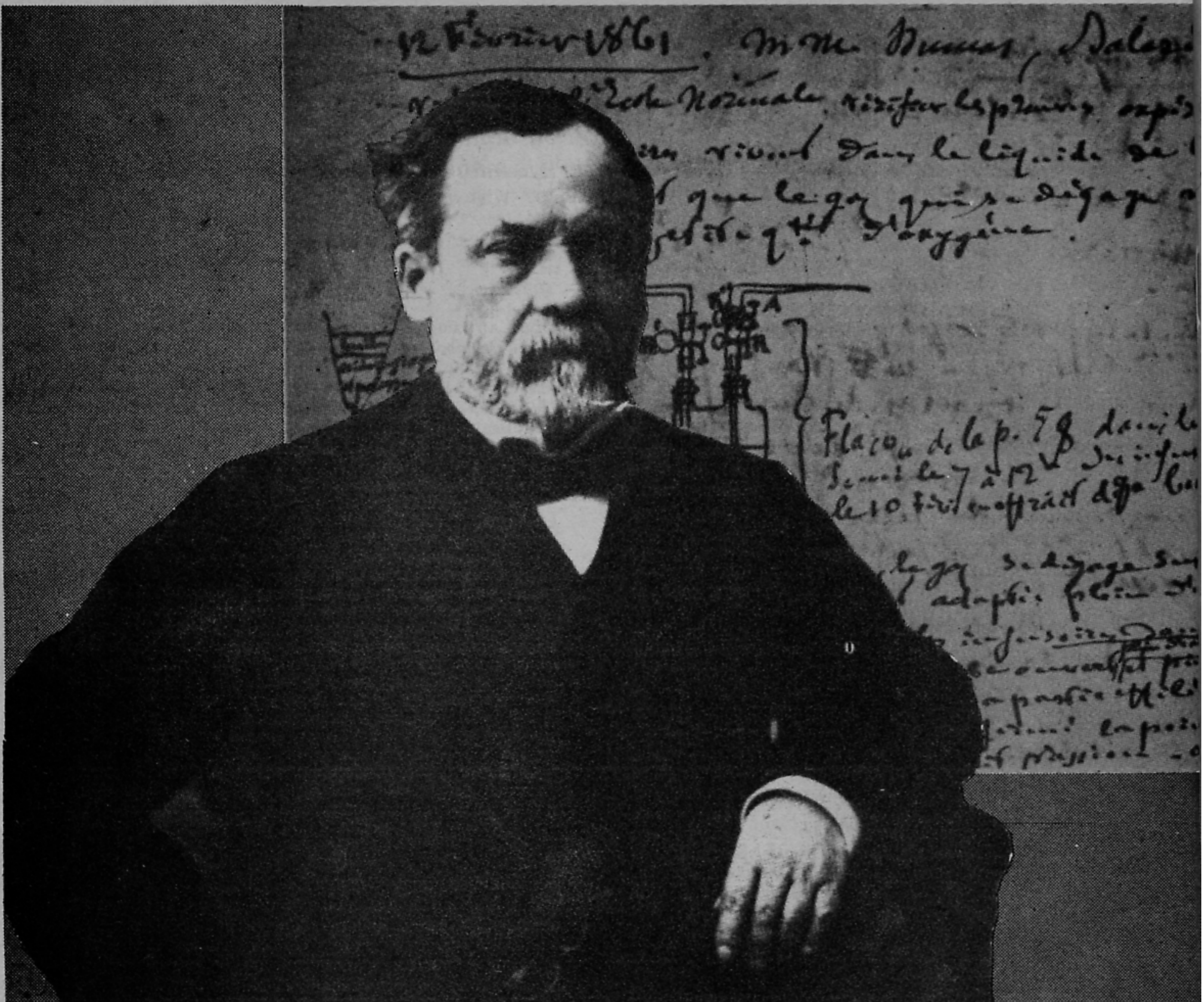

The Overlooked Importance of Pasteur

Warren Hamerman

INTRODUCTION

*The universe is a dissymmetrical totality, and I am inclined to think that life, such as it is manifested to us, is a function of the dissymmetry of the universe or the consequences which it produces** (1874)

In returning afresh to review the scientific contributions of Louis Pasteur (1822-95), I intend to reopen several fundamental epistemological questions underlying the biological sciences that are directly oriented toward recent advances in plasma physics. Current advances in the research of high energy-dense plasmas have already confronted scientsts with species of nonlinear effects that exhibit the qualities of right-handed and left-handed structures, helices, "twisted" filaments, and globular forms suggesting unmistakable comparisons to biological phenomena.

The range of problems investigated by Pasteur remarkably outline an appropriate agenda for ordering the collaborative contributions now called for between plasma physicists and biological scientists — with insights and theoretical clarity resulting from a process of interchange flowing in *both* directions.

The thematic aspects of Pasteur's work are threefold:

(1) Pasteur investigated the special geometries appropriate to the "inside" as well as the "outside" of molecular interactions in the chemistries of life. Pasteur's experiments and *Mémoires*, widely circulated throughout Europe, were the first empirical forays into an appropriate spatial theory of molecular chemistry.

For his achievements Pasteur is generally acknowledged to be the forerunner of *stereochemistry* — namely, the idea that during chemical processes molecules may fold and generate different shapes in space while maintaining the same structure and configuration. The reductionist classifies such effects as an epiphenomenon of the molecule. Pasteur's theory of "molecular dyssemmetry," based upon his experiments during the decade 1844-54, converged upon the advanced notion that there existed *in the physical universe a continuous evolution toward biologic "chemistries" of higher and higher mode.*

(2) From 1854 until the middle of the 1870s, Pasteur exhaustively investigated the laws of one such biologic chemistry, that associated with the process of fermentation. He derived a model of biologic interaction that stressed the coherence between processes occurring on the global ecological level, those directly under man's control through industrial development, and those occurring on the molecular level.

Pasteur's "theory of fermentation" represents the biologic and chemical processes occurring as a more primitive form of life cycle than that now predominant in the biosphere. One could thereby postulate correspondents to life under atmospheric and terrestial conditions prior to those found in the modern era. Pasteur's notion that "fermentation is life without air" implies a *notion of evolution that proceeds from the self-development of the biosphere as a whole.*

(3) Overlapping his studies on fermentation, during the years 1863-85 Pasteur formulated the modern "germ theory of disease," establishing the science of *epidemiology* and public health on a firm footing.

The primary theoretical consideration that motivated Pasteur's work on fermentation is generally overlooked or deemphasized. He operated very much in the tradition that human health was developmental. Health is decisively not a mere absence of disease that results from a homeostatic or harmonious balance between man and nature. Rather, *man has the ability to determine for his species a rising metastatic condition of healthier and healthier human beings.* Besides methods for combating specific pathologies through immunization, Pasteur organized for the establishment of preventive medicine.

Pasteur's profound relevance for study today arises from his successful and coherent translation of such insights from the scientific into the political arena. In contradistinction to the despicable Malthusian Charles Darwin, Pasteur fought politically to achieve those conditions in which scientific development would occur: a national commitment to economic expansion based on rapid industrialization and the utilization of new technologies, a flourishing of social investment to fund research for the scientific community, the establishment of an overall policy for advanced scientific education and research centers, and the broadest-based dissemination of scientific ideas and training throughout the general population.

As will become apparent in a discussion of biographical material, Pasteur was a leading organizer of scientific cadre around the task of constantly upgrading the scientific culture of the general workforce. He was concerned with the transformation of the working class into skilled workers and scientific cadre by programs of general scientific education modeled explicitly on those of Benjamin Franklin. Darwin's political concern, on the other hand, was to downgrade the European working class along the lines expressed by the bestial Thomas Huxley in his notorious boast: "By next week I'll have the workers believing they're monkeys!"**

Although it is generally recognized that modern biological science owes an enormous debt to Pasteur, the methodological underpinnings of his work have been cavalierly brushed aside leaving a residue of disparate, banalized discoveries. As indicated by Pasteur's own comments on his work, the suggestive geometric and evolutionary conditions of protoplasm and plasma ought to

*A full translation of "Observations on Dissymmetrical Forces," from which this quotation is taken, appears in the Appendix.

***Thomas Huxley's role as a sponsor, popularizer, and ideological mentor of Charles Darwin is fully documented in the latter's Autobiography* and *Selected Letters* (1887). For a discussion of the Huxley family's role throughout the twentieth century in promoting the proliferation of cognitive-destroying drugs, see "Rockefeller's Biochemical Warfare" (Hamerman and Stahlman 1976).

be taken as an entirely lawful occurrence by any scientist imbued with the modern world outlook of the advanced humanist tradition. The laws of the physical-biological universe are coherent with those laws determined to be appropriate to the development of human creative cognition. The scientific term employed to describe such coherence is *hylozoic monism*, a concept derived in the sixth century BC by the philosopher Thales of Miletus.*

That this notion is within the scope of Pasteur's projects is revealed by the following notebook entry he penned in 1871:

> Show that life is in the germ, that it has been put in a state of transmission since the origin of creation. *That the germ possesses possibilities of development, either of intelligence and will, or — and in the same way — of physical organs. Compare these possibilities with those possessed by the germ of chemical species which is in the chemical molecule.* The possibilities of development in the germ of the chemical molecule consist in crystallization, in its form, in its physical and chemical properties. Those properties are *in power* in the germ of the molecule in the same way as the organs and tissues of animals and plants are in their respective germs. Additionally, nothing is more curious than to carry the comparison of living species with mineral species into the study of the wounds of both, and of their healing by means of nutrition — a nutrition coming from within living beings, and from without through the medium of crystallization in the others (emphasis added).

From the time of Pasteur's death in 1895 through the immediate post-World War I period, the hegemonic scientific conceptions for biological systems (closely following developments in mathematical physics) was that the protoplasmic field was a unique state of matter in which all then-known laws of chemistry and physics were extended to the breaking point. Today, utilizing the most advanced conceptual terminology, we can succinctly address the seeming uniqueness of that state of matter.

A phenomenology of living systems describes self-regulating and self-reproducing processes of high energy density characterized by the differentiation and growth of nonlinear structures. The totality of interactions is appropriately termed *metabolism*. The overall quality of such systems, in which marginal effects determine overall transformations in chemistry, is to continuously generate the capacity to evolve living systems of a qualitatively higher order. Their evolution, therefore, can be described as *negentropic*.

The character of living systems is by no means exclusive to their domain. As we will demonstrate using Pasteur's magnificent experimentation, so-called inorganic, organic, and biological distinctions do not differentiate themselves, one from the other, by virtue of distinct "stuff" in their composition.

It was precisely because Pasteur coherently translated such insights from the scientific into the political arena that he so raised the wrath of the reductionists. For related reasons, Pasteur is generally afforded the same disparaging treatment as Benjamin Franklin. What a criminal episode that simpletons of unfortunate influence have described the scientist Franklin as if he were a mere flyer of kites and Pasteur as a simple heater of wine, milk, and beer, or the inoculator of sheep! The essence of such psychopathologic historians of science — hatched among the enemies of progress who prefer multiplying their paper money to real development — is to besmear through falsification the very basis of all science: man's actual, practical contributions to alter the material universe through scientific discovery.

It is by no means accidental that the victims of such slanders were all committed political partisans in the humanist struggle for scientific progress. The Rothschild, Warburg, and Rockefeller school of scientific history has gone to outrageous extremes to cast the image that Pasteur was even an imperialist and racist because of his commitment to industrial expansion and his hatred of monetarism.** Such ludicrous mythologists and slanderers also tend to label the great chemist and Colbertian political leader, Antoine Lavoisier, as a tyrannical landlord and René Descartes, the epistemological father of modern science, as a hopeless mechanist.

The Reductionist Consequences of Misrepresenting Pasteur

Such butchery of man's creative history breeds disastrous scientific consequences. For much of the twentieth century the biological sciences have been the dormitory for either reductionist theorizing of *the biologic molecule* as a "thing-in-itself" or a pseudo-Kantian abreaction with Malthusian complications.***

The biological sciences, as well as plasma physics, ought to constitute the clearest empirical expression of nonlinearity and negentropic behavior. Living systems absolutely violate the notion of thermodynamic entropy, the standard laws of constant and multiple proportions, the fixed precepts of growth based upon molecular simple additions of carbon or other chain linkups in discrete increments — as well as violating all common sense prejudices against self-reflexive structures in nature.

At the outset it is necessary to cast aside the overly influential and unfortunate formulation of Erwin Schrödinger in the early 1940s — namely that organic-biological systems are characterized by negative entropy whereas the remaining "stuff" in the universe holds to the laws of en-

*Further discussion of hylozoic monism can be found in *Dialectical Economics (LaRouche 1975); "Beyond Psychoanalysis" (LaRouche 1973); The Origin of Life (Oparin 1923); The German Ideology (Marx 1846); and "The Self Development of the Biosphere," (Hamerman 1975).*

**For example, Robert Reid in his 1974 biography *Marie Curie* (New York: E.P. Dutton) refers to Pasteur as a "jingoist" and a "snob" and implies that Pasteur held back French science by his refusal to accept Darwinism.

