thus, if you accept these suggestions, also an emergent from the continuous evolutionary process, operating at a significantly higher level of complexity but nonetheless part and parcel of the process. I belabor this point about mind being an extension of self-regulation and intention because it will be important to remember a little later when we come to consider living systems of greater magnitude which do not have a brain but do have subjective intention.

Self-regulated cells coordinated in a larger system exercise a mutual influence. Ward H. Goodenough points out that "the processes going on at one level of organization affect the patterns which emerge at a higher level of organization. This is as true of cultural as of biological evolution. A community takes its shape and its institutions are established as a result of the actions of individual people."[50] Conversely, N. Botnariuc says: The functioning *direction* of the system of laws of a certain level is determined by the more general laws of the higher level systems."[51] The influence of the pattern of self-regulation of a higher-level system upon the development of its constituents is what is really happening in natural selection. The direction of natural selection is determined by the laws of the ecological system within which a species lives. It is species, not individuals, which are selected because biological adaptation through random mutation of genes occurs at the species level; individuals strive for adequacy through varying "counteractive responses to changes in the environment," says Botnariuc.[52] Natural selection is a link in the control mechanism of an ecological system: "The modification of the relations within the biocoenosis [a community of diverse organisms living in a circumscribed environment] will inevitably lead to the change of place occupied by the species in the economy of the ecosystem, to a change of direction in natural selection."[53] Or, as Fuller and Putnam put it: "In a sense the theory of evolution does not so much explain the origin of the diversity of the forms of life as pass the buck to the diversity in the environment. It is the highly specialized and varied ecological niches that produce patterned diversity of plant and animal life on the basis of adaptive radiation into the available niches."[54]

Thus, living systems exercise determinative influences on other systems quite aside from the use of intelligence or symbolic communications. Smaller systems communicate with larger just by what they produce, and larger systems determine the direction of growth of smaller systems just in the way the larger systems function.

An Autonomous Individual

When a cell consistently acts according to its own self-direction, it becomes a centralized system and therefore an individual. As von Bertalanffy points out: "The principle of centralization is especially important in the biological realm. Progressive segregation is often connected with progressive centralization, the expression of which is the time-dependent evolution of a leading part. . . . At the same time, the principle of progressive centralization is that of progressive individualization. An 'individual' can be defined as a centralized system."[55]

The focusing of the tendencies within a cell, the channeling of all the preferences of the constitutents of a cell through a central point, gives a unity to the cell which makes it an individual.

Now, the question is whether a cell in a larger system has freedom to initiate action, or simply reacts to its environment. Except for one-celled organisms, cells are integrated into larger organisms whose collective tendencies condition the action of the cells. This raises the question of whether cells are in any sense autonomous. We have already seen that the cell as a bounded unit responds selectively to its environment; as an open system it chooses what other entities it will relate to. Moreover, by definition a cell is free or it could not enter into relations to form a larger whole. According to Hartshorne:

> The social view of organic unity is that individuals form organs for other individuals. This proposition is convertible: namely, if individuals are organs, organs are individuals, singly or in groups. Now an individual is self-active;

if there are many individuals in the ultimate organism there are many self-active agents in that organism. Being is action, what is really many must act as many. The higher is compounded of the lower, not by suppression but by preservation of the dynamic integrity of the lower. The cosmos could not guarantee that the many individuals within it will act always in concord; for to carry out such a guarantee the cosmos must completely coerce the lesser individuals, that is, must deprive them of all individuality. Existence is essentially social, plural, free, and exposed to risk, and this is required for our conception of organism. For if the action of the parts had no freedom with respect to the whole, there would be no dynamic distinction between whole and parts and the very idea of a whole would lose its meaning.[56]

The degree of autonomy or freedom depends upon the degree of interdependence of the parts within the living system. The constituents of a cell may be so tightly structured and so interdependent that they have little autonomy, although the malignancy of cells when they become cancerous and destroy the organism within which they live, and hence themselves with it, illustrates that even with high interdependency there is final local autonomy. Alvin W. Gouldner defines the correlation between autonomy and interdependence when he says that there are varying degrees of interdependence, depending upon whether an individual exists in mutual interchange with all other parts of the system, or with only one other part, and that autonomy varies accordingly. He adds:

Still another way of viewing interdependence is from the standpoint of the parts' dependence upon the system. The parts may have varying amounts of their needs satisfied by, and thus varying degrees of dependence upon, other system elements. A number of parts which are engaged in mutual interchanges may, at one extreme, all be totally dependent on each other for the satisfaction of their needs. In this case the *system* they comprise can be said to be "highly" interdependent, while these *parts* can be said to possess "low" functional autonomy. Conversely, a system may be composed of parts all of which derive but little satisfaction of their needs from each other; here the system may be minimally interdependent and the parts would be high on functional autonomy. Operationally speaking, we might say that the functional autonomy of a system part is the probability that it can survive separation from the system.[57]

The functional autonomy of parts of a system is necessary to its survival, says Gouldner; otherwise there would be no possibility of the system's increasing its adequacy by changing to respond to tensions produced by changes in the environment. When new challenges emerge in the enrironment, the system would either collapse under the impact of powerful disruptions, or it would have to undergo radical structural reorganization.[58] Internal rigidity makes a system unfit for survival.

