

# "THE GENERAL THEORY OF META-DYNAMICS SYSTEMICITY"

*Part 5: Mechanisms driving the systemicity of universal metadynamics*

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## ABSTRACT

The General Theory of Systemicity is being published - part after part since 2004 - from after the application of "The Bioethism Transdisciplinary Paradigm<sup>1</sup>" that the author J.-J. Blanc developed since 1996. Made from an extensive research on "Systems science" that induced to his developing a new systemic<sup>2</sup> paradigm, it was termed as a *transdisciplinary approach* to "Living systems" he named "The Bioethism". A transdisciplinary paradigm that is meant to support the acquisition of a large understanding on living systems' naturally structuring and behaving for survival from adapting to their milieu.

The "Cosmo-planetary and terrestrial metadynamics systemicity<sup>3</sup>", the "Life's metadynamics systemicity", and the "Biological survival metadynamics systemicity" processes are the core of the general theory, which, resulting from a large research and approach of the whole set of universal metadynamics and their retroactivity, show their interrelationship and interdependency. The systemicity of their atomic and molecular cycles has made and sustains both cosmic systems and Life on planet Earth. As to exist, living systems replicate and evolve within global, glocal and local permanently changing milieu and environment.

The Universe Cosmo-planetary gigadynamics and metadynamics have participated in the Sun system and its planets to form, particularly the Earth orbiting around it at the right "habitable green zone". The General Theory shows the close links between Cosmo-planetary and terrestrial meta-dynamics systemicity, its forces, fluxes and moves cycles that made Life to have happened and thriven. From proto-organisms to humans, their individualities, social traits and behavioral statuses have accounted for the biodiversity of species to develop and/or to get extinct.

For example, when the Earth became a "snowball" from a nearly total glaciation (-600 Mo/y), the survival of some bacteria and micro-organisms escaping the drastic extinction of most species, conversely boosted up an extraordinary explosion of marine species bearing quite new functions (- 545Mo/y), that after volcanism reheated the planet from the systemicity of interrelated metadynamics.

These metadynamics are the main physicochemical cosmic, galactic, stellar, planetary and terrestrial feedback process results that make atoms participate in forming matter and cosmic objects (nebulae, baby stars, stars and planets), within a molecular world as originated after the "Big Bang".

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<sup>1</sup> - "The Bioethism transdisciplinary approach paradigm" (acronym for **B**iology-**E**thology, ecology - **H**umanism) fosters universal specificities relative to the complexity of Life's processing, which in form of open systems, appeared on Earth from biochemical components and survival proprieties, in propitious physicochemical environments (J.-J. Blanc 1967).

<sup>2</sup> - **Systemic (adjective)**: "nature of a dynamic and retroactive process pertaining to or affecting an organ or the body of an organism".

<sup>3</sup> - **Systemicity**: the dynamical direction of a phenomenon towards a positive or retroactive status that sustain things, objects and creatures surviving.

The physicochemical environmental conditions became propitious for Life to “hatch” within biochemical thermodynamics, sustaining its evolution from the development of metadynamics systemicity pathways in form of survival cycles.

Influenced with a certain number of forces, and going towards specific directions in the environment, Life as a whole is confronted with gravitation, electromagnetism, chemical and physical phenomena..., particularly temperature and the “thermodynamics of entropy”, all forces and fluxes that are diverse but concomitant. Dynamical drivers at systemicity are the coalescence, conjunction, co-evolution, convergence, symbiosis, percolation, phase transition and threshold output, neighborhood adaptation, etc. Universal atomic, molecular and physicochemical worlds permanently provoke feedback that drives the evolution of systemicity cycles.

The specific bonds and traits of the structure and behaviors, as well as the evolution trends of “surviving living creatures” require some knowledge about actions-reactions (drivers) with ago-antagonistic signals and stimuli from their ecosystemic and socio-systemic metabolism and environmental status. Since resulting in some sort of confrontation between the body milieu and the natural environment, the narration of a general information treatment refers to the fundamental “survival metadynamics systemicity” and “its drivers” like “symbiosis” being the processor of stimuli, signals from both the internal and external changing status of their metabolisms.

Part five of this theory only describes some drivers: coalescence, convergence and synergy, conjunction, symbiosis, percolation, phase transition, adaptivity from neighboring, threshold output, feedback and evolution effects... that permanently influence cosmic matter, objects and things, within interacting networks inside 3D worlds. Participating in processing successive mechanisms of feedback, the systemicity cycles being metadynamics are what we call “the atomic and molecular cycles from cradle to grave”.

**Keywords:** survival, metadynamics, symbiosis, feedback, entropy, metabolism, synergy, convergence, coalescence.

### A RECALL OF THE INTRODUCTION TO GENERAL SYSTEMICITY

#### A General Systemicity of Giga and Metadynamics of the Universe

##### *The Reality of “Forms” and evolution*

A survey in the different scientific disciplines concerned with the actual "Science of Systems", shows too many scientists as developing systems' knowledge in the strict philosophy of human "reason" (ref. to logic and metaphysics) and under anthropocentric and theoretical viewpoints.

Consequently, such “academic systemics” learning (Mario Bunge 1970s), not often and pragmatically related to the Universe and Life’s realities, offers moderate interests for application preferment.

The “verb” development as related to insights and spirit, in essence, if expressing the reality of survival necessities, in philosophical or other terms should also mean to be propitious with the care of sustainable and evolutionary natural surviving behaviors.

Throughout the World, Cultures express the transfiguration of humans’ insights, in their reality and imagination, their mentality expresses then a spiritual “form” or an intellectual “idea”. Greek philosophers Plato, in its Allegory of the Cave and Aristotle in Metaphysics, suggest that: “With their sole senses and insights, humans cannot access to the knowledge of reality since their sensible bodies are in constant flux and imperfection”.

Plato's theory of "Forms"<sup>4</sup> postulate they are mostly fundamental kinds of reality, but Aristotle associates Plato "Forms" to the nucleus of the individual thing, which is called *ousia* (English as *substance* and *essence*). And essence is a real and physical aspect of what philosopher says "*the inward nature, true substance, or constitution of anything, is opposed to what is accidental, phenomenal, illusory, etc*". The Universe and the World sustain from cataclysms and cycles deviations since major giga and metadynamics have a systemic retroactive survival direction for specific prolonged time.