***The pseudo-Kantian notion of "holist biology" is associated with the work of Jan Christian Smuts, the British Round Tabler field marshal *(Holism and Evolution)*; J.B.S. Haldane, special advisor for British Intelligence MI-5 (*The Causes of Evolution*); R.A. Fischer, the raving Malthusian (*The Genetical Theory of Natural Selection*); and others emanating from the Theoretical Biology Club of Cambridge University in the early 1920s. Their holist thesis presents a seemingly seductive alternative to reductionism that is actually an even more vicious denial of universals than reductionism per se. In their pluralist epistemology each cell, each atom, and each mind is seen as its own whole — a thing unto itself. The laws of nature as they define them ensure an increasing convergence upon a perfectly ordered empire (equilibrium) with each distinct whole neatly arranged in a hierarchy.

The thrust of the British holist notions laid the basis for biometric and social statistical studies that justified genocide program among so-called inferior subhuman populations in the Third World. Holism was used as the cultural relativist ideology for population control programs by Corliss Lamont's networks in the United States among black populations and for intelligence penetration operations by the Rockefellers into the Soviet scientific community. Others associated with the holist school include mad geneticist Theodosius Dobzhansky of the Rockefeller Institute as well as the even more notorious Arthur Koestler and Ludwig von Bertalanffy.

In the recent period the holist ecology movement has been revived tropy. The ABC of all modern scientific inquiry into the nature of extending human development must emphasize the hylozoic nature of that particular universe that has generated man, or, to be more precise, thinking man.

An early but representative expression of the mechanist approach is Albrecht Kossel's 1911 lecture at Johns Hopkins University in Baltimore. Kossel's *bausteine* or building block theory, along with Emil Fischer's "sequence" hypothesis of amino acids and Hermann Staudinger's "macromolecules" degenerate into a Chomskyesque horror show in recent interpretations of the genetic code.*

Kossel's "linguistics" lecture began by comparing the arrangements and recombinations of proteins in the animal or vegetable organism to the making up of a railroad train from its unit cars:

> The number of *bausteine* which can take part in the formation of the proteins is about as large as the number of letters in the alphabet. When we consider that through the combination of letters an infinitely large number of thoughts may be expressed, we can understand how vast a number of the properties of the organism may be recorded in the small space which is occupied by the protein molecules. It enables us to understand how it is possible for the proteins of the sex-cells to contain, to a certain extent, a complete description of the species and even of the individual. We may also comprehend how great and important the task is to determine the structure of the proteins and why the biochemist has devoted himself with so much industry to their analysis.

The development of reductionist biology in the twentieth century is most closely associated with the funding and influence of the Rockefeller family. In the early 1930s Warren Weaver, then director of the natural science program of the Rockefeller Foundation, invented the term "molecular biology," which he defined as the study of "the ultimate units of the living cell." From 1932 to 1959, the Rockefeller Foundation invested more than $90 million in an effort to wed molecular biology to quantum physics. The principal quantum physicists involved in the project to search for ultimate life particles were Max Delbruck and W.T. Astbury in the 1930s, Schrödinger in the 1940s and Francis Crick from 1947.

Their central theoretical output was a linear model to explain biological specificity. Molecular interactions are linearly coded to fixed, lock-and-key or "template" configurations. These models, outlawing the nonlinear processes that are empirically pervasive in biology, are referred to in the trade as the *central* and *secondary dogmas*. The phenomena discussed in these models are real; what is wanting is a process of higher-order mapping to understand the interactions and their ordering into observed configurations to replace the linear, computer code paradigm. Representative interactions demanding immediate theoretical clarity by qualified specialists are: one DNA, one RNA; one gene, one enzyme, one protein; one antibody, one antigen; one amino acid sequence, and one protein.**

Advances in our understanding of the biological sciences, superseding the dogmas, will occur in conjunction with developments in the domain of plasma physics, along the lines charted by the application of Georg Cantor's notion of

Cartoon of Charles Darwin from the *Hornet*, 22 March 1871

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to enforce the zero-growth economic policies of the Rockefellers. At this moment the Carter administration and other policy vehicles for the bankrupted Rockefeller circle are cynically cutting the funding of crucial research, training, and health programs, at the same time that they parade all sorts of Malthusian rubbish and quackery to justify policies of genocide in the guise of academically accepted biological laws.

Three of the most prominent examples involve: (1) the presentation of so-called reports, experimental data, and studies justifying the criminal proliferation of dangerous, cognition-destroying drugs such as marijuana, cocaine, heroin and methadone; (2) the fostering of phony and incompetent Darwinian theories of ecology which argue that, according to the long-since debunked "law of natural selection," man must engage in a fierce survival-war-of-the-fittest with lower species such as clams, louseworts, snail darters, and other assorted fauna and flora; (3) the deliberate enhancement of gross epidemic holocaust on a global scale through the outlawing of basic public health and immunological programs, all "exonerated scientifically" through the pronouncements and policy recommendations of far too many accepted authorities and institutions.

*Under the bogus discipline of "linguistics," MIT Professor Noam Chomsky has been a principal developer of the *brainwashing* technology used by the intelligence community to create so-called zombie terrorists and send them on various hideous assignments.

The computer technology languages in which Chomsky specializes take as their fundamental premise that the universal quality of *human creative mentation* is nonexistent. The linguistics approach is oriented toward the inducement of an "artificial intelligence" in the victim. The clinical state of mind that results from a process of "programming" under an aversive environment is paranoid schizophrenia. The brainwashing victim undergoes a complete mental collapse, adopting infantile emotional patterns. Words, phrases, and gestures take on purely *magical* and *mystical powers* that then control the victim's behavior.

The development of the "codon" theory of information transfers in human genetic material since World War II (work supported by immense Rockefeller funding) closely parallels the incompetent model of human "artificial intelligence" developed by the Chomskyesque linguisticians. See "Linguistics: A Tool of the CIA's Global Terrorism" (LaRouche 1976 "PsyWar! The Science Versus the Art" (LaRouche 1976); and "Artificial Intelligence" (Gallagher 1975).

**There has been a fairly substantial development of the dissymmetry question in the twentieth century, albeit in a formal and paradoxical way. In 1874 the Dutch physical chemist van't Hoff (1852-91) and the French chemist Le Bel (1847-1930) established the rules of stereochemistry. Their work focused on unraveling the properties of dissymmetric carbon structures in space, which provided the explanation for the optical activity of organic structures that results from the peculiar bonding attributes of the carbon atom. Laevo (L) and dextro (D) forms of isomers, the two alternate spatial configurations, are possible if the four the *transfinite* to the physical laws of a Riemannian continuum.*

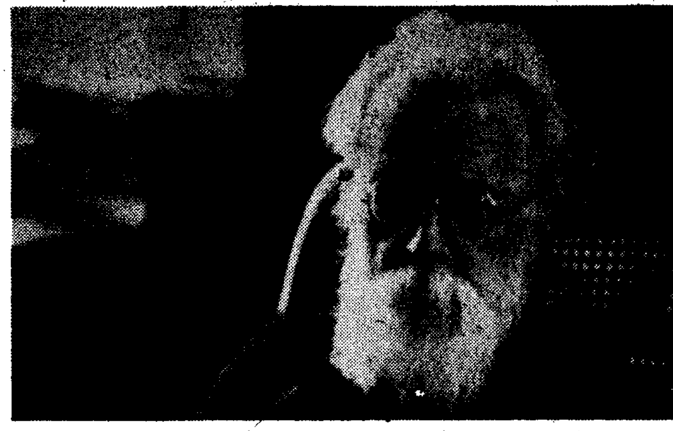
Reducing the Reductionists

To reach such theoretical territory, it is first necessary to regenerate a systematic polemic against both reductionist and pseudo-Kantian interpretations of biological processes. Earlier in this century there was indeed such a polemic, developed *in the tradition of Pasteur.* Oparin's classic work *The Origin of Life* (1923) emphasizes the critical features:

> The theories attempting to explain the properties of living matter on the basis of some specific radicles in the protein molecule are untenable. Attempts to deduce the specific properties of life from the manner of atomic configuration in the molecules of organic substance could be regarded as predestined to failure. *The laws of organic chemistry cannot account for those phenomena of a higher order which are encountered in the study of living cells.* The structure of the protein molecule, its amino and carboxyl radicles, polypeptides or other linkages, etc., determine only *the ability of this material to evolve and change into a higher grade of organization, which depends not only on the arrangement of atoms in the molecule but also on the mutual relationship of molecules towards one another* (emphasis added).

Establishing the basis for Oparin's later work, Pasteur's research spanned the full spectrum from the coherence between the seemingly disparate laws of "living" and "dead" chemistries to the formulation of the modern germ theory of disease.

From 1844 until 1854 Pasteur conducted an expanding series of experiments investigating the relationship between molecular forms — complex "twistings," deformations, and foldings in space — and their different properties. His discussion of the geometry of chemical transformations took chemistry decisively beyond the fixed atomism of John Dalton.**



V.I. Vernadski (1863-1945) was the intellectual father and scientific organizer of modern Soviet physics. He adopted a *fully nonentropic* notion of ever-increasing energy density as the invariant feature in the biosphere's evolution. His research approach was one of "biogeochemistry": mineralology, geology, and crystallography are subsumed by their participation in the "living" cycles and development of the biosphere as a whole. Vernadski emphasized that human creative mentation formed the highest part of the "energy continuum" in the universe and he used the concept *noosphere* to describe man's intellectual power that allows for his species' mastery of the material universe through scientific discovery, technological progress, and extended reproduction of the modern world economy.

Pasteur recognized that there was a crisis in the current notion of a fixed chemical species: "It will become necessary to pose the problem not only of the transformation of species but also of the creation of new species." His primary studies on molecular dissymmetry led to the startling discovery that forms the basis of his entire research and from which standpoint he called for advancing the frontier of theory *beyond* a "science of chemical mechanics," the chemistry

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different groups around the carbon atom are placed at the four corners of a tetrahedron. For every n dissymmetric carbon atoms present in a molecule then, there exist 2^n number of active forms. F.R. Japp in 1898 advanced the hypothesis that dissymmetric molecules do not arise from some sort of "primary synthesis" but can be the result only of activity from other prior-existing dissymmetric molecules.

Between the years 1904 and 1907, two principal features of the discussion came into experimental focus. W. Marcwald and A. McKenzie demonstrated that through the influence of an optically active molecule there exists the possibility of dissymmetric synthesis. A. Byk, on the other hand, reproposed that the primary operative force was not to be located in given molecules but in the global terms of the effect of the earth's magnetic field upon partially plane polarized light from the sky.

The paradoxical duality between these two viewpoints haunts subsequent thinking. Some scientists have argued that dissymmetry is a precondition for life, namely that it arose prior to biologic processes and in fact was a primary generative precondition for the creation of living molecular interactions; in the modern period, J.D. Bernal (1951) is the most well-known advocate of this view. Other scientists have chosen instead to feature the primary character of biologic processes, arguing that living processes have generated the dissymmetry phenomenon; S.W. Fox (1957) and A. and H. Amariglio (1971) have aligned themselves with this latter current.

From a purely methodological standpoint this duality on its own terms appears destined to degenerate into the trivial theoretical "chicken-or-egg" controversy. There is the unmistakable ring to the debate over whether it is DNA or protein that ought to be given evolutionary priority.

Mathematical physicists who understand the epistemological implications of Riemann and Cantor for the experimental data accumulated by the study of plasma domains, as well as scientists of Marxian political economy who have assimilated the basic conceptions of Lyndon LaRouche's *Dialectical Economics* (1975) will immediately recognize the classic features of the real problem underlying this seemingly irresolvable paradox. Wherever one tends to come across chicken-or-egg controversies in the interpretation of modern scientific data, one can be fairly certain that it is necessary to resituate the theoretical problem along lines of the advanced geometric dynamics associated with interactions between the totality (evolving manifold to qualitatively higher manifolds) and the particular (individual or finite number). Scientists who work on the significant sort of "borderline" phenomena between living and inorganic forms ought to be in the most advantageous positions, from their knowledge of experimental evidence, for relating empirical evidence to the specifications of the General Evolutionary Law of the universe.

It is exciting and lawful that in the twentieth century the work of Pasteur on dissymmetry gave birth both to the thesis of A.I. Oparin in *The Origin of Life* and, mediated through the Curies, to the advanced scientific notions associated with the school of V. Vernadski. Furthermore, since the 1920s there is a body of experimental concerns broadly associated with the origin of life thesis that represents — compared to the rest of Darwinian- and reductionist-permeated developments in the biomedical sciences — a healthy current of contributions from which to advance the understanding of living processes as a whole. Such positive features, generally speaking, are absolutely not to be confused with the laboratory attempts to recreate the origin of life under various combinations of primary conditions.

From this standpoint we will briefly reference what is only one of many intriguing experimental concerns that the tradition of Pasteur has led to in the twentieth century: the comparative studies, well known in specialist fields, of the similar yet differing qualitative distinctions associated with the cosmogony of Laplace and Lagrange.