With such functional autonomy, how can there be relative stability to maintain the integrity of an organism? If entities within the system are free to do as they choose, how can the system become and remain organized? Some of the entities in the system will be disorderly, but overall stability is maintained if a sufficient number of constituents respond cooperatively to the messages circulating in the system. We are here confronted with a situation where the laws of probability or statistical mechanics apply, by which I mean that the integrity of the system is maintained by the correlated functioning of a majority of the constituents; the pattern of operations is a statistical one. Organisms have back-up mechanisms so that one channel of operations can break down but another takes over. The indeterminacy of action of particular parts becomes determinate, probabilistically, when a sufficient number of constituents are involved. Thus, a relatively stable configuration of activities is manifested in a living system with autonomous parts.

Duration

A cell is not a permanent order, but its form does endure. To counter disorganization, it is not necessary that a structure be permanent. It is necessary only that the form persist. How does a living system achieve duration of its own order? Duration of order is achieved by maintaining continuity of order through change in substance. This is done in two ways. First, the persistence of the pattern is achieved by constantly and rapidly replacing the constituents of the cells. "It is the basic characteristic of every organic system that it maintains itself in a state of perpetual change of its components," says von Bertalanffy. "In the cell there is a perpetual destruction of its building materials through which it endures as a whole. . . . In the multicellular organism, cells are dying and are replaced by new ones, but it maintains itself as a whole. . . . Thus every organic system appears stationary if considered from a certain point of view. But what seems to be a persistent entity on a certain level, is maintained, in fact, by a perpetual change, building up and breaking down of systems of the next lower order; of chemical compounds in the cell, of cells in the multicellular organisms, of individuals in the ecological system."[59] Duration through the constant restoration of substance underlines the fact that it is the pattern and not the substance which endures. As J. Z. Young points out: "Individual chemical atoms remain in the cells for only a short time; what is preserved must be the pattern in which all these interchanging atoms are involved. . . . Biology, like physics, has ceased to be materialist. Its basic unit is a non-material entity, namely an organization."[60]

The organization maintains the dynamic and exquisitely complex physical and chemical components of its system in a state of delicate balance or homeostasis. Without some comprehending unity of organization, the components would fragment. James G. Miller says the steady state is the consequence of the system's capacity "to maintain multiple variables within a stability range. This steady state is maintained despite wide environmental fluctuations by negative feedback processes."[61] Oparin points out that the decomposition of organic compounds within a system releases energy necessary for the synthesis of new substances, but duration is achieved by the preponderance of the synthesizing process: "In the protoplasm, owing to the existence of a definite physicochemical organization, the chemical processes are so reciprocally coordinated that a decomposed substance is at once replaced by a newly synthesized one, and a structure which had been destroyed is immediately restored. Thus, there is a constant exchange of substances, but synthesis always predominates over destruction, and this creates the dynamic stability of the system."[62]

However, in the process of self-renewal, "copy errors" accumulate and gradually undermine the capacity of the organism to maintain its organization. Microscopic entities "undergo quantum perturbations, whose accumulation within a macroscopic system will slowly but surely alter its structure," says Monod. "Aging and death in pluricellular organisms is accounted for, at least in part, by the piling up of accidental errors of translation. These, in particular affecting certain components responsible for the accuracy of translation, tend to precipitate further errors which, ever more frequent, gradually and inexorably undermine the structure of those organisms."[63]

Since the replacement of the constituents of an organism gradually degenerates an organism, cells and organisms have evolved a second strategy for duration, that of duplicating themselves. Cells or one-celled animals accomplish reproduction by binary fission, or simply splitting in two right down the middle, following which each half grows to a normal cell. In more complex organisms of structured cells, reproduction is by spawning an egg cell either asexually, in which case the offspring is an exact reproduction, or sexually, in which case the combination of half of the coded genes from each parent produces a variety of offspring. In any case, order proceeds from order through reproduction. Or, as Whitehead has put it: "Endurance is the repetition of the pattern in successive events. This endurance requires a succession of durations, each exhibiting the pattern."[64]

In summary, I think we can say that a cell is a very successful little living system in its self-organization to produce order from chaos. The primordial dynamics of attraction in the chemical or electromagnetic bonds of the elements amalgamated the basic elements in ever increasingly complex forms of organization which comprised an open system with a boundary within which selective interactions could achieve new functions, including the conversion of energy, in order to maintain the form through change. Once established, the cell becomes determinative of its parts, and self-directs its further development, thus becoming an autonomous individual in control of its own destiny, and achieves duration. In short, the cell has become an organism, a highly complex structure of parts so integrated that the relation of the parts to one another is governed by their mutual relation to the whole.