Our modern democratic and technological world behaves towards the will to build and progress as the contrary of fatalism. However, it is sometimes yielding to counterproductive "verbs and behaviors" because social and climate changes as always, encounter the "impermanency"<sup>5</sup> of things". Nature was and is always confronted with the permanency of forces, moves and flux cycles bringing the best and the worst: cataclysms emerge from cosmic and planetary changes (plate subduction, earthquakes, meteor busts... or flourishing periods usually fragile) representing the impermanency of things and a great anthology of civilizations. If our learning on how to survive was permanently oriented with a large knowledge and apprenticeship to on how to manage changing condition effects; science and evolution of survival, then our philosophy of forms and ideas would become much more symbiotic with the reality of Life, by pragmatism and philosophy of the impermanency, a far status from straight rationalism.

Scientifics confronted with the reality of the World, particularly those concerned with biological disciplines, biochemistry, physicochemical phenomena and physiology structure and behaviors would and sometimes are making science much progressing. Reaching scales where individual and societal feelings and emotions are much better taken into consideration, inducing to a large thinking and the practice of capable behaviors, those are well supporting a paramount and pragmatic understanding and practice of "*survival rules*" and negentropy<sup>6</sup>. Such approach has a realistic horizon since driving key wellbeing attitudes towards survival necessities because thinking "the survival metadynamics systemicity of the livings as necessities since confronted with the reality of environmental changes.

### *Teaching and Learning the Science of the Livings Reality*

An adequate learning for a sustainable development of societies, respecting the required survival diversity needs, is here based on a new general theory the author called "The general theory of meta-dynamics systemicity". A new theory that relies on the transdisciplinary knowledge of the whole body of forces and dynamics that made and makes physicochemical and biological moves and objects to exist and sustain a certain time in cycles at the different dynamics levels and scale of the Universe. By essence, the dynamics levels are: atomic and cosmic, galactic, stellar, planetary, terrestrial and biological.

Though diverse in structure and mechanism, the dynamics, being all interrelated provoke intricate moves and fluxes of differential gradients and event changes. The necessary permanent retroactivity with milieus and environments is, at such a level of interdependence of things, a permanent alert in perspective to the great danger of the "domino effect"<sup>7</sup>.

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<sup>4</sup> - **Forms:** "Plato supposes that there is a class of **stable, permanent, and unchanging** objects that warrant our knowledge claims".

<sup>5</sup> - **Impermanency:** the property of not existing for indefinitely long durations.

<sup>6</sup> - **Negentropy:** a factor of organization of the physical, and possibly social and human systems, of an organization, a structure, a form, an operation, ruled with energy consumption, coming from the outside of the organism.

<sup>7</sup> - **Domino effect:** "it is a chain reaction that occurs when a small change causes a similar change nearby, which then will cause another similar change, and so on in linear sequence".

Young generations, acquiring such new learning, give them a prominent ability as to develop protecting and fulfilling decisions in adequacy with the interdependency of the rules of Nature and of their evolution.

Within the whole of the Universe environment, various molecules, particles and objects develop abilities surviving and consequent postures. Behaviors said Postures<sup>8</sup>, which are bounded to adapt with the permanency of environmental changes.

These objects (e.g. the Sun system, planet Earth, Living beings...) adapt from the constraints and the effect of sets of forces and phenomena so as to sustain their differential temporal fate. As evolving, positive feedback phenomena develop into dynamic cycles that induce to the repetition and/or the adaptive replication of forces, moves, fluxes and creatures together being subject to changes and the wearing of entropy until death. The atomic and molecular recycling mode is a gigadynamics systemicity cycle happening, because of the permanency of thermodynamics environmental changes, showing that no object or system can be the subject of straight theorization. Many former theories, even in Physics, become obsolete because some "constants" are finally found changing into "variables".

### *Living Systems Science and Human Creation of System Science and Systemicity*

The necessity of a "large clarification of systems science" is principally due to the fact open systems permanently change of status, in other words the livings adapt and reproduce for survival for a certain natural period of time. Therefore, "a general systems science", or a "theory of system science" cannot assume Life's reality as pure theoretical. The "Systemics as theories" (actually still developed in 2011) apply to so many concepts and disciplines that they are not available for application because the reality is permanently changing. A large amount of morphological and intellectual forms of systems molded to many works in all disciplines provoke confusion by using the noun or the adjective "systemic" as assuming theoretical ends.

On Earth, the undisputed contextual situations as related to permanent changes of cosmic environments and of the livings survival from feedback, with "retroaction differential ago-antagonistic gradient results" have induced us to adopt research activities centered on "transdisciplinary fundamentals" and on the new paradigm named "The Bioethism". The latter is pertaining to building up a scientific and realistic development of Life's science taking into account the systemicity of universal giga and metadynamics forces, fluxes and moves.

In order to comfort the specificity of the "Living systems Science ", and thereby explain Life's origin and the sustainability of survival principles, methods and means, this study was based on understanding the retroactivity of fundamental dynamics. It was found out that, beyond the sense given to the noun (and adjective) "systemic", generally qualifying most "systems" in about 30 different meanings others than living systems, the notion of "giga or metadynamics systemicity" was an appropriate inference, assumption and conviction.

It turned out becoming a new theory, based on forces and moves dynamics that participate in Earth and living systems to survive.

Far more suggestive and realistic, it ends observing how the Earth and Life originated and actually sustain however they are confronted with permanent universal giga and metadynamics changes. Globally and adequately dynamic, the sense of "systemicity" is *not to be understood as synonymous to the noun "systemic"* though it is yielding to the same connotation in terms of moving retroactions that participate in Cosmos and Life to exist and systemically sustain for a short, medium or long time.

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<sup>8</sup> - **Posture:** "state or condition at a given time especially with respect to a sustaining capability in particular circumstances.

*The Swaying of The neologism "systemicity" I have launched (Monterey CA, 2004), is referring to "Life's survival drivers and its metadynamics" understood and described along with "The Bioethism transdisciplinary approach paradigm" (acronym for **Biology-Ethology, ecology - Humanism**). It fosters universal specificities relative to the complexity of Life's apparition and evolution, which processing in form of open systems, developed on Earth as having physicochemical components under environmental survival conditions. Dynamic thermodynamic phenomena made emerged from physicochemical moves of matter and energy, together with solar system forces and planet cosmic constraints, the progressively sustaining conditions until chemical survival reactions replicating formed the fundamentals of the organic chemistry.*

Understood as a universal survival principle, the primordial systemic "tick tock" of interdependence, interconnectedness and interactive forces and moves induced to also understand the permanence of intermediation (between two extremes). A phenomenon, which providing ago-antagonistic moves, in terms of "in-betweens" with quantitative and qualitative position and value, is the circular swing of any object, some sort of a clock pendulum acting here and forth from birth to death (Thermodynamics). This is why the Earth and Life were several times confronted with cataclysms that put "Gaia" at the fringe of becoming a dead planet (debris impact at Moon's formation, living creatures' mass extinctions).