This is usually misreported to be the exact opposite of Pasteur's intent. Pasteur draws from the dissymmetry experiments the notion that the products of vegetable and animal cellular activity are *not* distinguished from results that could occur *under special conditions* in the mineral world naturally or be achieved in the laboratory artificially by virtue of their material constituents or simple laws of interaction. As Pasteur wrote in 1853: "The barrier between mineral or artificial products and those formed under the influence of life, is a distinction of fact and not of absolute principle."

A few years after Pasteur's death his student Pierre Curie applied the concept of dissymmetry to broader physical phenomena which bore resemblance to unique characteristics of biologic systems. Curie suggested that the phenomena associated with structures exhibiting right-handedness (dextro-forms) and left-handedness (laevo-forms) were only one species of a broader class of effects, rather than the term dissymmetry. These structures could be more descriptively named "unique states of space" to emphasize their geometric foundations, Curie proposed.

Curie's student V.I. Vernadski later embraced the suggestion that the phenomena were broader than simple left and right antipodes. Vernadski wrote of different "states of cosmic space as the basic geometric substratum with all its material, temporal and energetic manifestations." He further specified that the geometry he had in mind would most naturally be created along the conceptual lines established by Bernhard Riemann's notion of a *n-fold extended manifold.* (Vernadski 1944)

The modern concept that applies to the observations developing from Pasteur, a notion already established in the scientific domain today, is *nonlinearity*.

In the next section I will develop the empirical material of Pasteur's dissymmetry experiments and then explore how far Pasteur himself was able to extend these insights to a wide range of scientific problems.

Pasteur: A Commitment to Progress

In a broader social sense, Pasteur embodies a sophisticated commitment to the notion of human progress through scientific development. From the early 1850s on, he was associated with programs to revive the tradition of the late eighteenth century Ecole Polytechnique that flourished when France was looked to as the pre-eminent nation of scientific achievement and technological innovation.

In 1854 Pasteur was appointed the founding dean of the Faculté des Sciences at Lille, in the midst of France's industrial brewery center. Under Pasteur the Lille project introduced unique conceptions of scientific pedagogy. The school program consciously recruited student cadre from the families of the industrial workforce and students were allowed to enter the laboratories to repeat the crucial experiments of the lessons. Pasteur also introduced the policy of taking physics and chemistry students on tours of French and Belgian factories, iron foundries, and steelworks.

The theme underlying the Lille project, a theme Pasteur was to strike often in the next four decades, was that the French nation could avert crisis and decay only by recovering its commitment to scientific development embodied in the establishment of the École Polytechnique in 1794 by the world's leading scientists. In his polemic Pasteur emphasized the decisive influence of *the American* Benjamin Franklin on founding the École.

At the turn of the twentieth century, when mathematician Felix Klein traveled to the great Chicago Exposition, he referred to the foundation of the École as the "decisive event" in initiating the nineteenth century's unprecedented advances in science. Klein isolated two attributes of the École's influence: the approach of combining theoretical research and active instruction and the publishing of lectures which served as the textbooks for European science instruction.

As I shall show, the principles embodied in this tradition are not at all unrelated to the overlooked importance of Pasteur's scientific contributions.

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between inorganic catalysts and enzymes. By no means do we intend to offer either an exhaustive or even a schematic representation of the enormous literature in the field. Rather, we hope to demonstrate the lawfulness of approaching such a question from the borderline experimental standpoint that is the essence of Pasteur's contribution. Between the years 1929 and 1933 four principal achievements occurred as a subdomain of the dissymmetry question:

(1) Kuhn, Braun, and Mitchell succeeded in a dissymmetric synthesis utilizing circularly polarized light;

(2) G. Bredig et. al. used catalysts to demonstrate that in living cells dissymmetric enzymes function like catalysts outside living forms, but far more efficiently;

(3) Karagunis and Drikos first succeeded in a dissymmetric synthesis of organic compounds;

(4) Schwab and Rduolf published results suggesting that dissymmetric crystals might be used as stereospecific catalysts.

In the 1950s and 1960s a great many scientific workers converged upon the investigation of phenomena that could be characterized as the relationship between the tradition of experiments in dissymmetry and the phenomena of *autocatalysis*. It is no longer seen as a startling occurrence that in living organisms one regularly encounters the formation and accumulation of only one particular antipode. In living beings, the insights first stated by Pasteur long ago have stood firm through a fantastic array of accumulated knowledge; in living beings amino acids and hence proteins almost all occur in the L-form, while biologic sugars are almost always in the D-configuration. A more detailed review on the relation between origin of life and dissymmetry studies in the twentieth century is available in *Chemical Evolution and the Origin of Life* edited by Buvet and Ponnamperuma, 1971. (See especially, "Origin and Development of Optical Activity of Bio-Organic Compounds on the Primordial Earth" by K. Harada and "Unsuccessful Attempts of Assymmetric Synthesis Under the Influence of Optically Active Quartz Crystals: Some Comments About the Possible Origin of the Dissymmetry of Life" by A. and H. Amariglio.)

Our motivation in this discussion is to emphasize a broader point bearing upon the necessary future course of events. Precisely the line of scientific development emanating from the origin of life circle has emerged in the past two decades as a leading cadre source for tackling the scientific tasks necessary for man's eventual colonization of outer space. Scientists in the United States, Soviet Union, and elsewhere from the tradition of studies associated with the origin of life thesis have emerged in the forefront of work associated with the creation of the newly termed domain of "exobiology." It is by no means accidental that a catalogue of the workers on the recent Viking Mission or similar Soviet endeavors, along with the extant literature on similar subjects, is filled with a high proportion of scientists who first were concerned with the body of literature developed on the origin of life question.

*For a full discussion of Cantor's concept of the transfinite as applied to a Riemannian continuum, see "The Concept of the Transfinite" (Parpart 1976).

**John Dalton (1766-1844) was the English physical chemist at the turn of the nineteenth century who developed a statement of atomic theory particularly oriented to chemical reactions. Dalton's theory, based upon atomic weights, indicated that chemical molecules were made up of atoms combined in ratios of small whole numbers. He wrongly used the formula HO to describe water, since he held that the most common compound of a set of given elements ought to have the simplest formula. Dalton (who was color blind) also carried out an extensive study of color blindness.

THE DISSYMMETRY EXPERIMENTS

Life is dominated by dissymmetric actions. I can even foresee that all living species are primordially, in their structure, in their external forms, functions of cosmic dissymmetry. (1854)

Pasteur's experiments on molecular dissymmetry imply a complete break with atomist theories of homogenous, flat molecular geometries in the small.* Even further, as Pasteur himself sought for some empirical reference points, his experiments imply that molecular geometries are not static and absolute but allow for transformations of internal molecular space and even the creation of new chemical species. These properties may be compared to the phenomena of differentiation and development generally associated with physiology. Proceeding from the totality of development on the biosphere as a whole to the particular, it would be on the right track to venture the formulation that *evolution* in the universe is mediated through the ordering of molecular physiology, namely that these transformations of molecular space have a direction to them.

In 1844, while a student in mathematics and physics, Pasteur accidentally came upon the problem that was to launch his investigations on dissymmetry for the next decade. The problem was embodied in a note by the physical chemist Eilhard Mitscherlich (1794-1863) which Pasteur recognized as appearing to completely upset every notion then standing in the concept of a chemical species.

The note in question concerned a startling conclusion drawn from a detailed study of two salt crystals of ammonia soda named tartrate and paratartrate. Tartrate had been studied since 1770 as a substance somehow critical to the process of grapes fermenting to wine; it was commonly found in wine barrels as thick, crusty material. Paratartrate, also known as racemic, was something of a mysterious curiosity among chemists from 1820 until 1853, when Pasteur succeeded in understanding its composition and easy production. The reason for the curiosity was that paratartrate had been observed once in the factory of an Alsatian chemical manufacturer. Chemists flocked there to study the new substance, but none succeeded in understanding its structure or could explain its presence.

Mitscherlich's famous note was on conclusions drawn from an exhaustive study of the two crystals: "The nature and number of atoms, their arrangement and their distances are the same. However, the tartrate rotates the plane of polarized light while the paratartrate is indifferent to it."

What troubled Pasteur was the seeming paradox in comparing Mitscherlich's conclusion to the then-taught definition of a chemical species as fixed in form and properties throughout members of the species. How could two substances, in all respects the same, differ with respect simply to the property of rotary power concerning plane polarized light?** From the outside both substances otherwise showed exactly the same physical and chemical data: identical crystaline form, specific gravity, index of refraction, melting and boiling points, solubilities, and so forth.

In conjuction with his teacher Jöns Jakob Berzelius,*** Mitscherlich himself had established the laws of isomorphism (1819) in which the "crystalline form is independent of the chemical nature." Pasteur's starting point was to establish that there was, in fact, a geometric relationship between the form of the molecules, their internal space, and their chemical properties. In 1848 Pasteur began an intense study of the crystalline structure of sodium ammonium tartrate, finding that the crystals were characterized by facets that annulled their symmetry. For the first time he established a definite relation between the form of the molecule and its rotary power on the plane of polarized light.

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*The same dissymmetry of nature that Pasteur first observed in the optical activity of biological chemicals has been shown to play a vital role in fundamental physics and appears basic to the structure of the universe — as Pasteur hypothesized.

In the late 1950s, experiments in high-energy physics carried out by Wu, Yang, and Lee, demonstrated that matter exhibited "right-and-left handedness" in its interactions at high energy. In particular, it was found that in the decay of radioactive cobalt, as well as several other similar decays, the electrons were emitted with their spins preferentially aligned opposite to their direction of motion, or "left-handedly." In experiments where the electron's "antiparticle," the positron, was emitted (the positron is identical to the electron except that it has the opposite charge), the spin was aligned along the direction of motion, or "right-handedly."

This behavior is directly analogous to the ability of optically active molecules to rotate the plane of polarization of light in a clockwise or anti-clockwise direction, and it implies that matter and antimatter are related to each other geometrically in an analogous fashion to *oppositely* active molecules.

The resemblance becomes even more remarkable when one considers the dissymmetry between matter and antimatter. While these two forms of matter appear to be mirror images of one another, as do oppositely active molecules, the universe appears to consist overwhelmingly of ordinary matter; antimatter is exceedingly rare. Just as in living matter where one form of molecule predominates, rather than racemic mixtures — in the universe racemic mixtures of matter and antimatter are highly atypical.

There is evidence that this asymmetry of matter and antimatter is reflected in certain high-energy reactions. For example, the decay of the metastable particle known as the neutral Kaon preferentially produces a slight excess of electrons over positrons, indicating that the properties of matter and antimatter are not equally favorable to all interactions.

Recent experiments performed at the Argonne National Laboratory accelerator using spin-polarized beams of protons indicate that the effects of asymmetrical geometries continue to increase in importance with increasing energy of interaction. One set of experiments demonstrated that when the spins of the target and beam protons were both aligned perpendicular to the beam, the protons were scattered to the right about twice as frequently as to the left (relative to the direction of the beam).

Similarly, when the spins of the beam and target particles are aligned in opposite direction to each other, the scattering effects at high energies and near head-on collisions are dramatically less than in the parallel case.

These results are exceedingly difficult to explain from the standpoint of existing quantum theory: they strongly indicate that the asymmetrical geometries — such as helixes and vortices — which play such a crucial

The Critical Discovery

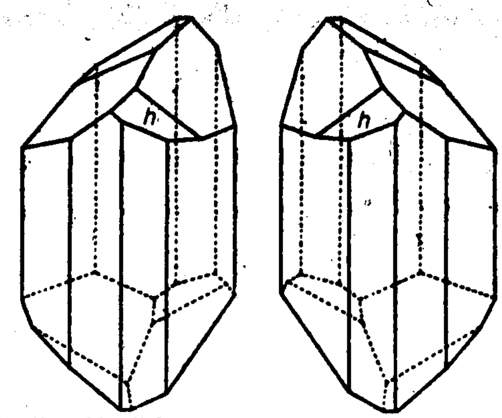
Pasteur observed that the crystalline forms of tartaric acid and all of its compounds have what he called dissymmetric form. By this he meant that their mirror images were not superposable upon the original; when the object rotated upon its axis to the right, its mirror image rotated to the left. Pasteur specifies other examples of dissymmetric forms, forms in fact that in the twentieth century have proven to be the critical structures of biological material: "a winding stair or helix, a screw, a hand, a branch with the leaves arranged spirally, and an irregular tetrahedron." Optically inactive compounds, he observed, however, did have superposable mirror images — for example, "a straight stair, a branch with leaves in a double row, and a cube." In the case of paratartaric or racemic acid, Pasteur discovered that the substance actually consisted of a neutral kind of balancing between some crystals of right tartrate and some of left.

Proceeding to separate right or dextro tartrate crystals by hand under the microscope from a paratartrate mass, Pasteur found that they rotated the plane of polarized light in the polariscope to the right. The crystals remaining with facets orienting to the left, had left rotary power. Thus, in 1853, he succeeded in transforming paratartaric or racemic acid into left-handed tartaric acid.