By what stretch of the imagination can we assume that the anatomy of a cell can teach us something about the nature of reality as a whole? Two concepts from the sciences can justify our tracing "hidden likenesses" between cells and larger orders of being: the concept of the continuity of all being, and the concept of the hierarchy of levels or organization. I have already used the words continuity and levels, but let us see what the implications of these words are as generalized concepts.

Continuity of Being

The continuity of all being has become evident to us in the continuing process of evolution. The observation of Darwin that each existent species evolved from a preexistent type, rather than having been created as an original type, leads to the recognition that all being exists in a continuum, a spectrum of entities including the inorganic and the organic, the inanimate and the animate. This conception of continuity has been reinforced, as Ralph Wendell Burhoe has pointed out:

> The scientists in this century particularly have built a web of relationships and interdependence among entities and their histories located along a dimension of increasing inclusion of subsystems, such as the interdependence ranging from the system of human civilization down through subcultures to individual men, to their organic parts, to the hundred billion cells that constitute these, to the chemical compounds that constitute these, to the subatomic particles that constitute these. Nowhere are there encountered any disruptive discontinuities, although in the realm of the more infinitesimal entities one must now be satisfied with laws which are valid only for large numbers of the hypothecated events.[65]

In this continuity of being, the boundary between the living and the nonliving is wavering and vague. If we look down the scale of organization of organisms, we come to a system which under varying conditions exhibits the properties of life and of nonlife: a virus. The tobacco virus, for instance, in crystalline form seems to be a dead system which can be warmed, frozen, dissolved, and recrystallized, but it cannot reproduce itself. Then put the tobacco virus into a nutrient solution at a proper temperature and it becomes a living system, growing and reproducing itself, but it can be killed by overheating.[66] Again we see that life is not a substance, but a quality of interaction.

It becomes increasingly clear that the evolutionary process shapes the development of matter in all its forms. Harlow Shapley, the late Harvard astronomer, is of the opinion that:

> *All* the chemical elements, all matter, we now believe, has evolved, and is currently evolving, from the simplest and lightest of atoms—from hydrogen.
>
> Thus we have evidence of a truly wide Cosmic Evolution from hydrogen to *Homo,* and probably somewhere an evolution beyond the *Homo* level of sentiency. We have in Cosmic Evolution a fundamental principle of growth that affects the chemical atoms as well as plants and animals, the stars and nebulae, space-time and mass-energy. In brief, everything that we can name, everything material and non-material, is involved. It is around this Cosmic Evolution that we might build revised philosophies of religion.[67]

If all matter has evolved from hydrogen, it obviously follows that we would expect to find the same elements throughout the universe, which is confirmed by M.I.T. physicist Sanborn C. Brown: "There is . . . no indication that what we observe as the structure of matter in the farthest reaches of space is different in any detail than those we see in our laboratories or find on the surface of the earth."[68]

Not only are the same structures of matter observable throughout the universe, but the same chemical and physical laws operate throughout. The law of gravity works just as specifically to hold me to my seat as it does to hold the planets in their orbits, or the laws of physics and chemistry work just as precisely to produce the energy in the sun by fusion of hydrogen nuclei as they do in producing the explosion of a hydrogen bomb.

Theodosius Dobzhansky, then professor of genetics at Rockefeller University, said in a lecture at the University of Chicago (May 1, 1967) that evolution is a differing process at inorganic, organic, and human levels, but however disparate the processes, they are part of a single story—"The whole show is a single undertaking."

Hierarchy of Levels of Organization

The second concept from the sciences which justifies our use of analogies in order to understand the nature of reality as a whole is the concept of levels. The evolutionary continuum has differentiated the organization of matter and entities in organizations on a scale of magnitude and on a scale of complexity. In its evolution, the stuff of reality has burgeoned in distinctive forms that emerge as a hierarchy of integrated beings. Charles Hartshorne is of the opinion that "we shall never understand the world, or the problem of God, until we learn to see reality as a system of individuals on many levels of many kinds, and that individual in the primary sense of *dynamic one* is to be contrasted with mere segments of reality carved out more or less arbitrarily by the beholding mind."[69] And von Bertalanffy says: "Reality, in the modern conception, appears as a tremendous hierarchical order of organized entities, leading in a superposition of many levels, from physical and chemical to biological and sociological systems. Unity of Science is granted, not by a utopian reduction of all sciences to physics and chemistry, but by the structural uniformities of the different levels of reality."[70]

The concept of levels refers primarily to the emergence of new definite forms with an order of their own and with qualities hitherto nonexistent—such as life, mind, and culture—and which, while novel, exist in continuity and interaction with entities at other levels. Each level of being has its own style of being according to its own laws. "Methodologically," says Abraham Edel, "a new level requires new descriptive concepts and, many believe, new empirical laws, independent of those of the old level."[71] Hence, when we speak of levels, we are speaking not only of the emergence of integrated organizations but also of laws which describe their predictable operations.