#### *Life's Pendulum*

The Life's pendulum of the clock is though still swaying! Throughout the interconnected living systems web within ecosystem networks, the Earth is sustaining determinant survival dynamics in form of dual transactions (predator-prey specific species balance, symbiosis... thus representing energy exchanges). Permanently confronted with physicochemical and cosmic periodical forces, move pressures and opposite changes in environments (volcanism, earthquake, tsunami and meteor collisions...) and metabolism milieus (body interior), the living systems have to permanently adapt between "hunger and satiety". A predator-prey may lead to an unavoidable strategy that ends to a species group crisis or extinction and an environmental stress or a flux fracture! The fox chasing rabbits, a dynamic equilibrium in a predator-prey natural and mathematical model of survival describing interactions between two species in an ecosystemic food chain, was developed by Lotka-Volterra (1925). The systemic game between predator-preys, or other dual game, never attains a stable equilibrium point. Instead the predator and prey populations seem to cycle endlessly without momentarily settling down unless the chain is broken. Birth, hunger, starvation, repletion and death are lying at the door of what I call the survival "in-between" moments opposing notions such as birth and death or high and low.

#### **THE "METADYNAMICS SYSTEMICITY" IS A GENERAL PHENOMENON**

On the whole, "Systemicity" is particularly explicit of the physicochemical process fields that have ago-antagonistic forces with differential outputs; particularly those promoting dynamical balance statuses i.e. those that evolve. Their direction induce retroactive phenomena to being irreversible, such as "symbiosis", "connectivity", "coevolution" and "synergetic" drivers that are sustaining the momentary survival of the phenomenon.

From sets of reactions and counteractions, which are submitted to the permanency of thermodynamic effects named entropy, the metabolism components are balancing with physicochemical survival moves systemicity.

One may observe why "gigadynamics and metadynamics systemicity" moves are general phenomena stemming from the expansion of the universe and confronted with the relative speed of thermodynamic processes (process of tempering entropy, production from heating and cooling of object environments called "annealing"<sup>9</sup>).

Among other moves, "Velocity" and "gravity" are dual forces that participate in generating cosmic objects that have a transitory survival. Why a survival? Because the above mentioned effects of ago-antagonist forces like those of gravitation and accretion<sup>10</sup> ... participate in the birth and sustainability of our planet and of its inhabitants.

Two major systems of cosmic "objects survival" are a galaxy and its components as stellar systems as submitted to the driving of thermodynamic free energy. Since free energy is "a subtraction of the entropy of a system" in terms of temperature giving out a thermodynamic status of "useful energy", the system is in other words in a survival state while "burning" its stock of energy.

### SOME GENERAL PRINCIPLES GOVERNING SYSTEMICITY

For example, the metadynamics systemicity sustains the momentary survival state of the actual Solar system, which energy depends on the Sun's life thermodynamic evolution, burning its own energy and sustaining from gravitation within our galaxy. The Sun's future will end "shrinking back" giving out a nebula, in about +5Go/years. From the nebula environment will thereafter raise new "baby stars" out of the metadynamics systemicity of the dust and gas environment of the molecule clouds.

Most changes are not being usually or mentally perceived at a human mind level. Considering micro or mega gradients and long lapse of time that are to be reckoned in thousands, millions and billions of years, they cannot physiologically and mentally be apprehended. The major example, which is a fatal perspective for Life on Earth, is in its programmed end way before our star, the Sun will have consumed its energy away as evaluated around 3 to 4 Go/years ahead.

On Earth, one small schedule exception in perceiving day and night light aspects under ever changing climates is however a false impression, given that the orbiting, revolving, contextual conditions are permanently differential.

Nonetheless, understanding the drivers of "the survival metadynamics systemicity" as the combination, coevolution and cooperation of all dynamical Cosmo-planetary, terrestrial forces and moves, particularly in their interaction-retroaction dynamics, is an opening on main formats coupling from feedbacks and synergistic differential events that makes things permanently moving about under the entropy pressure.

The universality of emergent differential clues seems to be quite close to evidence, by simply referring to the incidence of global warming systemic domino and butterfly effects within the four dimensions of space-time; and because of the weight of Cosmo-terrestrial and biological giga and metadynamics level scales.

Life arose within the limits of a particular set of flux, moves and forces in some specific local physicochemical environments where circulating molecules formed relatively short RNA

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<sup>9</sup> - **Annealing:** object (glass or metal) submitted to a process of heating and slow cooling in order to toughen and reduce brittleness,

<sup>10</sup> - **Accretion:** " a disk, or other object like a planet, of usually gaseous matter surrounding a massive celestial core in which the matter gradually spirals in toward and accretes onto the object as a result of gravitational attraction, progressively bringing up processed results capable to reproduce, assemble and form biochemical proto-elements able to cooperate and interact until the apparition of entities sufficiently autonomous to track energy and replicate.

molecules as viroid-like particles (nucleic acid without a protein coat) further becoming small virus very quickly replicating with great accuracy in a common liquid medium: water.

The convergence of Cosmo-planetary forces in the Sun system (thermodynamic pressure, energy, cosmic radiations, magnetism, gravitation...), the Earth-Moon accretion, its mass gravitation, its orbiting and new terrestrial conditions (geologic, geochemical, geophysical, geo-climatic...) were retroactively sustaining the Earth within a “habitable zone” propitious with Life to develop.

### **A General Survival Systemicity of Life under Cosmic and Early Earth Conditions**

A zone where living systems emerged from their survival biological metadynamics means (replication, biotope equilibrium, local ecosystems biodiversity, food chains, sustainable behaviors, reproduction ...) enabled with driving processes (symbiosis, synergetic...) that have a "re-seeding" ability.

The mass replication of molecules, then of organisms is a matter of energy, space, and building blocks (sulfur, phosphorous, oxygen, nitrogen, carbon, and hydrogen). The majority of life's structures and functional elements come from four macromolecule building blocks: carbohydrates, lipids, proteins, and nucleic acids. Soon becoming limited, they induced proto-organisms to compete, bringing on the processing of natural selection favoring efficient molecules at replication and survival benefits.

The sets of survival meta/intra/median dynamics systemicity sustain the livings within biological, physiological and psychological intrication at different body scales and sublevels. Consubstantial (atomicity and molecularity) and interrelated with the cosmic<sup>11</sup>, galactic, stellar, planetary and terrestrial meta-dynamics sets, they are driving the general principle of Life and of its survival metadynamics systemicity as participating in the whole of Earth called “Gaia” as a living system, and in its living organisms as to adapt and evolve, but temporally surviving.