At this point in his research a critical fact confronted the observant Pasteur: this left-handed tartaric acid was identical in *all* respects with the acid found in the grape. Further, during the production of wine (fermentation) racemic or paratartaric acid is transformed into left-tartaric acid. He advanced the hypothesis that the living microorganism involved in fermentation must be able to consume only the right form of tartrate as nutrition in its metabolism and leaves behind, as it were, the left form. The microorganism selects one form and not the other and this selection process occurs based on its capacity to recognize one molecular form from another. This fact marked a critical experimental area of intersection for biology, physics, and chemistry.

Through a comprehensive experimental series of studies, Pasteur achieved the following pattern:

> **All mineral products and all the numerous organic substances which one obtains artificially in the laboratory lack molecular dissymmetry and its correlative action on polarized light. Both of those properties, on the other**



The "marking" facet is designated h. The right tartrate rotates the plane of polarized light to the right and is referred to as the dextro (d) form. The left tartrate rotates the plane of polarized light to the left and is referred to as the levo (l) form. The substance paratartrate or racemic (not shown) consists of equal mixtures of right tartrate and left tartrate. Crystals that can exist in either the dextro-or levo-form are known as *enantiomorphous*.
Source: Pasteur 1853

Above: Pasteur's original sketches of left-handed and right- handed tartrate crystals.

Below: Pasteur's wooden models of left-handed and right-handed tartrate crystals.

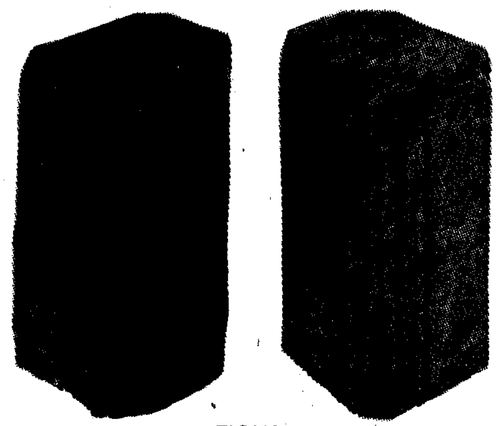


FIGURE 1

role in plasma physics phenomena as well as in the structure of biological molecules, are also central to processes occurring at very high energies and very small distances.

**In the year 1669 Erasmus Bartholinus discovered the phenomenon of *double refraction,* where a crystal oriented in a proper fashion divides a single ray of light into two. In 1677 Christian Huygens explained that each of the rays vibrated in a single plane and that the two planes were perpendicular to one another. Numerous scientists were fascinated with the implications including Johann Wolfgang Goethe (See the *Theory of Colors*).

In 1808 Etienne Louis Malus discovered the phenomena of polarization as a byproduct of researches on the double refraction properties of Iceland spar (calcite, a crystalline calcium carbonate). Malus looked from his room one day through the crystal at the brilliant sunset reflections coming off the windows of the Luxembourg Palace. Rotating the crystal slowly on an axis, he observed periodic variations in light intensity and certain positions of no light at all. In 1811 Malus's student Dominique-François Arago discovered that a specially cut quartz plate caused the rotation of the plane of polarization of plane polarized light. When the quartz is placed between perpendicularly crossed Nicol prisms, light passes through the second prism, whereas no light passes through simply crossed Nicols. Optical activity here refers to the ability to rotate the plane of polarized light. René Just Haüy had discovered two kinds of quartz which differed only in the location of two facets that caused the crystals to be nonidentical mirror images, termed *enantiomorphs* (from the Greek *enantios*, opposite and *morph*, form).

In 1815 Malus's student Biot found that plates of the same thickness from two different kinds of quartz rotated plane polarized light the same amount but in opposite directions. In a series of experiments from 1815 to 1835, Biot established that certain quartz crystals deflect the plane of polarized light to the right, others to the left. He noted theat certain natural organic material — for example, the solutions of sugar or of tartaric acid (α,β-dihydroxysuccinic acid or HOOCCHOHCHOHCOOH) have right rotary power; they are dextrorotatory. Other substances, such as turpentine and quinine, have left rotary power; they are levorotatory.

These findings were the immediate historic backdrop for the development of Pasteur's work.

***Jons Jakob Berzelius (1779-1848) was a Stockholm professor of chemistry who is credited with discovery of the elements silicon, thorium, and selenium. He developed the current system of element symbols, was an early leader in the determination of various atomic weights, and proposed an electrochemical theory of compound formation and stability based on the attraction between opposite electrical charges. His articles, texts, and reviews had a widespread influence on the European scientific community.

hand, are inherent in a great number of *natural* organic substances and an even more considerable number of substances related to physiology: that is, cellulose, sugars, albumin, fibrin, caseine, certain vegetable acids, etc. (1860).

What distinguishes Pasteur's work absolutely from the reductionist dogmas that currently pervade molecular biology was the way in which he sought to understand the indicated pattern:

> We discover that the natural products elaborated under the influence of vegetable life are, as a rule, dissymmetric. This is contrary to what we find in the case of artificial and mineral products. *This disposition of the elementary particles is* not *a condition of the existence of the molecule — that the twisted organic group can be untwisted and so assume the ordinary character of artificial and mineral substances.* Conversely, it seems to me logical to regard the latter as capable of exhibiting a dissymmetric arrangement of their atoms after the manner of the natural product. The conditions for their production have still to be discovered. (emphasis added) 1860

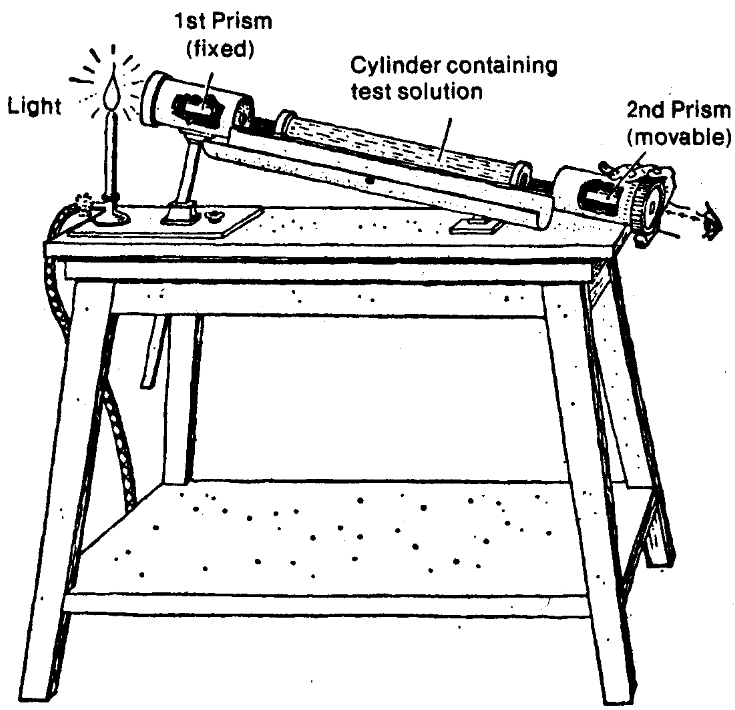
This marks the qualitative aspect of Pasteur's work. Against tremendous public and peer vilification he advanced the concept that what he termed a "living, well-ordered ferment" — like all living beings — tends to take the carbon and other elements necessary for its nutrition from right forms in preference to that from left forms. This could be explained only by the fact that the principal constituents of the living cell in turn were oppositely dissymmetric in form.

Pasteur established the thesis that

(1) molecular dissymmetry was correlative to living processes that gave them the capacity for higher grades of organization.

(2) this quality of living forms was not an epiphenomenon intrinsic to specific molecules as things-in-themselves,

(3) the dissymmetric forms encountered in living systems were somehow an attribute of that system's capacity to order itself on a higher level — that is to evolve, and



Source: *Grant* (1959)

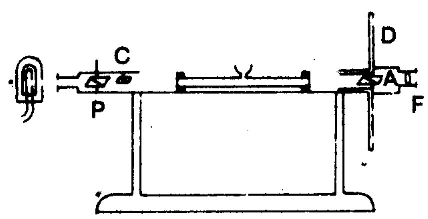


FIGURE 2a

Cross-section of a polarimeter

The polarimeter or polariscope is the optical instrument used to measure a substance's power of rotation of plane polarized light.

Source: Noller (1962)

FIGURE 2b

Representation of the polarimeter constructed by Pasteur

A fixed Nicol prism, P, is known as the polarizer. Today, a monochromatic light source is used. The second Nicol prism, A, is also known as the analyzer, which in turn is attached to a special disc, D, graduated in degrees and fractions of a degree. Both A and D can be rotated. The sample for assay is placed in the tube which has clear glass ends. Usually a third small Nicol prism is located at C and rotated through a small angle in order to divide the viewed field into halves of unequal brightness. The eye piece for focus is at F. The zero point is when the two fields are at equal intensity after they have been rotated. Then a substance is introduce into the assay tube, placed in the path of light and the two fields of light become unequally bright. Rotation of D and A through a certain angle to the left or right brings the two fields to equal intensity of brightness. The number of degrees through which the analyzer is rotated measures the direction (right or left) and activity of the sample.

(4) this process was identical with the laws of the universe as a whole.

Pasteur wrote in 1874:

> What is the nature of these dissymmetrical actions? I myself think that they are of the order of the cosmos. The universe is a dissymmetrical totality, and I am inclined to think that life, such as it is manifested to us, is a function of the dissymmetry of the universe or the consequences which it produces.

Pasteur Maligned

With this thesis in mind, Pasteur pursued his researches yet further in directions that caused his fellow scientists to become hysterical. The common gossip in French chemistry and physics circles was that the promising young Pasteur had gone "over the deep end." Slandered as a mystic, Pasteur became the object of efforts by leading scientists to "turn him" from his course. The Academy of Science in 1857 refused to elect him despite his acknowledged discoveries.*

Pasteur had begun an array of experiments to subject living phenomena — plants, fermentations, and so forth — to various combinations of fundamental forces. His idea was that the dissymmetrical forces of the universe had to result from the mutual interaction between heat, light, magnetism, and electricity. He launched a path in experiment which is not at all distant from the pathway in theory which Riemann was considering at that time.** Pasteur constructed mirror machines, giant clockworks, powerful magnets, and electrical apparatuses. With variable light properties he combined these effects upon living processes to observe unique effects. A notebook entry from the 1870s, when he again picked up these experiments reads: "I want to be able by experiment to grasp a few indications as to the nature of this great cosmic dissymmetrical influence. It must, it may be electricity, magnetism..."

People thought he had gone mad. Professor Jean Baptiste Biot (leading experimenter on polarization and Pasteur's direct scientific mentor) wrote him with pleadings to "turn you from the attempts you wish to make on the influence of magnetism on vegetation.... To begin with, you will spend a great deal on the purchase of instruments with the use of which you are not familiar, and of which the success is very doubtful. They will take you away from the fruitful course of experimental researches which you have followed hitherto, where there is yet so much for you to do, and will lead you from the certain to the uncertain."

In the immediate aftermath of the failure of the 1848 Revolution in France, the forces opposed to scientific progress relentlessly harassed Pasteur and severed his funding. The same bankers who fought to maintain their looting rights over the working class tried to squelch any discoveries going beyond "mainline" experimentation of existing frontiers into the domain of the uncertain. Pasteur himself held on in Paris, quietly continuing his studies. "I am still hoping" despite no experimental success all year, he wrote in his notebook in December 1853. He held on for much of the year thereafter, too.

In the beginning of December 1854, Pasteur left Paris for Lille, the then center of France's industrial interests, particularly brewing, to found a unique institute for science funded by regional industrial interests. Pasteur was named dean and professor at the Lille Faculté des Sciences where he instituted revolutionary concepts of pedagogy.

Pasteur's speech December 7, 1854 to the combined audience of scientists, Lille area industrialists, members of the region's workforce, and students struck themes of future tasks that mobilized the spirit and morale that after 1848 had been atomized and crushed in many more souls than that of Pasteur.***

> Where in your families will you find a young man whose curiosity and interest will not immediately be awakend when you put into his hands a potato, when with that potato he may produce sugar, with that sugar alcohol, and with that alcohol ether and vinegar? Where is he that will not be happy to tell his family in the evening that he has just been working out an electric telegraph? And, gentlemen, to be convinced of this, such studies are seldom if ever forgotten. It is somewhat as if geography were to be taught by traveling; such geography is remembered because one has seen the places. In the same way your sons will not forget what the air we breathe contains when they have once analyzed it, when in their hands, and under their eyes the admirable properties of its elements have been resolved....
>
> Without theory, practice is but routine born of habit. Theory alone can bring forth and develop the spirit of invention. It is to you especially that it will belong not to share the opinion of those minds who disdain everything in science that has not an immediate application. You know Franklin's charming saying? He was witnessing the first demonstration of a purely scientific discovery, and people around him said:
>
> "But what is the use of it?" Franklin answered them: "What is the use of a new-born child?" Yes, gentlemen what is the use of a new-born child? And yet, perhaps, at that tender age, germs already existed in you of the talents which distinguish you! In your baby boys, fragile beings as they are, there are incipient magistrates, scientists, heroes as valiant as those who are now covering themselves with glory under the walls of Sebastopol. And thus, gentlemen, a theoretical discovery has only the merit of its existence: it awakens hope, and that is all. But let it be cultivated, let it grow, and you will see what it will become.
>
> Do you know when it first saw the light, this electric telegraph, one of the most marvelous applications of modern science? It was in that memorable year, 1822: Oersted, a Danish physicist, held in his hands a piece of copper wire, joined by its extremities to the two poles of a Volta pile. On his table was a magnetized needle on its pivot, and he suddenly saw (by chance you will say, but chance only favors the mind which is prepared) the needle move and take up a position quite different from the one assigned to it by terrestrial magnetism. A wire carrying an electric current deviates a magnetized needle from its

*In 1857 the Académie des Sciences rejected Pasteur despite the fact that he had already received international recognition for his groundbreaking studies in molecular dissymmetry. It was not until the third election vote on his membership, in December 1862, that Pasteur was elected to the Académie. Even then he received only 36 votes out of 60.