Botnariuc says that the features of open systems, from the atomic level to ecological systems, of wholeness, self-control feedback circuits, and steady state "are shared in common with all the representative units of the various levels of organization, but they are differently realized in the units belonging to different levels, owing to the fact that each organization level has its specific organization and functional features, as well as its own laws."[72]

A significant implication of the levels of systems is stated by Botnariuc:

> Due to their simultaneous existence, the open systems are in relations of successive subordinations, so that the individual level systems may be considered as subsystems of the population (species) system, the latter being in its turn a subsystem of the biocoenosis system, etc.
>
> The successive subordination of biological systems of various levels is also reflected in the relations between the specific laws of different levels. *The direction of the law's action at a certain level is determined in the last analysis by the more general laws of the next level.*[73]

Thus, the line of development of a particular system is circumscribed by its participation in the next-higher level of organization, unless the particular system decides that messages from other sources, perhaps still higher levels, are more pressing.

Since many configurations of reality can be conceived as a hierarchy of systems organized in ever more comprehensive levels, why should we presume that the self-organizing activity no longer prevails beyond the level of organisms, especially of human beings? Why should we presume that all existence more inclusive than an organism is composed only of aggregates of autonomous entities? It may be a conceit of man that, since he is so successful in adapting the environment to his needs, he is the ultimate living system.

James G. Miller suggests that each system is a subsystem of a suprasystem:

> Thus, *cells* form the *tissues* and *organs* of an organism. . . . *Organisms* usually live together in different sorts of groups—herds, families, tribes, working teams, and many other face-to-face groups. *Groups* are subsystems of *organizations*, which in turn make up *societies*. There are limited supranational systems, like alliances or economic communities, and in recent years early precursors of world-wide supranational systems may be beginning to appear. Finally, there is the largest living organization of all—the biota of the world, all the life on the planet. This forms a system with the planet itself.[74]

Living Systems

Now we can see whether what we learned about a living system from an analysis of an organic cell can give us insights into the nature of living systems as a generalized concept. We have seen that living systems emerge as a voluntary association of parts interacting and self-directed which form an organization, and that the most stable elements in reality are not congeries of matter but patterns of relationships of particles of matter. The question is whether the categories characteristic of cells are analogous to categories in all living systems. We will not expect to find a one-to-one correlation, and we do not require it, as each level of order acquires its own style and laws corresponding to its functions.

The concept of reality as a hierarchy of wholes is difficult to visualize since we are inside the larger wholes. But the conception of wholes is becoming much more general. The concept of "wholeness" is becoming more central in biology, psychology, sociology, and in other sciences, as indicated by the more frequent use of such expressions as "system," "gestalt," "organism," "interaction," and, says von Bertalanffy, "the whole is greater than the sum of its parts."[75] And Botnariuc comments: "Wholeness is the most striking feature of the systems at all levels of living matter. It arises and develops as a result of structural differentiation and functional specialization within the given system."[76]

In considering levels of wholes, we have to distinguish between magnitude and complexity. Complexity is not a function of magnitude; in fact, some larger wholes are less complex. As we think about levels, we have to think in two dimensions, the dimension of increasing complexity and efficiency, and the dimension of increasing size. Teilhard de Chardin points out that there are not only the infinitely small and the infinitely large but also the infinitely complicated. Cosmic evolution, he says, moves in two main directions: expanding from the infinitesimal to the immense and, folding in upon itself and centering on itself, from the extremely simple to the immensely complex.[77] Therefore, we will not expect to find a correlation between magnitude and complexity. The greater system will not through the whole scale of magnitude always be the more complex and efficient. In short, suprasystems will not necessarily have all the attributes of man.

Another confusion can be cleared up by making a distinction between living and nonliving systems. A living system, we have seen, emerges from nonliving matter as order from disorder or chaos. Dead matter is not the opposite of living matter, for it is the system that lives, not the material. "Dead" as an adjective describes an *organic form* which once lived but has lost its power to maintain its organization. However, there is a difference in kinds of organization of matter. All living systems are organized matter, but not all organized matter is a living system. A living system is distinguished by self-organization, interaction, a communication network with feedback, self-direction, autonomy, and duration achieved by self-replacement and replication. A cell or a man has these qualities.

But we also speak of systems which have some of those qualities and are not living, such as sewer systems or mechanical systems. My typewriter, for instance, is a beautiful mechanical system, but it is not living; it is not self-organizing, it is made by man; and, though I expect it to last a few years, it has no duration either by self-replacement of worn-out parts or by duplicating itself.