An overview upon the entire body of universal interdependent physicochemical mechanisms, moves, processes and streams of atomic and molecular particles (molecular velocity, massive clouds, accretion disk, stellar system, gravitation ...) shows that all of these driving processes are interwoven in systemic "3D networks". The “survival abilities and performances” of cosmic objects and living creatures is epigenetically provided with the resulting effects of the metadynamics systemicity of particles and molecular worlds of diversity.

### **An Object or Thing with a “Filtering Skin” as a General Survival Function**

A “filtering skin” is an interface of exchange that may be considered as the general protection of integrity of an element or object for its survival to be sustained for following reasons:

- To build up a frontier in between milieus or a medium that may be called an interface,
- To have a specific mean as to absorb energy (heat, light...) or food or other elements participating in developments for survival,
- To protect against harmful aggressions coming in from the environment,
- To cause oozing or spread out in specific directions (to exude) particles, elements, molecules propitious with the object’s metabolism sustainability and excess of energy and wastes,
- To be an intermediary mean of communication and of integrity protection.

An object or element has its survival sustainability for a certain period of time while it is confronted with thermodynamics.

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<sup>11</sup> - **Cosmic**: the essence of the general relativity is in the space-time that has a general dynamic cause and its effect properties.

Survival forcefully depends on capacities to get protected and adapted to both the endogenous-exogenous events and changes of milieu. They both support functions of filtering and protection outfit. At the molecular level, the interstellar medium consists of dust grains and gas. Dust grains have an icy surface protecting chemical bonds molecules from stellar radiation providing a surface on which a diversity of atoms and molecules congregate and interact in-and-out. At planetary level, the earth crust and atmosphere have “filtering functions”, the Van Allen belt (electromagnetism) and the magma playing an immense role in the survival giga and metadynamics systemicity of terrestrial moves to sustain “Gaia” with filtering functions (volcanism, weathering..). At individual unicellular organism levels, a membrane is both the interface of the nucleus and the cell in its water milieu. A virus has only an outside membrane.

At multicellular organism levels, like mammals, the interface is both the placenta of the developing embryo and of its newborn skin. The egg of egg-laying creatures is some sort of an exterior “placenta” with an inner and outer membrane as processing its own development (air, albumen and yolk) inside its shell forms the best protection, filtering heat and vibrations under the animal. However practically all animals have protecting “skins”: shell, carapace, armature, every of them with similar functions.

At many cultural, functional and survival levels, any creature, humans included, have “protecting and filtering skins” capable to participate in expressing a behavior, a fright, a feeling, an insight and an emotion: a cry, onomatopoeia, a sound, a gesture, or the “verb”.

### **The "Cycle Principle": Retroactive Results within an Ecosystem Cycle**

The process of sending status information back for comparison with previous status information called feedback, and the whole processing of inputs, outputs, errors or differences in signals, is called a closed loop; however differences in the status qualification induce the loop to get open the next step. Then, becoming an open system, variations of status qualifications in gains or losses oscillate around a critical point depending upon the type of system and its sensibility to entropy.

The environmental conditions on Earth, at time Life gradually came out of the limbo, were strongly radioactive under an atmosphere with very little oxygen and no ozone exposing protobionts<sup>12</sup> with much UV radiations. The pressure of Earth mass and accumulated energy of its radioactive components heated its interior to the point gases and vapor expelled from it, participated in the formation of air and oceans.

Among these gases was enough hydrogen for life's elements - organic components – to form and survive: hydrogen presence in the universe is essential to life's components (carbon, nitrogen, oxygen, phosphorus, iron, zinc and calcium. Hydrogen is also the fuel of Sun that provides, together with water, the flux of energy essential to the physiology of organisms.

Stirling A. Colgate et al. (2003) also states that the redox potential difference between hydrocarbons and oxygen is the energy source that drives autocatalytic reactions.

Hydrocarbons are formed in the cooling molecular clouds and “fixed” on the catalysts of some bonded silicate dust grains ending into carbonaceous chondrites falling on Earth.

Then also, a mathematical model finds its application as to describe the interaction phenomena between metabolic chains and homeostatic mechanisms in general.

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<sup>12</sup> - **Protobionts** are systems that are considered to have possibly been the precursors to prokaryotic cells. If RNA is trapped inside, the system can use the RNA or select for it.



Chemical interactions, physics of particles, astrophysics and cosmology, matter behavior, vacuum, time ("its arrow") studied by Y. Prigogine (1977) led him to develop the notion of "dissipative structures"<sup>13</sup> that he describes as open systems operating far from a thermodynamic balance in an environment of matter, energy exchange and entropic pressure as well as adapting to "surviving conditions" within the momentary limits of a dynamic equilibrium.

### BIOPHYSICS AND SYSTEMICITY

#### Universal Systemicity Cycles: a Matter of Physics and chemistry

The notion of survival is, in its definition: "the struggle to remain living", or in other terms "to replicate and sustain the livings". Milieus and environmental conditions influence the speed of a chemical reaction and yield information about their physicochemical mechanism and transition states. The link between physics with chemistry is that:

- **Physics** is involved with the fundamental principles of physical phenomena and the basic forces of nature, within space and time conditions. Physics also deals with the basic principles that explain matter and energy, and may study aspects of atomic matter.
- **Chemistry** focuses on how substances interact with each other and with energy (for example heat and light). The change of matter from chemical reactions and synthesis give rise to organic functional groups and to their rate role.

Inorganic and organic interactions produce physicochemical transformations that show the conversion of a substrate (substance upon which an enzyme acts) to a product that can be an inorganic or biological product. Products are the by-product of chemical reaction according to the second law of thermodynamics showing that natural processes have a preferred direction of progress.

For example, heat always flows spontaneously from regions of higher temperature to regions of lower temperature, and never the reverse, unless thermodynamic works are performed on the system as for example "entropy" or kinetic energy.

The released energy comes from atom chemical bonds changing in reagent molecules (conversion of one substance into another by chemical reaction which may be given off in the form of heat or light). Products are formed from chemical reaction progressing toward a physicochemical dynamic equilibrium.

At a certain reaction rate, they depend on the reagents and environmental conditions. In terms of thermodynamics, entropy is the amount of unavailable energy in the system to sustain, let's say a living system confronted with its natural loss of vitality.

Biophysics is an interdisciplinary science that uses the methods of, and theories from physics to study biological systems that spans all levels of biological organization, from the molecular scale to whole body of organisms and ecosystems. Behind the scene, physical and biochemical matter, forces, fluxes and moves with their giga-thermodynamics systemicity are supporting Life to retroactively sustain.