**See Riemann's "New Mathematical Principles of Natural Philosophy," 1853, in *The Campaigner* 9 (January-February 1976).

***The existence of a Lille industrial faction, committed to scientific development and the application of new technologies to production, raises some extremely important questions. The obvious indication is that, despite widespread historical accounts to the contrary, the anti-Rothschild forces in France were by no means politically dead in the aftermath of the 1848 Revolution. It is interesting in this context to consider with what determined swiftness Karl Marx was forced out of France and into London immediately after he developed his groundbreaking epistemological studies and program in France during the 1840s.

position. That, gentlemen, was the birth of the modern telegraph. Franklin's interlocutor might well have said when the needle moved: "But what is the use of that" And yet that discovery was barely twenty years old when it produced by its application the almost supernatural effects of the electric telegraph!

The Spectrum of Pasteur's Research

Pasteur on many occasions located the scientific tradition from whence he came — both in specific research and in general scientific spirit — by saying he was "the child of the great Ecole Polytechnique of the late eighteenth century." The Ecole Polytechnique was established in 1794 as the institutionalization of Benjamin Franklin's scientific cadre network in France after the brutal assassination of chemist Lavoisier.*

The Ecole represented the greatest concentration of leading scientists then in the world. These men were organized around a political commitment to the development of scientific theory as the means to utilize technology for achieving material progress: Gaspard Monge and Lazare Carnot the mathematicians; Abbe Huay, physicist of crystals; the chemist Claude Louis Berthollet; Antoine Francois Fourcroy, Jean-Antoine Chaptal, Guyton de Morveau; and, of course, Joseph Lagrange and Pierre Laplace.

In 1865 Pasteur wrote the frontispiece for the first official publication of Lavoisier's collected works, a piece in which he highlighted the necessity for France to reacquire the scientific commitment and spirit of the age of Lavoisier. Pasteur attributes to Lavoisier the first establishment of a system of "chemical mechanics," which was necessary for

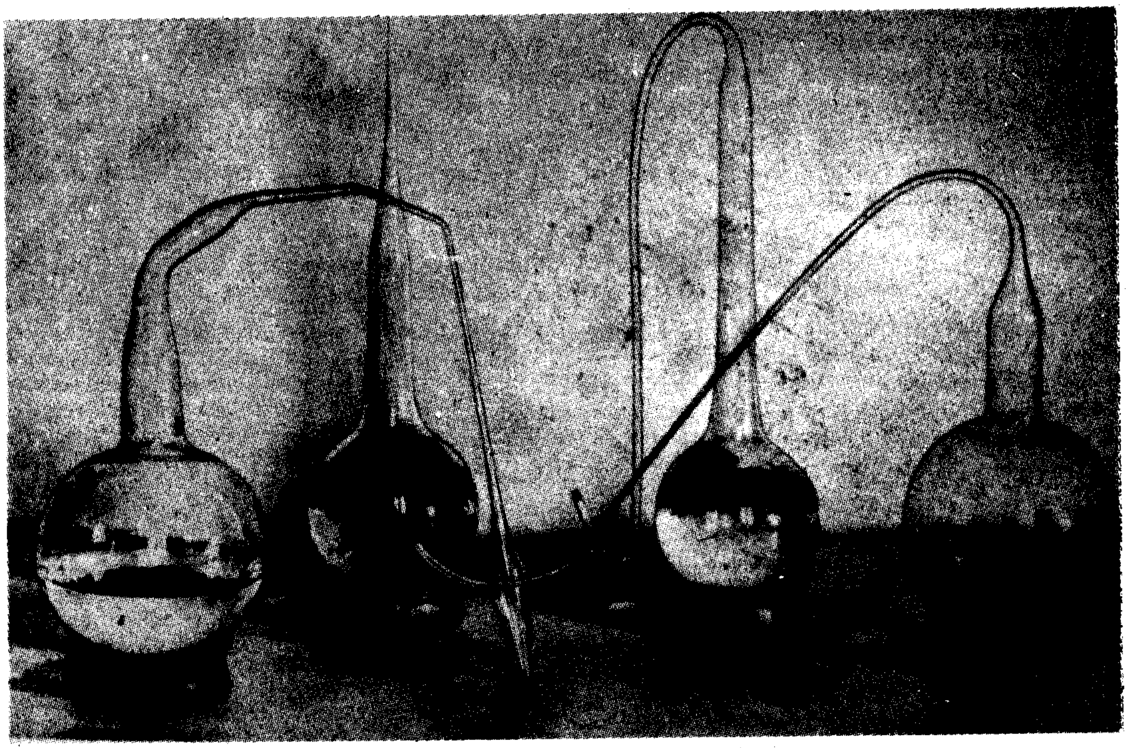


FIGURE 3

The glass apparatus used by Pasteur in his experiments on "spontaneous generation"

These experiments were the bridge from Pasteur's earlier work on molecular dissymmetry and fermentation to the development of the germ theory of disease.

Pasteur first demonstrated that air contained microorganisms in abundance. Air was drawn through a tube plugged with gun cotton; after 24 hours the cotton plug was dissolved in a mixture of ether and alcohol. The solid particles that settled were viewed under the microscope to reveal thousands of microorganisms. Thus Pasteur proved the presence of large numbers of organisms in the atmosphere, that appeared to be the same as known microorganisms and germs.

Second, Pasteur demonstrated that the germs floating in the air may be the source of infection. Modifying the technique of Schwann, he sterilized solutions in sealed flasks by heating them. In all these experiments the solutions were unspoiled and without microorganisms; if the flask was broken, however, the solution inside would quickly regrow bacteria and other microorganisms.

In response to objections from critics that his heating procedure destroyed the "life principle" in the air, Pasteur used the swan-necked flasks above. Untreated air entered the flask but dust particles were trapped in the S-tube before they could fall into the previously sterilized solution. As long as the swan-necks were unbroken, the solution in the flask remained uncontaminated. However, when the flask's neck was broken at the top before the curve began, the flask quickly became contaminated with microorganisms again. (Flask with broken neck is second from left)

These experiments gave birth to the science of bacteriology that underlies the modern germ theory of disease. Neither *vitalist* nor *deus ex machina* theories to explain the origin of living forms were tenable after Pasteur's experiments. As noted: "By his experiments Pasteur demonstrated beyond peradventure of doubt the impossibility of autogeneration of life in the sense as it was imagined by his predecessors. He showed that living organisms cannot be formed suddenly before our eys from formless solutions and infusions. A careful survey of the experimental evidence reveals, however, that it tells nothing about the impossibility of generation of life at some other epoch or under some other conditions. Incidentally, Pasteur himself, with his usual reserve, placed such an interpretation on his own experiments." (Oparin 1923) the science to begin. At the end of the eighteenth century Lavoisier had cleared away the obstacles for the study of such processes as combustion and fermentation by disproving the then-dominant phlogiston theory. Phlogiston was a mental artifact, a mysterious substance, supposedly contained in matter, that burned in air.

The discovery of oxygen and thereby an accurate theory of combustion led Lavoisier to conclude that all living things need oxygen for the breakdown of sugars into carbon dioxide and water for their nutrition. From the time of Lavoisier's publication of the *Traite Elementaire de Chimie* until Pasteur was urged to study the fermentation process by the Lille brewery industrialists years later, there was a complete shift in emphasis on the problem.

When Pasteur began his studies in 1854 the hegemonic view was that the breakdown of sugar into alcohol and carbon dioxide (fermentation) represented the general tendency in all organic material toward decomposition and putrefaction. Pasteur's experiments decisively altered the general tendency: "Fermentation is correlative with life, with the organization of globules, not with the death or putrefaction of those globules." (1858)

By stressing the continuous direction of living organisms toward higher orders of interaction and development, Pasteur opened the door for man's successful intervention into the "quality control" aspects of numerous industrial processes. Furthermore, he outlined the path for later contributions in the control of infectious disease — the abnormal condition of the general tendency.

While at Lille, Pasteur demonstrated that the fermentation process when milk sours (the production of lactic acid) is the result of a specific microorganism whose mode of metabolism depends upon a very selective environment and nutrition (1858). Through deliberate control of the parasite's environment and nutrients, Pasteur showed that men could consciously reorder the seemingly unstoppable natural tendency toward putrefaction. As is commonly known, Pasteur carried the same principles through for the understanding of the manufacture of wine (1863) and beer (1871-77).

Generally overlooked, however, is Pasteur's conception of the implications of his work on the idea of the evolution of the biosphere as a whole. First, Pasteur demonstrated that the fermentation process could be described as an interrelated complex that exhibited the character of his previously discovered notion of a cosmic force — molecular dissymetry.

The primitive microorganism involved in one or another mode of fermentation orients and controls, as it were, its metabolic process through the selection of one molecular form of nutrient in preference to others. In wine manufacture, for example, the microorganism feeds more easily upon the right-handed form of grape acid (right tartaric) than on the left-handed form.

Thus, through careful observation and control of the geometric manifestations of the nutrient media, Pasteur was able to develop a practical assay method for following the development of the fermentation. The sugar-alcohol ratios could be controlled through scientific means instead of the current monkish rites. Fermentation could be described as a primitive or lower-order physiological process capable of being controlled by the human species.

Implications for the Biosphere

From this standpoint then Pasteur developed the insight, later understood most notably by Oparin and Vernadski, that a proper evolutionary principle ought to be applied to the biosphere as a whole. Pasteur's research led him to the discovery of primitive *anaerobic* microorganisms (metabolizing without need of oxygen) in butyric fermentation. In a series of experiments he then uncovered a special regime in the fermentation process in which microorganisms undergo a transformation from the aerobic to an anaerobic condition, a transformation that corresponds to transformations in the form of the microorganism from a more complex to a less complex physiology. Sugar is transformed into alcohol during the more primitive condition.

Pasteur formulated this insight into the principle, "Fermentation is life without air."

Most notably Oparin and Vernadski**, but others as well, later made explicit the suggestion that fermentation represents a condition of the biosphere as a whole at some time prior to what is referred to as the photosynthetic revolution. In order to indicate the dimensions of expansion embodied in the negentropic development of a world manifold characterized by fermentation processes of life to the higher order characterized by photosynthetic-respiration processes, one must isolate an appropriate invariant between the two totalities. As a first approximation, the notion of the energy throughput of the biosphere as a whole in its conversion of energy into biomass reveals a 24-fold increase. The maximum energy release in fermentation is 28 kilocalories per mole of substance, compared with 674 kilocalories per mole of substance in photosynthetic-respiration metabolism.

We can put Pasteur's insight into the most advanced scientific terms: The characteristic feature of the biosphere as a whole, in distinct comparison to what we know of the rest of the universe, is the capture of solar energy that is converted into biological material (biomass) through the mediation of inorganic material and biological waste material. Living process is not matter as such but energy.

Of the total energy captured as added biomass, one part is consumed in maintaining the inorganic preconditions of life, another is consumed in maintaining the biomass of existing species, and a third, or surplus, is available as free energy. It is the last group that constitutes the margin of expansion into new modes.

The negentropic evolution of the biosphere prior to the existence of man, is coherent with the ideas embodied in the work of Riemann and Cantor: There is a transfinite quality of the ordering of the nested manifolds corresponding to the development of human species existence.

To locate the scientific principles involved in this transfinite, we can pedagogically extend familiar phenomena

*Antoine Lavoisier was executed May 8, 1794, as a result of the machinations of Jean Paul Marat and other British agents. Lavoisier, the principal collaborator of Benjamin Franklin in France, was a member of the Farmers General founded by Colbert. In 1778 he began a series of experiments to increase agricultural yield by scientific means. As secretary of the Society of Agriculture he most enraged the British monetarists by publishing a Franklinite agricultural program for France. Lavoisier argued in 1790 that debt, inflation, and taxes were looting the surplus from agriculture so that it could not be reinvested to expand agricultural productivity by industrial and scientific development. The immediate reason for his assassination was Lavoisier's issuance of a Plan for Public Education (1793) that designed a system of broad scientific education for the population along with the creation of a national central institute of leading scientists. Months later, Marat had him beheaded.