We have no difficulty recognizing that in animals cells are organized into organs which perform various functions, and the organs are integrated in an organism, a being about whose quality of living we have no doubt. But when we consider more inclusive if less complex systems, we are only coming to realize that they have qualities of life. Why assume that the self-organizing, self-directing, energy-using activities cease at the level of human beings? I propose that we conceive of our immediate environment, at least to the level of the whole planet earth, as a living system with the characteristics of a cell if not of a man. I have already quoted James G. Miller's remark that systems exist at various levels and that, "finally, there is the largest living organization of all—the biota of the world, all the life on the planet. This forms a system with the planet itself."

The relatively new science of ecology, the study of the interrelations between organisms and the environment as a series of interlocking systems, is opening new vistas into the nature of the total environment. Paul Bigelow Sears, professor emeritus of conservation, Yale University, comments that "it should be kept in mind that earth, atmosphere, individual organisms and communities of organisms all represent dynamic systems, or processes, whose mutal interplay is the concern of the ecologist."[78] Plants and animals are interrelated in highly complex natural communities which, with their nonliving environment, form ecosystems on land and in the sea. Ecosystems perform "community metabolism" for the more efficient use of energy.

Ecosystems evolve from simple to more complex forms, tending to converge in a climax community suitable to the climate of the region. An example of such succession is when a lake fills in and becomes a grassy prairie or a beech-maple forest. Such climax communities endure unchanged, unless new factors are introduced, such as climatic changes, fire, or pests. Thus, ecosystems organize themselves for the most efficient use of energy under given conditions. Sears says:

> Succession represents a process of increasing integration between life and environment. It apparently tends to follow the principle of Le Chatelier as developed by Bancroft, i.e.: heterogeneous systems tend progressively toward a condition of minimum disturbance by external forces and internal stresses. So far as the somewhat limited evidence goes, succession also tends towards a progressively more efficient use of energy. The climax community is a close-knit and delicately balanced system which stores and uses solar energy. So intimately adjusted are the nutrient and reproductive cycles of its constituent organisms that the minimum of useful energy is wasted in the chain of metabolic relationships. Thus the climax community represents the maximum in organic economy, as contrasted with the extreme of energy waste in a bare area which receives solar energy only to dissipate it into space without benefit to living organisms.[79]

The oceans provide habitats for numerous plant and animal communities which merge in a vast ecosystem with overlapping borders at the beaches with other ecological systems.

The thin layer of atmosphere forms a global weather system, and pollution of the air in sufficient quantity anywhere affects the quality of the air everywhere.

Mankind wherever it lives is a part of these ecosystems, often modifying or destroying natural communities as a consequence of the density of his population or the advanced development of his technology, which so far has flourished at the expense of the exploitation of energy stored in fossil fuels or the ruthless harvesting of plant and animal life. It has also learned to husband plant and animal life to the benefit of its own food chain.

With its distinctive capacity for intentional behavior, mankind also has organized its own form of living systems, human communities from families to nations. You can trace the succession of human communities toward more complex and efficient organization just as you can that of natural ecosystems toward a climax forest. But to make a long story short, let us look at the, so far in human history, climax social system—a nation, specifically the United States of America, as a living system.

The constituents of the nation are its citizens who are voluntarily associated to increase survival ability (a dynamic obscured by birthright citizenship) but mutually serving each other's needs through specialized activities. Within the nation are subsystems (organs) to serve particular needs, such as families, businesses, industries, schools, hospitals, churches, clubs, city and state governments, and so on. The system converts energy by raising and distributing food and by manufacturing power with water, fossil fuel, and atomic generating plants. The nation has a boundary which it defends against invasion, but which is open to a selective exchange of people, goods, and services with other nations. It has a complex web of communications which integrates its activities. The nation is self-forming, self-directing, and autonomous. All of its tendencies are centered in a national administration which expresses the sense of direction of the whole, thus achieving individuality epitomized in such phrases as "national policy," "the American way of life," or "Uncle Sam." The nation achieves duration by constantly replacing its population and renewing its subsystems, though it is still an open question whether it has achieved the stability of a climax forest.

It seems to me that a nation has most of the attributes of a cell as a living system. And there are compulsions toward forming the nations into a global human community, such as increasing economic interdependence and satellite communication systems. Human intentional communities as well as biological communities tend toward forming planetary living systems.