#### Biological structures and the survival metadynamics systemicity

Usually, a higher-level structure is composed of multiple copies of a lower-level structure.

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<sup>13</sup> - **Dissipative structure:** is a dissipative system that has a dynamical régime that is in some sense in a reproducible steady state. This reproducible steady state may be reached by natural evolution of the system.

### *Role of macromolecules*

Already elementary organisms transform matter and energy into different form of functional structures, showing response to changes in their environment (adaptivity and evolution) showing satisfaction with survival needs, growth and reproduction. All living organisms undergo changes due to large organic compounds called macromolecules. Four main types of macromolecules control all biological activities: proteins, carbohydrates, nucleic acids and lipids. The survival metadynamics systemicity moves underlay the processes of such transformations.

A macromolecule is a very large molecule made up of smaller units called monomers. Macromolecules are formed by dehydration reactions in which water molecules are removed from the formation of bonds. The diversity of macromolecules comes from a few monomers that can recombine to create a lot of different combinations. Within carbohydrate species, polysaccharides play important roles in cells such as energy storage (animal glycogen) and structure support (plant cellulose).

### *Role of molecular biophysics*

Molecular biophysics is close to molecular biology, but more quantitatively. This field is concerned with understanding the interactions between the various systems of a cell, including the interactions between RNA/DNA and protein biosynthesis, as well as how these interactions are regulated. Molecular biology has one dynamic which we call the “survival gigadynamics systemicity” as sustaining the primordial building bricks of Life.

Molecular biology deals with the molecular basis of biological activity, overlapping with genetics and biochemistry. Chiefly concerned with the molecule interactions between the various systems of a cell, (different types of DNA/RNA and protein biosynthesis) it is as well how these interactions are regulated.

Here again the survival metadynamics systemicity moves underlay biological activities, showing the complexity of the physiological and neural processes necessary for life to sustain.

William Astbury (1961) postulated that any material component of the gene must have two key properties: it must be thermodynamically stable and exhibit a high degree of structural variation. Of all the different types of biological molecule, one candidate fitted both these criteria - proteins.

Astbury then believed that the complex three-dimensional forms of biological molecule structure, as protein, were able to carry genetic information, participating into genesis and physiological function<sup>14</sup>. A positive retroactive cycle sustained by the systemicity of metadynamics molecular interactions.

### **Protein Biosynthesis, Survival Systemicity**

The protein biosynthesis is the process by which biological cells generate new proteins; it is dynamically balanced by a loss of cellular proteins via degradation or export. *Translation*, the assembly of proteins by ribosome, is an essential part of the biosynthetic pathway, along with the generation of messenger RNA (mRNA), aminoacylation of transfer RNA (tRNA), co-translational transport, and post-translational modification<sup>15</sup>. Protein biosynthesis is strictly regulated at multiple steps, and error-checking mechanisms are in place.

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<sup>14</sup> - **Physiological function:** Processes carried out by organs, tissues, and cells to maintain health. Major physiological functions include respiration, coordination, excretion, circulation, and reproduction.

<sup>15</sup> - **Post-translational modification (PTM)** is the chemical modification of a protein after its translation. It is one of the later steps in protein biosynthesis, and thus gene expression, for many proteins.

Messenger RNA (mRNA) is a large family of RNA molecules that convey genetic information from DNA to the ribosome<sup>16</sup>, where they specify the amino acid sequence of the protein products of gene expression. Following transcription of mRNA by RNA polymerase, the mRNA is translated into a polymer of amino acids: a protein. An amino acid, which key elements are: carbon, hydrogen, oxygen, and nitrogen. In transcription, an mRNA chain is generated with one strand of the DNA double helix in the genome as a template.

This strand is called the template strand where transcription can be divided into 3 stages: initiation, elongation, and termination, each regulated by a large number of proteins such as transcription factors and co-activators that ensure that the correct gene is transcribed. Protein biosynthesis is a meta-subdynamics driver, which systemicity generates protein directions, particularly through transcription and translation along with species of RNA molecules.

### GENERAL DRIVERS PARTICIPATING WITH SYSTEMICITY CYCLES

#### Feedback and Systemicity

A "feedback" is the process that enables "loop control" moves participating in the management of systems' regulations processes. In a closed-loop system, a feedback dynamic device has the property permitting to an output (or some other controlled variable of the system) to be compared with an input to the system (or an input to some other internal component or subsystem of the system) so that the appropriate control may activate some output or input function propitious with the metabolism dynamic balance.

In short, feedback is a loop system in which it responds to perturbation either in the same direction (positive feedback) or in the opposite direction (negative feedback). There are many biologic processes that use negative feedback to maintain homeostasis or dynamic equilibrium or homeostasis, which is the maintenance of a stable internal state within an organism also known as "steady state".

Organisms must respond and maintain homeostasis in relation to many endogenous, exogenous factors and moves. Organisms detect changes in their environment and respond to these changes in a variety of ways occurring at the cellular or organism level.

Most cycles of the Cosmo-planetary and terrestrial dynamical materials and energies are retroactively sustained and then evolve from positive feedback, at least within the influence of galaxies gravity on the very long term of their "immense spatial survival moves". More generally, feedback is said to happen in a system when a closed sequence of cause-and-effect relationships exists between the system's survival variables. In parallel, an "open-loop function control" produces a distinctive control action since it is independent of the output (J. Distefano, 1967).

The "Sun" and its planets is a star system, having an evaluated survival length of another 5 billion years time, which "death" will be ending into a supernova blow out, from which matter, chemicals and energy will seed again the interstellar space and neighboring stellar-systems in a cascade of retroactive moves. In reality, there are a large number of feedback mechanisms that involve processes and interactions within and between: the atmosphere - the cryosphere<sup>17</sup> - the biosphere - the solid earth - Living organisms and their ecosystems.

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<sup>16</sup> - **Ribosome:** cell organelle responsible for manufacturing proteins

<sup>17</sup> - **Cryosphere:** The cryosphere is an integral part of the global climate system with important linkages and feedbacks generated through its influence on surface energy and moisture fluxes, clouds, precipitation, hydrology, atmospheric and oceanic circulation. Through these feedback processes, the cryosphere plays a significant role in global climate and in climate model response to global change.

The whole network is indeed forming a very complex set of metadynamics which systemicity depends on the direction of feedback results and the nature of its drivers (e.g. symbiosis). Subsequently, the survival seeding of a cosmic object if is historically and retroactively sustained, is yet confronted with the thermodynamic entropy that ends with a thermonuclear bust of particles and matter feeding the apparition of new star-systems (ref. to supernovae life). On Earth, organisms are all confronted with entropy and degradation (thermodynamic breaking down) that feed back new elements for survival such as energy, food chains and reproduction chains. The most important feature a feedback imparts to a living system's integrity and behaviors is in its comparison function that continuously detects differences existing between inputs and outputs effects (in ref. metabolism).