**Vladimir I. Vernadski (1863-1945) and his more famous Soviet scientific colleague A.I. Oparin were the subject of a study by the author entitled "The Self-Development of the Biosphere," published in *The Campaigner* 8 (January-February 1975).

from the sciences of archeology and anthropology to satisfy the conditions of a Riemannian "crucial experiment." The problem under consideration, it should be noted, is associated with the evolutionary laws that result from the ordering of human progress, along the methodological track described by G. W. Hegel in *The Phenomenology of Mind* and *The Philosophy of History*.

The record of human species civilization in ancient Mesopotamia is demonstrated by the existence of "tells," mounds rising 60 feet or more above the alluvial plain between the Tigris and Euphrates Rivers. The "tell," each of which stretches varying distances down into the earth, is the site of man's successive social development — temples, houses, tools, and kitchenware layered over the centuries one settlement on top of the other — down through man's past to the virgin soil of an ancient marsh newly emerged from the Persian Gulf at the beginning of human Neolithic life.

For pedagogic purposes, imagine extending the tell backwards toward the remote early Pleistocene when man's social existence was barely distinguished from that of other higher primates and the human species' population potential was of the order of a million or so. Then, mentally extend the tell up to the present population approaching four billion. The current potentiality of human culture based on the development of fusion power is for a population in the order of ten billion, even before man extends his domain outward into space. The transfinite quality of human species existence now stands properly in focus as the characteristic tendency for the realization of human creativity in scientific development.

Extended Reproduction

At moments of profound crisis regarding existing resources and limits of energy capture, man has applied his creative powers to science. Through technological advances we are able to alter and generate qualitatively higher orders of the production process. The concept properly embodying this transfinite aspect of human social development in a conscious and deliberate fashion is that of the Marxian notion of *extended reproduction*. Marx was well aware of the broader application of this concept to natural sciences: In 1854 he wrote in *The German Ideology*:

> The first premise of all human history is, of course, the existence of living human individuals. Thus,

1 **AD 600-300** The level of an early Christian church. On a nearby site are even later Byzantine ruins and bronze crosses of the priests.

2 **AD 300-64 BC** A village partly contemporary with early Christian missionary activity in Antioch.

3 **circa 64-500 BC** An occupation of the period of the Persian Empire and of the Greek empires that followed the conquests of Alexander the Great.

4 **circa 500-1000 BC** Layers of the Syrian Hittite kingdom, contemporary with the later Assyrian Empire and the Babylonian Nebuchadnezzar.

5 **circa 1000-1200 BC** Ceramic traces of the "peoples of the sea," some of whom are known as the Philistines, others as the Archaeans who sacked Troy.

6 **circa 1200-1600 BC** A period rich in imported pottery of Cypriote and Aegean type.

7 **circa 1600-1900 BC** The beginning of marked technological advances in the second millennium BC.

8 **circa 1900-2000 BC** A period of transition, probably brief, during which distinct types of pottery were manufactured.

9 **circa 2000-2300 BC** A time of brilliant work in metal pottery.

10 **circa 2300-2600 BC** A period rich in connections with the south and east.

11 **circa 2600-3000 BC** A range marked by a fine red-and-black pottery series, excellent metalwork, and by cylinder seals of the Mesopotamian type.

12 **circa 3000-3500 BC** A period of technological advancement at the end of which appear the earliest known castings of human figures in metal. Links to both Egypt and Mesopotamia.

13 **circa 3500-3900 BC** Levels yielding rather drab pottery but the earliest types of tectonically conceived metal tools.

gap

14 **circa 5000-5500 BC** (?) Traces of materials in the range of the earliest known villages of Syro-Cilicia. Hand-made polished pottery, simple tools in bone and flint.

Step trench at
Tell Jedeidah, Syria

Tell, an Arabic word meaning "high," is used to designate a mound that was occupied by a succession of cities or towns. After destruction by war or fire, a new city would be built on the ruins of the old and the mound grew successively higher. Tell Jedeidah shows a series of civilizations superimposed on one another, with 14 distinct levels of occupation identified from 5500 BC to AD 600.

Source: The Biblical World: A Dictionary of Biblical Archaeology (New York: Bonanza Books, 1966)

the first fact to be established is the physical organization of these individuals and their consequent relation to the rest of nature. Of course, we cannot here go either into the actual physical nature of man, or into the natural conditions in which man finds himself — geological, orohydrographical, climatic and so on. The writing of history must always set out from these natural bases and their modification in the course of history through the action of men.

The proper ordering of the history and self-development of the biosphere as a whole — its successive transformation from one mode to those of a qualitiative difference — can be successfully compared to the universal evolutionary principle of man's development. Under the enormous influence of the philosopher Spinoza, mediated through Goethe, there is a deep current of hylozoic monism in the material universe throughout the methodology of nineteenth century scientists. Using this approach to view the history of the biosphere as a whole, the qualitative transformations from one mode to another exhibit the transfinite characteristics of nested manifolds:

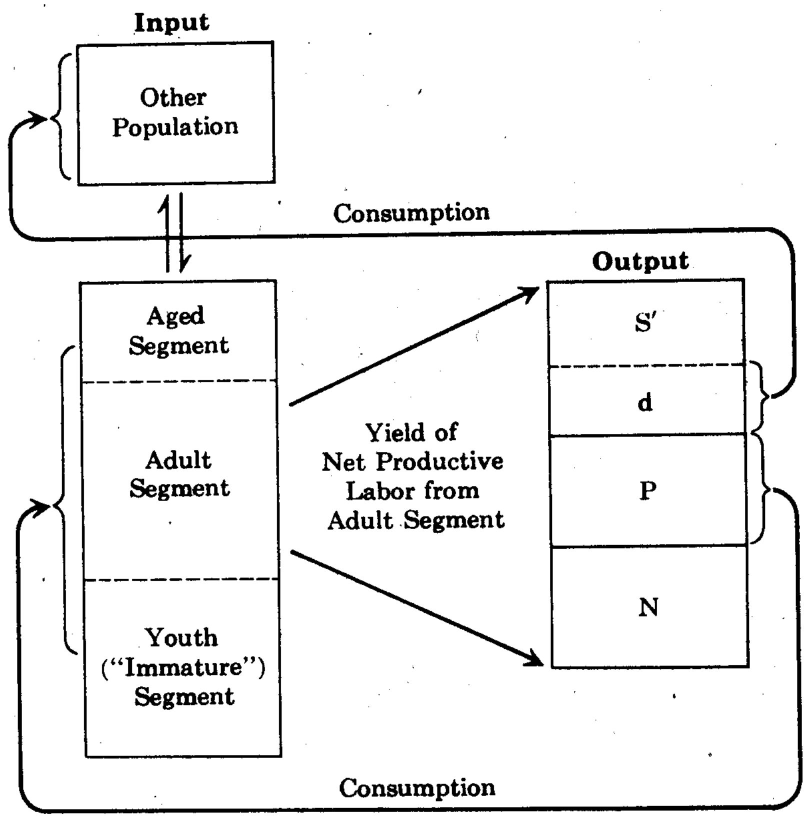
(1) the generation of a special nonlinear biologic geometry on earth evolves into a mode of "life" without air, a manifold of "life" under conditions prior to the current biospheric atmosphere until its expansion is strained by the limits of energy capture and net resources;

(2) the creation by this prior mode of life advancing beyond crisis through the invention of chlorophyll and the establishment of new preconditions for itself generating a higher manifold of life — the photosynthetic revolution;

(3) the generation by this mode of the capacity to evolve the characteristically higher-order feature of human life.

Man thus recapitulates the entire phylogeny of the universe. By the ability of the human species to consciously understand the universal laws characterizing this transfinite ordering process, man may utilize that concrete knowledge to alter the future course of the universe. The evolutionary principle here described subsumes the qualities of nonlinearity that are empirically seen in the coherence between the growing complexity of chemical and animal-plant species on the global life, as well as processes involving species interactions in the small.

The capacity of the universe to generate higher modes of living processes self-reflexively, processes of development that can then be replicated self-consciously by man, is the



A Refutation of Environmentalism

The actual historical relationship between man and nature can be defined concisely by the pedagogy developed by LaRouche in *Dialectical Economics*. LaRouche's general model of social reproduction yields the self-reflexive ratio

$$\frac{S'}{P+N}$$

where

P = material consumption required to reproduce the general productive sector of the population. In many societies P is only an ecological category and not a social one.

N = costs of maintaining nature and man-altered nature. Like P, N in many societies is not a social category.

d = consumption of sectors other than the general productive sector of the population.

S = social surplus.

S' = free energy of the society to maintain itself in a given mode (simple reproduction) or invest in expansion to a qualitatively new mode; defined as S — d.

The relationships among these categories can be heuristically modeled in the "input/output" diagram above:

The figure contains three principle elements:

(1) The large bar on the left represents the entire productive population with the society's own social (not biological) subcategories of immaturity and overage for productive work. The smaller bar, top left, represents the nonproductive, "other" population as a whole.

(2) The bar on the right signifies the totality of productive labor's "output."

(3) The arrows between the two bars signify the movement of persons, goods, and services.

A rise in the current value of the ratio

$$\frac{S-d}{P+N},$$

therefore, is a measure not only of development but also of existence. Since P and N must increase relative to their values for preceding states, from the standpoint of such states the impulse that gives rise to development or existence is ***an exponential tendency for rise in the value of the given ratio.*** Ralph Nader's "environmentalism," Herman Kahn's "ecosphere and biosphere people," and Barry Commoner's nonsense deny that there has been human social development by maintaining that man ought to bestialize himself to the level of brute equality with animals and other objects of nature. Their argument corresponds with increasing segment P while reducing N, d, and S' — thus forcing human existence to approach an animal state of reproduction: N = 0, d barely greater than 0, and S' extremely small or 0.

It is obvious that the condition of "zero growth" actually corresponds to a "negative growth" of human development rapidly converging upon the "extinction" of the human species. Conversely, as one approaches human development, N increases "at the expense of" P, and S' increases. Then S' increases "at the expense of" both P and N, but N continues to increase relative to P; that is, man produces the material preconditions to advance his productive existence to a higher level.

universal law of the cosmos for which Pasteur sought experimental data in his experiments of molecular dissymmetry.

The fact that this notion of an evolving universe is decisively beyond the realm of a Newtonian outlook bears special emphasis. At the close of the eighteenth century, Leibniz, and in particular, Kant, had advanced the worldview of Newton to its breaking point in a series of paradoxes. In this endeavor, Kant especially was constrained by the hegemonic authority of Lagrange and Laplace.

In the epistemological realm, both Leibniz and Kant utilized the phenomenon of left-handedness and right-handedness to pose an insoluble paradox for the Newtonian universe of absolute space and absolute time. Leibniz asserted that given states of space in which absolute metrics prevailed, left-hand and right-hand distinctions would be "indiscernible." In geometric terms, Leibniz described a condition in which congruent forms cannot be transformed one into the other; either the internal space is different or the forms are not congruent.

After Spinoza, Kant nurtures the simple Leibnizian paradox in the direction of a devastating antinomy for the Laplacean world view. In the *Prolegomena to Any Future Metaphysic* Kant generates the notion of a "geometry of the transcendental" in which "mental space renders possible the physical space." Therefore, either creative thinking is impossible or Newton's universe is only a flattened approximation to a reality of wondrous self-perfecting proportions. For pedagogic purposes, Kant concentrates on Leibniz's problem of a right hand in front of its mirror reflection:

> There are no internal differences which our understanding could determine by thinking alone. Yet the differences are internal as the senses teach, for, notwithstanding their complete equality and similarity, the left hand cannot be used for the other. What is the solution? These objects are not representations of things as they are in themselves, and as the pure understanding would cognize them, but sensuous intuitions, that is, appearances, the possibility of which rests upon the relation of certain things unknown in themselves to something else, *viz.*, to our sensibility, and the internal determination of every space is only possible through the whole....

Can Man Change the Laws of the Universe?

But can man change the laws of the universe as a whole?

The answer is decisively answered in the affirmative by Goethe. When man tries to study nature's laws in order to change them, he becomes aware of the reciprocal influence of a "twofold infinitude," writes Goethe in his introductory note to his series of essays entitled *Natural Science in General: Morphology in Particular* (1807). The "infinitude" in natural objects resides in "the diversity of life and growth and of vitally interlocking relationships." The other "infinitude" is in man himself — "the possibility of endless development through always keeping his mind receptive and disciplining it in new forms of assimilation and procedure."

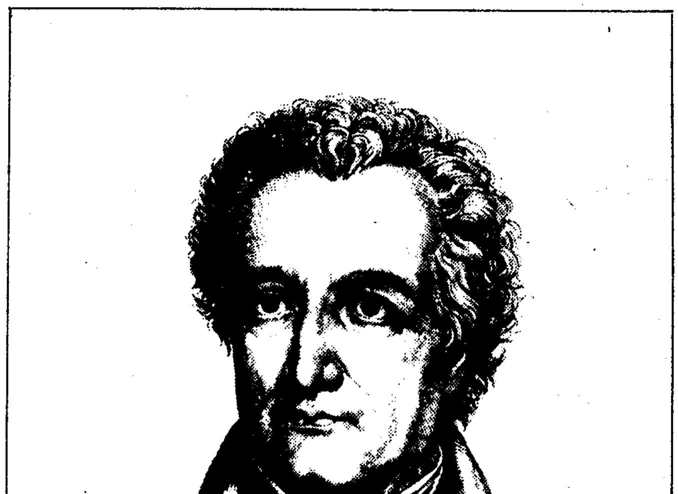
Echoing Spinoza on Descartes, Goethe admits that the latter infinitude is accessible to powers of expansion and "self-perfection" that in itself represents the highest lawful orderings in the universe.