Teilhard de Chardin, the French priest and paleontologist, is of the opinion that the earth's being round brings the biological systems around to meet themselves and form a global system he calls the "biosphere," which he proposes is "a truly structural layer of the planet, a sensitive film on the heavenly body that bears us."[80] He also thinks that the sphericity of the earth is forcing culture to become "totalized" into a "noosphere (or thinking sphere) superimposed upon, and coextensive with (but in so many ways more close-knit and homogeneous) the biosphere."[81] The very shape of the globe sets a boundary within which all of life and all of culture is bound to interact. If the earth were flat, these phenomena would simply dissipate continuously away from themselves, forming no systems. But the oceans, the atmosphere, the biosphere, and the noosphere do form global systems, and this indicates to me that the earth itself is a great living system. The whole earth may be seen as a vast dissipative energy-flow structure using the energy from the sun to create and sustain order from disorder, with the same self-organizing characteristics as a cell.

Since the earth is part of larger orders of the solar system and the Milky Way galaxy, why not carry the living-systems analogy further up the scale of levels of being? The reason simply is that at some point, it seems to me, we cross the indeterminate boundary of the living. The dimension of magnitude loses something on the scale of complexity which is so essential to life.

Our solar system is certainly an order held together by gravity balanced by inertia, but it seems to be a simple system in which there is not much interaction. Only the earth seems to be in a position to capitalize on the energy flow from the sun and provide conditions for the emergence of living forms. Certainly the solar system is self-created, but it has not achieved the capacity of self-renewal or reproduction in order to achieve duration on its own scale. Astronomers predict the eventual "heat death" of the sun by exhaustion of the sun's energy-producing mass through radiation, although not for billions of years. The planets in their orbits around our sun seem to be ordered more by its mass than its energy flow, but as the mass is dissipated, so will the order be disrupted. But on the human time scale, billions of years are a practical eternity.

The Milky Way galaxy in which our solar system floats seems to be a relatively stable gravitational order which is more of an aggregation than a system. Though it is self-ordered and contains thousands of energy-radiating suns, the amount of energy reaching our solar system is of such small consequence that interaction is negligible. The structure of our galaxy is so heterogeneous that we can no longer trace the characteristics of a living system. Although Harlow Shapley predicts that there are probably millions of other planets where conditions are as favorable for the evolution of living systems as they are on our planet, there is so far no interaction of any significance. The distance to the nearest star is about four light-years, while the distance to our own sun is only about eight light-minutes. Since light travels at the rate of 186,282 miles per second, we are speaking of "astronomical" distances. In our experience, distances measured in light-years are practical infinity.

Beyond our galaxy, we do not seem to know what shape space is in. We are presented by the astronomers with a number of cosmological models.[82] Beyond our galaxy, matter seems to be distributed in space at random, except for clusters of nebulae. The hundreds of millions of stars disclosed by our telescopes seem to be independent systems not comprised in any inclusive order. Though there are other models to choose from, one hypothesis is that the galaxies seem to have overcome gravitational attraction and are streaming away from one another, and in good time may disappear over our visible horizon, according to the generally accepted dispersal theory. Our galaxy may be an island universe among other island universes. Indeed, our cosmos conceived as an orderly system may be no more comprehensive than the Milky Way, so that the universe does not comprehend all constellations of matter in one system; beyond our galaxy is chaos.

We ask about the nature of our environment only insofar as it is relevant to our needs and interests in the middle range of time and space where we live. Reality is significant to us only to the extent that we interact with it. Selective interaction, as we have seen, takes place within a boundary. As we have also seen, the levels of organization of matter diffuse from indubitably living systems to nonliving cosmological orders and ultimate chaos. At the macroscopic as well as the microscopic level, the borderline between living and nonliving is indistinct. However, the unclarity of ultimate boundaries is not critical. If we begin with the concrete organizations of the environment we experience, as we move out the scale of magnitude toward more remote organizations, we find that as they become less complex they also become less significant. I suggest a hypothesis that the boundary of the cosmos as a living system is to be found where forces of attraction cease to operate to form communities within which important interaction takes place.

One of Newton's laws specifies that every particle in the universe attracts every other particle with a force directly proportional to the square of the distance between them. At some point, for all practical purposes the degree of separation negates the attraction, and the distant entities are of little consequence to us.

In any case, for us it is not a critical question how far away the boundary of the great living system is, for the system is determinative not because of its remote boundaries but because of the conditions set by the immediate continuities of its organization. We are an intimate part of the interacting system in its concrete immediacy, and the question of how far beyond us the hierarchy of living systems ranges before they are finally bounded is not significant. What is critical for us is that we are involved in a hierarchy of living systems, a concrete continuum of related structures. The middle range of structures of the great living system affects us in positive correlation with its immediacy. The great living system is composed of all of its subsystems and manifests itself in its dense inner structures, not just at the periphery.

So let us return to the level of order which makes some difference to us, planet earth. How the earth fares in its solar system does ultimately make a difference to us, but only insofar as any changes affect the Earth as a great living system.

The Earth as the Body of God

From our human observation point inside the larger systems, we find it difficult to realize that our being is conditioned by our participation in larger systems, including the great living system of the earth. We have the myopic vision of a cell in a human body, as suggested in the theological parable about the liver cell who said to a neighbor: "What's this I hear about there being a man?" To which the second cell responded: "Pay no attention to such superstitions; that's just the figment of some brain cell's imagination."