Emerging endogenous and exogenous stimuli provide appropriate signals or information necessary to cope with input-output variations. In other terms, a “negative feedback mechanism” is a controlling mechanism, one that tends to counteract some kind of initial imbalance or perturbation.

In contrast, a “positive feedback mechanism” ( a positive evolution) is one that exacerbates some initial change from a steady state, leading to a runaway condition, acts promoting the enhancement of the initial conditions. In other terms, positive feedback is a process in which the effect of a small disturbance on a system includes an increase in magnitude of the perturbation.

*One may name such retroactive move as the capacity of collective drivers"(or meta-drivers) to keep up sustaining the survival meta-dynamics systemicity of Cosmo-planetary and terrestrial objects balanced with environmental events. A biological move, when, for example, a hand is to reach an object together reacting with endogenous and exogenous events, requires some specific chemical reactive pathways as interpreting and deciding what and when to reach it. Positioning something or behaving for security as getting a resource within reach are systemic acts.*

At different levels of action, variable signals are piloting out the sensitivity of chemical substances, filtering with cell's receptor and organ functions (e.g., light chemical vision as conversion of information, like that of eyes) and from their reactivity to "biops"<sup>18</sup> drives (e.g. unicellular organism' have a "brain"<sup>19</sup>, a chemical percolating memory with enough capacities for an efficient survival control, or bar receptors regulating blood pressure by inhibition drives...).

A “feedback inhibition” in a cell means that a cellular control mechanism in which an enzyme catalyzes the production of a particular substance is inhibited when that substance has accumulated to a certain volume level, thereby balancing the amount provided with the amount needed.

Biological processes might not have an accurate ability to reproduce faithfully an input, then the reducing effect of non-linearity and distortion usually drives to some oscillation or instability. This is why the circularity of moves is primordial to the maintenance of survival dynamics. Life's infinite complexity within its chemical exchange pathways generates feedback drives (or biological interactive emergent "biops") of which results affect the object survival steadiness direction (dynamical balance) while confronted to entropy.

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<sup>18</sup> - "**Biops**": the acronym for a bio-physicochemical event.

<sup>19</sup> - **Unicell brain**: biochemical processing information close to more elaborate neural function as the one neuron Aplysia.

### **Primordial and Fractional Process Interactions**

In particle physics, fundamental interactions concern elementary particles interacting with one another. These forces are said as non-contact forces but interactive: gravitation (mass gravity, tides...) electromagnetism (magnetism, electricity, light, chemical and biological reactions), strong interaction (atom nucleus coherence) and weak interaction (beta radioactivity), are often mentioned in terms of cosmic or biological objects which retroactive systemicity specifically resulting from physical, chemical and biological processing actions and statuses.

The "Science of the Living" has made "immense progresses" at understanding its mechanisms, particularly since the entire genome of humans and of quite many organisms has been chemically deciphered. From such base and from digitized data, one may reproduce and describe some of the Darwin natural selection and evolution mechanisms. The "paleo-molecular biology" is a method applicable to genes sequencing, which is the DNA synthesis applied to digitizing some of its models.

By sequencing models of gene fragments and test their capabilities to behave, it was obtained simulations of the reproduction of proteins that went silent for billions and/or hundred millions of years. However these tests cannot be but fractional since it will never be possible to biologically restructure the whole RNA/DNA of past species since the building up of genes should individually take into account the impact of environmental conditions of the moment.

In other words, to reproduce the contextual "dynamical systemicity" of the surroundings they happened to emerge from, live in, reproduce and adaptively evolve can only be presented in terms of a theoretical model viewpoint.

### **The Problematic of Opposing Contraries and Threshold Effect**

#### *Critical points*

In physical chemistry, thermodynamics, chemistry and condensed matter physics, a critical point, also known as a critical state, occurs under conditions (such as specific values of temperature, pressure or composition) at which no phase boundaries exist. There are multiple types of critical points, including vapor–liquid critical points and liquid–liquid critical points.

In any system containing liquid and gaseous phases (also the phase metaphor of social moves), there exists a special combination of pressure and temperature, known as the critical point, at which the transition between liquid and gas becomes a second-order transition. Near the critical point, the fluid is sufficiently hot and compressed that a distinction between liquid and gaseous phases is almost non-existent. Associated with the phenomenon of critical opalescence, a milky appearance of the liquid is due to density fluctuations at all possible wavelengths (including those of visible light).

Radical change of state within a system, whether being a physiological system like the human body or an abstract (conceptual) systems such as an economy, often suddenly manifests when a critical limit or threshold is crossed over leading to a new status in the system. The result of effects upon milieus and environments (natural, individual or societal) are usually not exactly at an opposite position but at an "in-between" and provisional stance.

#### *Duality*

Thus, mostly being ago-antagonistic, the "in-between behaviors" meet my feelings and assumptions about "Systemicity" and the reality of retroactivity. The fuzziness of reality in "what effectively happens" is usually any of a continuum of values in between the opposites until entropy takes over. This is particularly so when related to the role of time in the history

of unconscious and conscious natural and cultural differentiated retroactions dedicated to organisms behavioral actions of individuals and societies:

*"The everlasting rustle sound of the planet, the "Gaia's"<sup>20</sup> clock" tocks, echoes with Creatures' behaviors for survival, and together with the permanent change of things, build up their generation fate while confronted with environmental evolution (J.-J Blanc, 2004).*

In this work part, among many Cosmo-planetary and terrestrial dynamics involved in the systemicity of phenomena, we will describe the essential of natural flows and cycling moves resulting from the "universal retroactivity" and the major "meta-drivers" between opposed forces, dynamics and differential emergences.

Each dynamic has an imprinting mechanism from interactions, at all physicochemical and, or biological character level that produces quantitative and qualitative effects on matter and energy destination. However, as being interrelated with the complex characteristics of other dynamics, the effective emerging result, at instant-t, which is usually the result of combined ago-antagonism moves, induces the environmental ambient metabolism to be permanently modified: each "ecosystem's neighborhood" status evolve by some sort of a "vectorial synergy or momentum".