There is an unmistakable parallel between Goethe's Leonardoesque concept of "morphology" and Pasteur's sketches of a developmental physiology of molecular interactions. Goethe's botanical studies constitute a polemic with Linnaeus's fixed, discrete species.

Goethe's stated aim was to develop a theory of "the formation and transformation" of living organisms. Certain dunderheads have attempted to pollute his project by coopting him as a forerunner to that anti-scientific Malthusian, Darwin. Goethe's objective, to the contrary, was to study and trace the patterns and sequences of forms in organisms. Vegetative growth, he believed, was a type of continuous reproduction that occurs successively and not by individual discrete developments. Contrary to Linnaeus, Goethe sought to classify the great mass of plants into a systemic ordering which indicated their "multiplicity in unity."

From this standpoint, Goethe derived a twofold law of evolution for the physiology of plants: the law of inner nature, whereby the plant has been constituted and the law of environment, whereby the plant has been modified. He characterized the process encompassing these laws as involving infinite unfoldings and involutions — a "thousandfold twistings around its center" deriving infinite reproductions from within itself.*

Goethe's twistings, unfoldings and involutions are characteristics of expanding geometries (see Figure 4). His late conclusion was that plant growth and forms depend upon metabolism — changes in the internal chemistry cause changes in the overall laws of development. His insight along



Johann Wolfgang von Goethe, 1749-1832

*Johann Wolfgang Goethe (1749-1832) is a towering figure in the development of the modern scientific outlook. Contrary to the prevalent reductionist view that human creativity is a mere predicate of the fixed and discrete empirical laws of the universe, Goethe represents the *humanist* tradition emanating from the early Italian Renaissance. The actual universal and primary character of *man as subject* to know, master, and change the laws of the universe for the benefit of his species' development pervades Goethe's literary and scientific works.

As a byproduct of his studies on comparative and evolutionary anatomy, Goethe is credited with discovery of the intermaxillary bone in humans (1784). His studies of botany and physiology (1784—1831) decisively helped to shift the nature of the science from the earlier mode of Linnaeus. Goethe also explored an evolutionary approach to the development of the biosphere as a whole in his work on geology (1784). He also engaged in numerous experiments in attempting to advance the theory of light and color beyond Newton (1810).

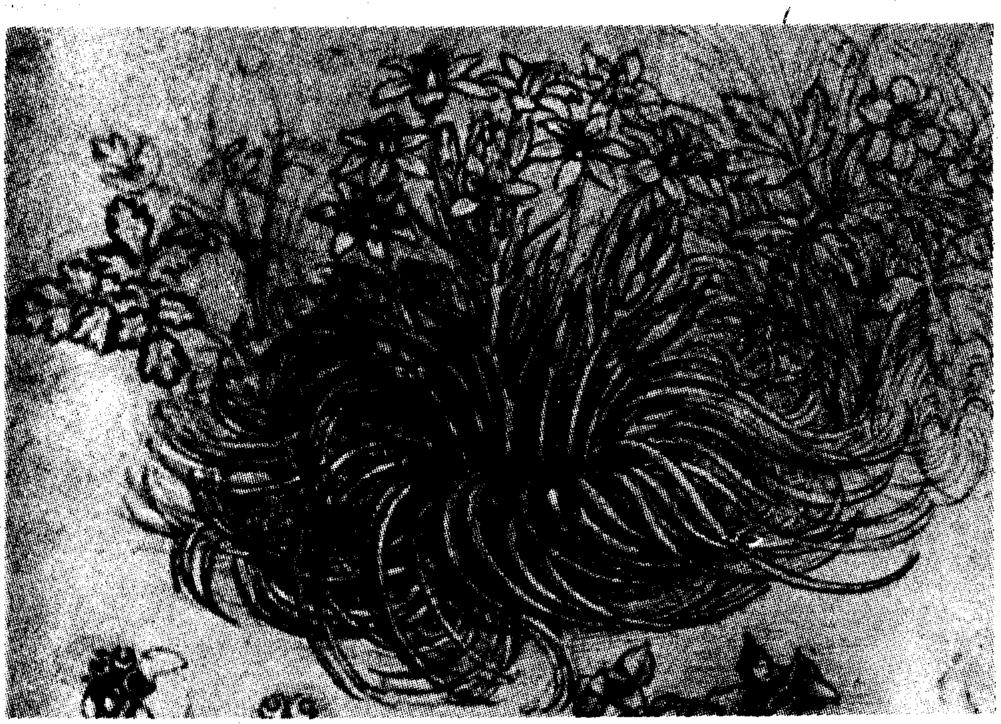


FIGURE 4

Wild Flowers by Leonardo da Vinci, 1513-14

Leonardo's famous drawing in pen and brown ink directly motivates Goethe's notion of morphology. Concentrating on the drawing one realizes both the principles whereby the plant grows as well as the individuality of the plant's form. Remarkably, while looking at the drawing, one is compelled to ponder the process of plant growth right before one's eyes.

these lines led Goethe to accurately characterize the problem with chemistry before Pasteur: Goethe wrote that the "chemist tends to annul form and structure to study properties and compositional relationship."

Pasteur's achievement was to empirically guide science beyond this system of classical "chemical mechanics."

Pasteur's Public Health Contribution

Returning to Pasteur's work itself, there is a development in his research from fermentation studies to investigation of what he termed "the borderlines between living and dead matter." In 1859 the director of the Museum of Natural History in Rouen, Professor F. Pouchet, published a treatise nearly 700 pages long that supposedly proved that spontaneous generation was possible.*

Pouchet's thesis, which Pasteur refuted in a widely known series of experiments (see Figure 3), was that life could arise in the presence of putrescible matter and a "life force." Furthermore, Puchet denied that microorganisms could be airborne and implicitly attacked the broader evolutionary principles embedded in Pasteur's work.

Although other sources identify the empirical accomplishments of Pasteur's research on spontaneous generation, two broader notions at the core of Pasteur's motivation are not generally given proper emphasis. Pasteur's notebooks and letters of the 1860-65 period make it clear that he was engrossed in the following questions:

Is there a way to reject the notion of spontaneous generation and what Pasteur termed "facile researches on primary causes" without discarding the notion of a hylozoic universe characterized by a "living" principle suggested in the tendency toward higher "organization of globules"?

How can the scientist establish the necessary bridge from man's ability to control disease conditions in such processes as fermentation in industrial production to a broader "public health" program that can control the spread of infectious diseases?

Pasteur's contributions toward the science of epidemiology and the notion of antiseptics underlying modern surgical techniques (1865-95) are enormous and well known. His principal studies develop from consideration of abnormal or "diseased" fermentation processes to studies on silkworm disease and cholera (1865), anthrax (1877), chicken cholera (1879), rabies (1880) and cattle pleuropneumonia (1882). In the study of these specific diseases Pasteur developed a general understanding of the dynamics of epidemic spread, prevention, and cure — in short, the modern theory of germs.

The global nature of the problem confronted Pasteur from his first work in 1865. The silkworm disease then ravaging French industry had shown its first symptoms in France in 1849 and had then traveled to Italy, Spain, Austria, and eventually China (1864) before reemerging in a devastating 1865 French outbreak. The cholera epidemic, which claimed 200 victims a day in Paris in October 1865, had spread from Egypt, to Marseilles, to Paris.

Pasteur's *Memoire on the Germ Theory* (1878) presents the conception that disease results from specific microorganisms that can be isolated and controlled. The phenomena of lower-order parasites running amok could be controlled by man's conscious raising of the level of health in the general population and man's environment. Man had the capacity to raise the threshold to what Pasteur termed "the resistance level to disease." "You see clearly, that something more than the microbe is needed to make us ill, since in this case (anthrax) we so often find the organism and so rarely the disease," Pasteur wrote.

In addition to natural immunity man can acquire immunity through vaccination against specific diseases and hence, contain and control illness. As a result of Pasteur's work, disease was removed from the realm of a spontaneously generating mystery outside man's control:

> Is it impermissible to believe that a day will come when easily applied *preventive measures* will arrest those scourges that suddenly desolate and terrify populations — such as the fearful disease (yellow fever) which has recently invaded Senegal and the valley of the Mississippi, or that other (bubonic plague), yet more terrible perhaps, that has ravaged the banks of the Volga.

Pasteur's Lesson for Today

Today, more than a century later, for no reason other than the irrational fears of the human species of decisively overthrowing the policies of monetarism, the world faces the threat of global ecological holocaust. In the process of achieving a fusion-based world economy the human species must pass from the current rearguard stance of fearfully defending itself from one specific disease attack after another — from humbly aspiring to a mere absence of sickness — to an era of actually creating self-expanding conditions for growth and development.

The basic feature of human historic development, as emphasized here, has not been characterized by the maintenance of an equilibrium or homeostatic state of health, but rather by the continuous production of a healthier and longer-lived human species.

There are three interrelated theoretical and practical aspects for superseding the acute ecological and epidemeological crisis for man and nature at the moment. All three demonstrate that processes in the universe — whether in the domain of human political economy, the biological sciences, plasma physics, agriculture, or an integrated chemistry of the inorganic and organic — are characterized by the sort of universal laws of development and pathology discussed above.

The primary, emergency consideration for all scientific advance in eradicating disease must necessarily be focused on the level of the biosphere as a whole. The health of man's biosphere is determined by qualitiative increases in the conversion of energy throughput into biomass; hence, fusion power.

The second area of focus is associated with human population policy as it determines the state of the overall ecology. Competent policies begin with a complete rejection of all Zero Population Growth, Malthusian-Darwinian models and all Schachtian *arbeitsdienst* programs.** Positively stated, human population policy is expressed by the Marxian notion of expanding *labor power*.

The third area — that of living processes within the individual human organism itself — will rely most greatly on recent advances in plasma physics for qualitative breakthroughs in understanding.

Pasteur's concept of the necessity for rising qualities of public health was highlighted by a sophisticated political campaign for scientific development, which he developed at the same time that he was engrossed in studies of infectious disease. The specific issue was the 1868 Budget of Public Instruction, dictated by the Rothschild bankers, which allocated no one *sou* for physical science research. Pasteur issued his own program entitled "Science's Budget," which appeared first in the departmental journal, *Revue des Cours Scientifiques*, and later as a mass-distribution special pamphlet since all official government and educational journals had balked at printing the piece. Pasteur embarked on a nationwide speaking tour urging the establishment of a special advanced university program dedicated to scientific development and upgrading higher education.

His program called for the Paris institute, modeled on the old Ecole Polytechnique, to become the centerpiece of a nationwide university network of regional scientific institutes patterned on his Lille Faculte des Sciences. In his science budget pamphlet he wrote:

> The boldest conceptions, the most legitimate speculations can be embodied only from the day they are consecrated by observation and experiment. Laboratories and discoveries are correlative terms; if you suppress laboratories, Physical Science will become stricken with barrenness and death; it will become mere powerless information instead of a science of progress and the future. Give it back its laboratories, and life, fecundity, and power will reappear. Away from their laboratories, physicists and chemists are but disarmed soldiers on a battlefield.

Pasteur's pamphlet directly addressed the common interest of the French industrialist and working class in advancing science:

> The deduction from these principles is evident: if the conquests useful to humanity touch your heart — if you remain confounded before the marvels of electric telegraphy, of anaesthesia, of the daguerreotype, and many other admirable discoveries — if you are jealous of the share your country may boast in these wonders — then, I implore you, take some interest in those sacred dwellings meaningfully described as *laboratories*. Ask that they may be multiplied and completed. They are the temples of the future, of riches and of comfort. *There humanity grows greater, better, stronger; there she can learn to read the works of nature, works of progress and universal harmony, while humanity's own works are too often those of barbarism, of fanaticism, and of destruction.* (emphasis added.)

Pasteur then wrote that France would head into a crisis unless the nation made a total commitment to scientific development. Three-and-a-half years later when that disaster had come in the form of the Prussian army crushing the Paris Commune, Pasteur wrote a piece entitled "Why France Found No Great Men in the Hours of Peril." He answered the question of his title with a polemic against what he termed France's "forgetfulness, disdain even for great intellectual men, especially in the realm of exact science."