In constructing cosmologies, Howard Percy Robertson, professor of mathematical physics at the California Institute of Technology, points out that man "in attempting to bring order into the universe as a whole . . . must hew to those lines of thought by which he has already brought order into that portion with which he is most familiar."[83] It is at least reasonable that the concept of a living system—which is so useful in helping to understand formations as wholes, from cells through organisms to ecosystems and human communities—can help us to understand the environment as a planetary whole.

Besides, if our environment were not bounded in a unity, its constituents would disperse over the horizon like the galaxies in space. There is a logical necessity for a comprehensive unifying order to hold the subsystems in relations or they would repel one another. Oparin writes that it is characteristic of bounded organizations to be somewhat antagonistic to their environment, as nations are to other nations. Selective interactions also imply rejections, and negations would tend to drive systems apart were they not structured in a larger organization. For the interactions to take place which we observe on a global scale, it is necessary that the parts be organized in a comprehensive system.

British philosopher Samuel Alexander suggests a way of thinking about our relation to the great living system: "For any level of existence, deity is the next higher empirical quality. It is therefore a variable quality, and as the world grows in time, deity changes with it. On each level a new quality looms ahead, awfully, which plays to it the part of deity."[84] The great living system is most vividly known to us in the next-higher comprehensive order, and becomes less vivid the more comprehensive the order is.

To me, the concept of a living system as model for the environment conceived as a whole seems real. From this point of view, I feel as Copernicus did when he imagined himself standing on the sun and observing the solar systems—everything falls into place and makes sense. However, also like Copernicus who could not fully account for the movement of the planets because he assumed their orbits had to be a perfect circle (a difficulty removed when Kepler suggested that planetary orbits were elliptical), my own mind-set has no doubt left contradictions in this conceptual system. Still, the living-system analogy is satisfactory to me in making the environment coherent, and in describing how there comes to be meaningful order in reality.

Moreoever, the living-system model for the structure of existence, culminating in a great living system, the earth, which is conditioned by participation in orders of greater magnitude, obviates some old theological paradoxes of the Judeo-Christian tradition. Most religions are based upon an intuition of some transcendent creating and ordering power which conditions human existence. The transcendent power in our tradition has been named "god." He created the world and laid down the laws of its being. He is supernatural, manipulating the stuff of existence from beyond. This model leaves a problem: "Who made God?" The declaration that he is eternal and immutable (uncreated), or the "unmoved mover" of Platonic thought, dismisses the question without responding to it. "God" is the name given to the mystery of creation, not a contribution to understanding it.

The living-system model, on the other hand, helps us understand how the order of living systems was self-created in an evolutionary process. We have not accounted for the origin of atoms and molecules, but we have seen how order emerges from disorder, and how the process culminates in an emergent great living system which is determinative for the behavior patterns of its constituents. Instead of a supernatural power, we see that order is produced by a "democracy of influences" which functions through a communications system. A consequence of this view is that we understand that in the life process influence is exercised not so much by brute force or violence as by interaction coordinated by signal systems.

The living-system model also obviates the anthropomorphism characteristic of Christian theology, making God in man's image. Now we can see that the ground of our being has less the attributes of human beings and more the attributes of a biological cell. For instance, Christian theology often speaks of the "mind of God," as if the supreme being had a brain capable of thinking in symbols, communicating in language, and projecting conceptual purposes. The great living system is immense in magnitude, but—except for the "noosphere" of three billion brains—not in complexity, so there is no evidence of the emergence of a superhuman brain with those qualities at the level of the nonhuman elements of the great living system. In its transhuman dimensions the great living system functions more like a cell, manifesting self-direction at such a comprehensive level that it is determinative in setting the conditions for self-fulfillment of all its participant beings. This is the equivalent of the "will of God"; it is not a self-conscious projection of a conceptual goal, but is the realization of the form in the pattern of internal relations of the great living system. The way the supreme will functions is through the operation of natural selection. Men have long intuited the operation of such a regulating power and, from the systems point of view, I think we can more clearly apprehend its working as simply the process of natural selection requiring that every being adapt to the conditions set by participation in the next-higher order or more inclusive system. The unique presence of mind in man does not negate the transcendent control of the great living system; it only emphasizes the responsibility of man to exercise his intelligence to understand the conditions of his successful existence and not to project his fantasies as "live options."