### **Percolation, Interactivity, Amplification of Disturbance**

#### *Percolation theory*

Another phenomenon which shows phase transitions and critical exponents is percolation. The simplest example is perhaps percolation in a two dimensional square lattice (e.g. a fishing net). Sites are randomly occupied with probability  $p$ . For small values of  $p$  the occupied sites form only small clusters. At a certain threshold  $p_c$  a giant cluster is formed and we have a second order phase transition. The behavior of  $P_\infty$  near  $p_c$  is,  $P_\infty \sim (p-p_c)^\beta$ , where  $\beta$  is a critical exponent. Percolation is one of the metadynamics systemicity drivers in biological networks such as the protein interaction network and metabolic networks.

Life has happened through the "dynamic molecules percolation", that of physicochemical reactions processing communication in an extended environment where quite a number of "sites" (also bifurcation or crossroads) are likely to locally relay information and stimuli (physical, biological or of a fluid property (J. M. Hamersley, 1957). They communicate passing information by way of links or emission whose effectiveness is most of the time random. According to whether the proportion of active connections is, or not, higher than that of a threshold value, the information to long distance may be transmitted when over passing a critical point.

### **Illustration of a Natural Alarm Phenomenon**

"The thorny acacia tree is not the usual food of the Kudu antelope, but it began at eating its leaves. Scientists learned then the acacia tree for self-defense begins to produce chemical called tannin with other chemicals to give the leaves a bad taste. But worse for the antelope, the tannin impairs their ability to digest food, and eventually starve to death though there are plenty of trees. Scientists found that while not normally found in high concentrations in acacia leaves, the tannin level in the leaves nearly double within 15 minutes of leaf damage (critical point). They also found that the trees communicate, warning other trees about browsing animals in the area. When a leaf is chewed, it releases a scent that causes neighboring acacia trees to begin to produce tannin! In other terms, this biological percolation of a chemical "alarm" is some sort of a driver of the metadynamics systemicity for survival.

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<sup>20</sup> - **Gaia hypothesis:** the biosphere is a self-regulating entity (Lovelock, 1960s)

These phenomena explain clearly the genetic impact provoked by predator (in the predator-prey game): e.g. the capacity of opposed species as preys to genetically and physiologically adapt to the capabilities of predators. Since percolation relies on the critical point phenomenon, which is constitutive of a phase transition<sup>21</sup>, one observes that below the threshold, information remains confined in the spot where it originated; beyond the threshold, "percolated" information (ref.: genetics evolution, ecosystems transformation...) is then found far from its starting point by passing over critical points as it happens with *domino or/and butterfly cascading effects initiated from starting conditions*. The particular situation of transitions from phase is one out of the many physical, chemical and biological move phenomena occurring to number of cosmic, planetary and biological mechanisms as driving their survival metadynamics systemicity.

### **Social life organizations**

The appearance of highly sensitive behavioral conditions issued from phase transition is also observed in social life organizations. Disturbances permanently modify living creatures' behaviors and their metabolism while interacting with environmental events and stimuli. Alike the butterfly effect, a small fact can induce important and perverse cascading effects in proprieties, attitudes and physiological statuses in consequence of its amplitude. Societies of creatures are meta-organizations functioning at the verge of a lethal equilibrium that is a compromise between contradictory constraints not predictable and controllable, though maintaining a temporal survival. However, a social situation might be severely sensed, depending on the weight resented at people expectations according to feedback results.

A synergistic move in an ecosystem space, at short and/or long term, might produce a temporary disturbance effect, which confronted with some permanent change, becomes a possible evolutionary factor affecting the metadynamics systemicity output of a Cosmo-planetary and terrestrial events such as solar vents, tides..., predators fear... social moves...ending at damaging species integrity or their extinction.

### **Changes of Status and Phase Transition: a systemicity survival driver**

Accordingly, a phase transition is the transformation of a thermodynamic system from one phase or state of matter to another. Phases of a thermodynamic system and the states of matter have uniform physical properties. During a phase transition of a given medium certain properties of the medium change, often discontinuously, as a result of some external conditions, such as temperature, pressure, and others. For example, a liquid may become gas upon heating to the boiling point, resulting in an abrupt change in volume

Transition can be that small events in a society like a social move, a manifestation, or a blocked crowd that might end in a clash. The measurement of external conditions at which the transformation would occur is termed the phase transition one. Phase transitions are common occurrences observed in nature and in many engineering techniques exploiting certain types of phase transition. The term is most commonly used to describe transitions between solid, liquid and gaseous states of matter, and, as we aforementioned, in biological and societal circumstances.

Matter and energy exists in various forms, or phases. If the temperature and, or pressure of matter or energy is adjusted, the systemic phenomenon may undergo a phase transition and

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<sup>21</sup> - **Phase transition:** the transformation of a thermodynamic system from one phase or state of matter to another.

change over passing a threshold. Pierre Papon, (2002) describes the change of status together with the dynamic of phase changes as confusing the boundaries with metastability. He wrote about different classes of phase transitions such as: vaporization, (the passage of the liquid to gas), fusion (the passage of the liquid or solid and its reverse that is solidification), the transition between the ferromagnetic status (the material with a permanent magnetization) and the paramagnetic status (without permanent magnetization), the transition supra conducting (the material becomes a perfect electric conductor, etc). These phenomena between opposite statuses usually pass by an intermediary qualification known as the phase transition move that over pass a threshold.

During the phase transition move, matter shifts between its three statuses: solid, liquid, and gas from which the distinction of two phases is "almost non-existent" and fuzzy. "*The statuses of matter are like the countries of a complex geography, separated by borders*" said Pierre Papon, the passage from one status to another as named transition phase corresponds to the crossing of a border".

Transition is usually fuzzy (indistinct or vague); in certain conditions, the substance can pass by a status known as *metastable* before changing course towards a stable status (reference to thermodynamics: the entropic move).

The process of transition from one state to another is not instantaneous and might be "undecided" with particular properties, halfway between liquid and solid, such as the Earth's transformation status from cratons cooling down at the Early Archaean (before 2.5 Ga/y), or grounds freezing in a permafrost status. Metastability scrambles the thermodynamic borders separating the solid, liquid and gas status. Beyond of a certain range of thermodynamic parameters, the phase considered becomes unstable and necessarily passes in another status through a transitory status.

The complex history of the Earth has proven successive statuses in its "evolutionary planet body"; a history that illustrates the results of slow sequences of fuzzy changes of phase within ago-antagonistic dynamics that Cosmo-planetary metadynamics systemicity engenders. These phenomena, perpetuating themselves throughout the Earth's life and Life's actual context, show that Earth's evolutionary living conditions and survival sustainability are "governed" with systemicity. The Cosmo-planetary and terrestrial set of dynamical forces retroactively sustain moves far from equilibrium unless a major thermonuclear catastrophe should wipe both out. A change of status, as observed at the passage from one status to another, is also called the "threshold effect".