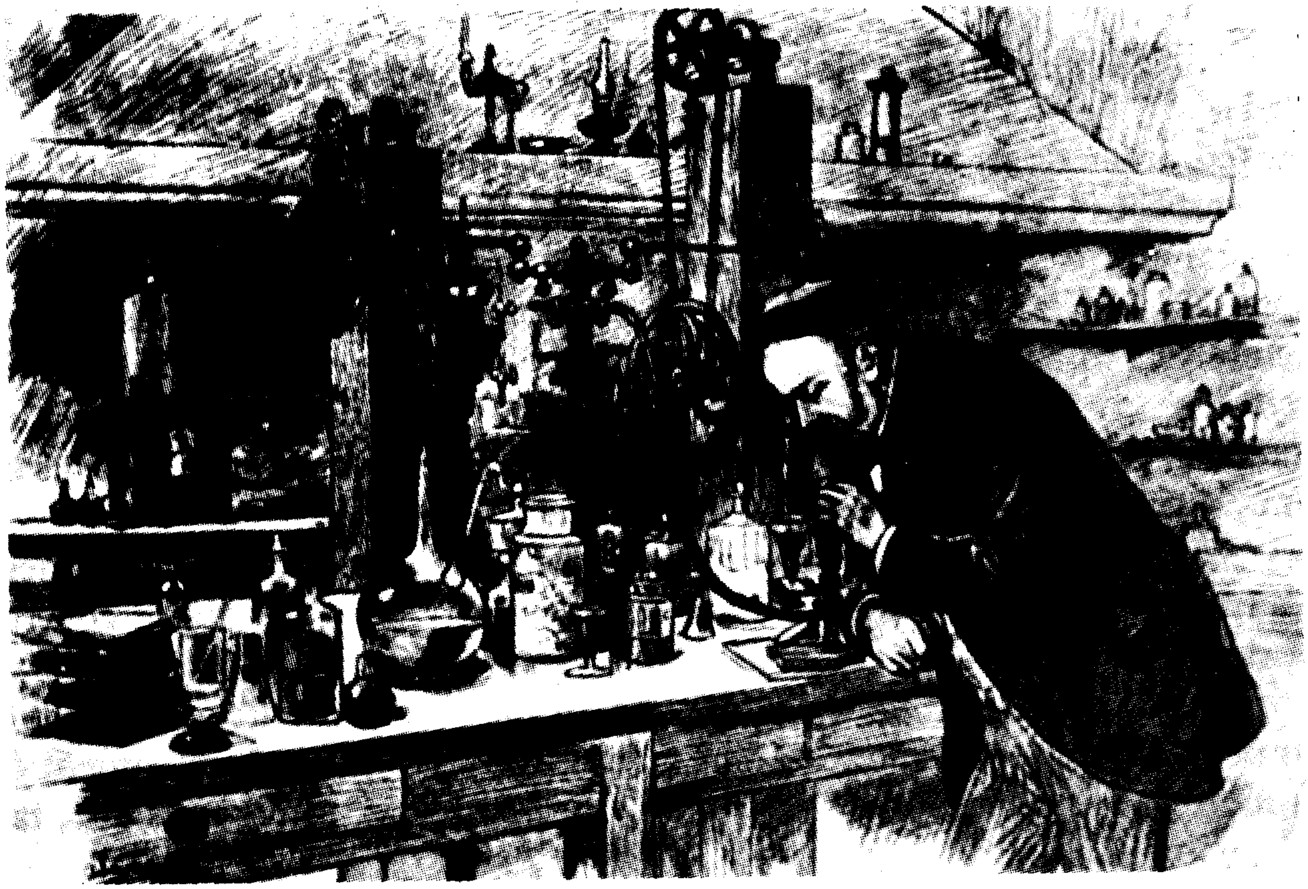
Pasteur contrasted the current crisis in France with that faced during 1792 when the nation "was able to face danger on all sides" because Lavoisier, Fourcroy, Morveau, Chaptal, Berthollet and others applied the advanced principles of scientific discovery to practical industrial and military tasks.

The tragic guillotining of Lavoisier as a result of Marat's incitements convinced Monge, Berthollet, and others, Pasteur wrote, that they must found an institution for scientific development — the Ecole Polytechnique — as a bridgehead for progress lest all scientists be arrested, tried, condemned, and executed. Pasteur then described how Napoleon coopted science for his military campaigns and broke up the Ecole; France fell from its superiority in science.

> A victim of her political instability, France has done nothing to keep up, to propagate, and to develop the progress of science in our country. She has merely obeyed a given impulse; she has lived on her past, thinking herself great by the scientific discoveries to which she owed her material prosperity, but not perceiving that she was imprudently allowing the sources of those discoveries to become dry....
>
> The cultivation of science in its highest expression is perhaps even more necessary to the moral condition than to the material prosperity of a nation. Great discoveries — the manifestations of though in Art, in Science, and in

*The history of the debate on spontaneous generation is easily accessible to readers through works by Oparin, Keosian, and others.

**For a full discussion of the mutually exclusive notions of *Schachtian economics*, on the one hand, and qualitatively expanding *labor power*, on the other, see *Dialectical Economics* (LaRouche 1975), "Rockefeller's Fascism With a Democratic Face" (LaRouche 1974); "The Italy Lectures" (LaRouche 1975); and "A Multi-Partisan Energy Policy" (LaRouche 1977).



Pasteur in his laboratory

Letters — in a word the disinterested exercise of the mind in every direction and the centers of instruction from which it radiates — introduce into the whole of Society that philosophical or scientific spirit, that spirit of discernment, that submits everything to severe reasoning, condemns ignorance, and scatters errors and prejudices. Great discoveries raise the intellectual level and moral sense, and through them the Divine idea itself is spread abroad and intensified.

Pasteur then reiterates his call for a national program of scientific development.

In 1876 Pasteur placed himself as a candiate for the French Senate to "represent in the Senate, Science in all its purity, dignity and independence." One of the outrageous ironies of history is that the 650 senatorial electors gave Pasteur only 62 votes — placing him fifth and last behind the monarchist candidate! The official explanation of the electors was that "science has its natural place at the Institute" and not in the parliament.

As a result of the immense public and industrial pressure that Pasteur mobilized during his campaign, three months after the election the minister of public instruction was forced to announce his endorsement of the program outlined in Pasteur's 1868 pamphlet that had become the basic political theme of Pasteur's senate campaign: providing the College de France with new laboratories, transferring and enlarging the Faculty of Medicine, developing a nationwide program for the physical sciences, and so forth.

At the close of his life, Pasteur established a scientific Institute named after him. The Pasteur Institute was funded by the extraordinary means of an international subscription drive so that science research, in his words, would not be shackled to the particular whims of a particular government. He raised 2,586,680 francs from industrialists, government officials, workers' organizations, and small individual contributions from around the world.

Pasteur's fundamental premise that the laws of evolution of living forms and the universe as a whole are "distinctions of fact and not of absolute principle" emanate directly from his political approach to the question of scientific development. If this is not to be misunderstood in a frivolous sense — running completely counter to Pasteur's own intent — biological scientists, plasma physicists, mathematicians, and broader sectors of the population must compare notes with utmost regard for the task orientations required by a fusion-powered world economy. If we are intent on getting there, Pasteur cannot be overlooked.

APPENDIX

Observations on Dissymmetrical Forces

Louis Pasteur

The following is a translation of Louis Pasteur's "Observations sur les Forces Dissymétriques, Comptes rendus de l'Académie des sciences, séance du 1 juin 1874."

The author was motivated to translate this article by the incredible paucity of Pasteur's early works in English. Pasteur's two longer essays on molecular dissymmetry, given as a famous lecture series in 1860, were printed in a miniscule English pamphlet by the Alembic Club of Scotland in 1897 and have never been reprinted. There exist in English a few extant excerpts from some of Pasteur's pieces, but the conceptual content is usually edited out.

The above selection was chosen because it touches upon the range of Pasteur's thinking in a highly concentrated form.

This is the first English translation of the selection.

I would like to see the products obtained by M. Cloez subjected to the action of polarized light, in comparison with similar products prepared with the aid of a steel magnet. However strange it may seem at first glance, these are the reasons for my wish.

All mineral products and all of the numerous organic substances which one obtains artificially in the laboratory lack molecular dissymmetry and the correlative action on polarized light. Both of these properties, on the other hand, are inherent in a great number of natural organic substances most important from the physiological standpoint: such as cellulose, sugars, albumin, fibrin, caseine, certain vegetal acids, etc.

Indeed, I have recognized that ordinary succinic acid, an (optically —WH) inactive body, in the hands of MM. Perkin and Duppa supplied some paratartrate acid resolvable into right tartaric acid and into left tartaric acid.

Subsequently M. Jungfleisch in a series of experiments accomplished with rare skill arrived at the same result after starting with the synthesis of succinic acid which M. Maxwell Simpson had successfully prepared from the elements carbon and hydrogen. Notwithstanding these last achievements, they do not alter the truth of the following statement: Up until the present no one has ever formed a simple (optically —WH) active body with inactive bodies. I am even inclined to believe that the number of *paratartrates* and *derived paratartrates* is considerable. The *paratartrates* are one of the forms of bodies which have a symmetrical plan and they originate under the influence of actions which have nothing dissymmetrical.

The opposition between the existence of chemical actions of symmetrical order and of dissymmetrical order was introduced into science the day when it was recognized that the physical and chemical properties of right and left tartaric acids (identical whenever inactive non-dissymmetrical bodies are set going in their presence) became, on the contrary, dissimilar when these acids are under the influence of active, dissymmetrical bodies. The role of molecular dissymmetry was also introduced as a factor to the phenomena of life, the day when it was verified that a living well-ordered ferment takes to fermenting right tartaric acid easily, while not to left tartaric acid.

Living beings take the carbon necessary to their nutrition from right tartaric acid in preference to carbon from left tartaric acid. Hence, since there is dissymmetry in the immediate natural laws — notably in those which can be considered as primary — namely, in the immediate constituent principles of living cells; since vegetables produce simple dissymmetrical substances to the exclusion of their inverses; since, in contrast to what is produced in our laboratory reactions, the vegetable kingdom does not form exclusively paratartrates or simple inactive suzstances; and since it probably forms these latter substances only through oxidations or secondary reducing actions similar to those of mineral chemistry, as natural oxalic acid or acetic acids show; I conclude that it is absolutely necessary that dissymmetrical actions preside during life over the elaboration of the true, immediate natural dissymmetrical principles.

What is the nature of these dissymmetrical actions? I myself think that they are of the order of the cosmos. The universe is a dissymmetrical totality, and I am convinced that life, such as it is manifested to us, is a function of the dissymmetry of the universe or the consequences which it produces. The universe is dissymmetrical, for if the totality of the bodies which comprise the solar system were to be placed before a mirror moving according to their own motion, then the image in the mirror would not be superposable to reality. The movement of solar light is dissymmetrical. A light ray never strikes in a straight line and at rest the leaf where vegetal life creates organic matter. Terrestrial magnetism, the opposition which exists between the north and south poles in a magnet, that offered us by the two electricities positive and negative, are only probably resultants from dissymmetrical actions and dissymmetrical movements.

From all of the preceding, I believe that it can be deduced that we will succeed in leaping over the barrier established between the mineral and organic kingdoms by our inability to produce dissymmetrical organic substances through our laboratory reactions only if we succeed in introducing into these researches influences of a dissymmetrical order. Success in this avenue will give access to a new world of substances, reactions and probably as well, to organic transformations. It is at that point, it seems to me, that we should locate the problem not only of the transformation of species but also of the creation of new species. Who could say what would become of plant and animal species if it were possible to replace cellulose, albumin, and their cognates in living cells by their inverses? The difficulty in resolving these problems should not prevent us from noting their existence. Since one succeeds in finding the inverse to right tartaric acid, surely one day we will succeed in possessing all the immediate inverse principles to those which now exist. When one wishes to go further in the physiological order, when one wishes to introduce these new immediate principles in living species through nutrition, the great difficulty — I fear — will be to win over the *becoming* characteristic of species, potentially contained in the germ of each of them, in which germ the dissymmetry of the immediate present principles will always be manifested.

Nonetheless, by every possible means, let us seek to provoke molecular dissymmetry from the manifestation of forces having a dissymmetrical action. Today, and in reference to the just completed discussion before the Academy on hydrogen carbides, it is enough for me to know that magnetism has mysterious properties of opposition and that Ampere was able to represent magnets as formed by electrical currents in solenoids. For this I believe myself justified in posing the following question: would not the magnet — penetrated with an unknown (force) which makes it a magnet and which, I imagine, is not superposable to its image — yield dissymmetric molecules at the critical moment of the mysterious combination of its carbon with hydrogen? I would go even further. I would like to compare the (various) carbides of hydrogen formed simultaneously and separately by submitting them to the attack of the two poles of a magnet, even though a magnet can be considered formed of an infinity of elementary "magnets," the resultant of which effects constitute the properties of natural or artificial magnets.

Our colleague M. Thenard and his son obtained some new as well as previously known substances in a series of original and profound researches with electrical fluxes. Wouldn't these substances tend to have molecular dissymmetry? There are numerous other circumstances where one can suspect the influence of *solenoid actions*, if I may say so. The ones I motivated are enough for you to understand what I mean. Engaged in more than enough work to absorb what I have left of activity and strength, I leave to the younger scholars of a new generation the preceding ideas with the hope that they will know how to bring them to fruition.

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* Denotes work on questions central to the methodology of the modern scientific outlook.