The living-system model for the supreme being also obviates the dualistic view of the environment: the natural and the supernatural, the immanent and the transcendent, with the attendant problem of how one realm communicates with the other. Christian orthodoxy has allegedly bridged this gap by postulating "special revelation" (the divine word recorded in the Holy Scripture). The concept of the hierarchical levels of being makes the supreme being both immanent and transcendent, just as I experience the United States as both immanent in the political order in which I participate, and transcendent in the coalescent character of the nation as a whole. Hartshorne points out that the perception that immanence and transcendence exist in a continuum precludes two errors: it "is in fact the only way to achieve a just synthesis of immanence and transcendence, the only way to avoid the twin errors of mere naturalism and mere supernaturalism."[85]

When dualism is rejected in favor of the continuum of the immanent and the transcendent in the living-system model, two other consequences immediately follow. First, the old distinction between the sacred and the secular is abandoned, and all existents are seen as sacred since they are constituents of the supreme being. This has implications for the way we value and treat not only human beings but all beings in our environment. Second, the old epistemological distinction between revelation and reason is obviated by the recognition that knowledge about all levels of being is acquired not only through insight, intuition, and the wisdom of previous experience accumulated in tradition, but also through observation, experiment under controlled conditions, and rational thought by comparison, inference, or manipulation of mathematical symbols. All truth is knowlege of God. Discovery ensuing from imaginative hypothesis and experiment, as regularized in the scientific discipline, is the mode of increasing knowledge of, and the adequacy of our coping with, all levels of reality, including the highest. Such a mode of knowing can provide common ground for dialogue among the various religions of the world.

Sanborn C. Brown finds contemplating the whole complex of the "almost incredible laws of nature" a "truly satisfying religious experience," and says: "The scientific cosmos is more like the God of inescapable Law in the Old Testament. It is a single integrated system of reality, and the law of its operation creates and sustains all that is from everlasting to everlasting."[86]

This way of visualizing the nature of environment as a whole is no innovation; such a supreme being has been intuited by many for some time, although some have projected a conscious mind in the supreme being. The apostle Paul seems to have the same kind of supreme being in mind when he writes of the "unknown god" whom he said the Greeks in Athens were seeking: "Yet he is not far from each one of us, for 'In him we live and move and have our being'; as even some of your poets have said" (Acts 17:28).

Alexander Pope, the British poet, wrote in 1732:

> All are parts of one stupendous whole
> Whose body Nature is, and God the soul:
>
> . . . .
>
> To him no high, no low, no great, no small;
> He fills, he bounds, connects, and equals all.[87]

David Hume, the eighteenth-century British philosopher, reasoning by analogy, was of the opinion, according to Hartshorne, that "we should expect God to be the mind whose body is the universe, with the result that God would depend on the world as truly as the world depends on him, for 'equality of action and reaction seems to be a universal law of nature.' "[88]

Samuel Alexander said: "God is the whole world as possessing the quality of deity. Of such a being the whole world is the 'body' and deity is the 'mind.' "[89]

Writing between 1864 and 1868, Francis Ellingwood Abbott, minister of the Dover, New Hampshire, Unitarian church, "conceived of the universe as an infinitely intelligible and intelligent organism, in which each part, including man, participates in an evolutionary process of self-realization."[90]

Edmund Sinnott comments: "Even the idea of God may be related to that of the organization of life."[91]

And Charles Hartshorne sums up his own view by saying: "Thus on every ground we may well consider seriously the doctrine that the world is God's body, to whose members he has immediate social relations, and which are related to each other, directly or indirectly, exclusively by social relations."[92]

If you accept this model of a living system for the nature of the creative and transforming reality as a whole, your system of ethics and your strategy for social change and survival are affected. If we live in such a web of interconnections, nothing we do is without consequences; there is no hiding place down here where we can do in secret what we would publicly be ashamed of, whether deceit, exploitation, or violence. Certainly, it changes the all-too-common reading of the biblical statement that man is intended to have "dominion over the earth"; instead of trying to control and exploit our living environment, we will use our intelligence to try to understand and live in harmony with it. And the concept that man is made in the image of God is exposed for what it has always really been to many in the Judeo-Christian tradition (if not in some other religious traditions, such as Buddhism, Taoism, Shintoism, and Confucianism): namely, the assumption that the supreme being is modeled on the image of man. We can see ourselves as participants in the creative process, parts of the environment, constituents come to consciousness of the living system, and accept our responsibility for living interactively and constructively with the total environment.

A popular assumption in our society is that if you do not believe in God, he need not be reckoned with. But the living-system model makes the will of God inescapable. As an ancient Chinese sage said of the Tao ("the way of nature"): "The Tao that can be departed from is not the real Tao." The Old Testament poet spoke of the same inescapable God when he sang:

> Whither shall I go from thy Spirit?
>   Or whither shall I flee from thy presence?
> If I ascend to heaven, thou art there!
>   If I make my bed in Sheol, thou art there!
> If I take the wings of the morning
>   and dwell in the uttermost parts of the sea,
> Even there thy hand shall lead me,
>   and thy right hand shall hold me.
>
> [Psalm 139:7–10, R.S.V.]

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