Nature is permanently confronted with critical point examples, such as natural selection in terms of a population having adaptive responses (migration, inhibited developments, extinction, etc). They show the threshold effect is typically sensitive to certain characteristics of individual and group behaviors while confronted to environmental changes within specific contextual conditions. Phase transition critical point is an important contextual phenomenon that participate in a major primordial manner to form, for example in the past: part of atmosphere and oceans, volcanic and gaseous milieu at the origin of cells apparition (ref. Archaea cells, Cyanobacteria or blue algae) emerging from the systemicity of meta, intra and subdynamics.

The theory, from after a large analyze of actual scientific and transdisciplinary information and works, describes general aspects of "giga and metadynamics systemicity" cycles in terms of physics, chemistry and biology principles, statuses and facts.



Given that it illustrates postulations and realities of Cosmo-planetary, terrestrial and biological forces, processes, fluxes and moves, their interdependence and symbiosis.

### **SURVIVAL DRIVERS PARTICIPATING WITH SYSTEMICITY CYCLES**

Forces and moves that particularly participate in driving the systemicity of universal gigadynamics and metadynamics cycles are: percolation, phase transition and threshold output, symbiosis, synergy, coalescence, convergence and conjunction, adaptivity from neighboring, feedback and evolution effects.... The resulting output values of recycling forces and moves permanently driving cosmic molecules, objects and matter are interconnected processors in form of 3D graphs or lattices as well as numerous neighbors' nets spreading around space-time<sup>22</sup>.

#### **Coevolution**

Coevolution takes the form of different aspects of dualism, often ago-antagonistic, between living species that have reciprocal influence as interacting. For example, the keystones of survival are in:

Predator-prey dynamics, host-parasite, symbiosis between two species, or associations of several species as being systemic phenomena much significative of "survival principles" that is mostly common to living species.

The biology of evolution<sup>23</sup> shows these dual forms and the importance of coevolution in the history of species and sexual conflicts. Some biologists, such as Thierry Lodé and Richard D. Alexander, 1990, describe the effects of these antagonistic interactions, particularly at the sexual level, and the evolutions of characters as leading to an antagonistic coevolution of entities.

#### **Synergy and Emergent Results in Between Ago-Antagonistic Things and Moves**

Synergistic moves, (as below defined) are links in processing chain development of phenomena. In reference to some specific works on "Synergy"<sup>24</sup>, published by H. Hackermann (1994), or P. Corning (2003), one may observe that the notion of pattern is intimately describing linked phenomena within a "system of synergistic", a model as, for example, chemical macroscopic reactions in form of outgoing concentric waves, spiral waves, chemical oscillations...

Consequently, the notion of physical dynamics is said describing a phenomenon of synergy: e.g. "a water vortex" is the effect produced by the combined actions of several different forces<sup>25</sup> like gravity, water pressure, air pressure, rotational forces as centrifugal (or centripetal) forces, even from the initial status of a considered object or move.

Synergetic moves are "the drivers of cooperative relationships" of all kinds and at all levels and scales of living systems. The thesis, in a nutshell, is that synergistic effects have often provided functional advantages (structuring size and skin, adaptive abilities, economic benefits) in relation to survival and reproduction that have been favored by natural selection.

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<sup>22</sup> - **Space-time**: time cannot be separated from the three dimensions of space, because the observed rate at which time passes for an object depends on the object's velocity relative to the observer and also on the strength of gravitational fields, which can slow the passage of time.

<sup>23</sup> - **Biological evolution** is defined as any genetic change in a population that is inherited over several generations.

<sup>24</sup> - **Synergy**: "combined action of two or more agents which produces a result stronger than their individual efforts".

<sup>25</sup> - **Vortex**: a vortex is the means by which states of motion are transferred from one condition to another. Twin opposing electrical vortices are therefore the means by which the infinite variety of motions and their resulting physical forms manifest themselves in our Universe.

Examples are numerous, but here it is important to stress the fact "synergy" illustrates sets of linked phenomena, indeed combined and cooperative, given that they induce one emergent and often beneficial result.

The orientation of a synergetic move, at instant-t results, is at next instant t+1 usually combined with other chains of phenomena, forces and moves; and at term, having combined synergistic effects; it becomes differentiated from the character of retroactive effects.

Adding dynamical feedback moves, the survival systemicity of cycles produces successive changes in the environmental status. Symbiosis and Synergetics are then one of the survival metadynamics systemicity "arms" participating in driving the diversity of natural output results.

### SYMBIOSIS, A METADYNAMICS SYSTEMICITY DRIVER

#### Symbiosis alliances, cooperation and competition

Symbiosis (Greek: "together" and "living") is "a close and often long term set of driving interactions between two or more different objects", things or inorganic, organic molecules and biological species. A. Bennett (1877) a botanist used the word symbiosis in 1879 and German mycologist Heinrich Anton de Bary defined it as "the living together of unlike organisms".

Actually it is assumed that it applies to any types of species and things moving within the physicochemical and biological interactions networks: e.g. mutualism, commensalism, or parasitism in biological symbiosis in one or several ecosystems.

Therefore, the frame of the metadynamics systemicity theory induces to postulate "symbiosis" as one of "survival systemicity universal drivers" that participate in some metadynamics to sustain specific cycles both in the universe (interactions) and, on Earth, among terrestrial natural phenomena and living creatures interactions within their environment.

All along this chapter, survival manifestations mentioning alliances, cooperation, mutualism<sup>26</sup> and competition between individuals or groups of same or different species are:

- **Symbiosis** itself could either be beneficial to one or two organism's species that join for survival at conditions that both organisms be mutualists reciprocally beneficial. In general, only lifelong interactions involving close physical and biochemical contact can properly be considered symbiotic. Symbiosis is a broad category, defined to include relationships that are mutualistic, parasitic, or commensally<sup>27</sup>. For example, as some insects flee from army of ants, birds following their trail catch the fleeing insects, or that of the "foraging time, energy and optimal food-searching" in animal and human social interaction.

Many biologists restrict the definition of symbiosis to much close mutualism relationships. In natural symbiotic mutualism: the clownfish feeds on small invertebrates that otherwise have potential to harm the sea anemone, and the fecal matter from the clownfish provides nutrients to the sea anemone.

The clownfish is additionally protected from predators by the anemone's stinging cells, to which the clownfish is immune. These behavioral drives sustain the survival metadynamics systemicity of these two species as being beneficial and satisfying their reciprocal needs.

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<sup>26</sup> - **Mutualism:** is the way two organisms of different species exist in a relationship in which each individual benefits.

<sup>27</sup> - **Commensalism:** a class of relationship between two organisms where one organism benefits without affecting the other. It compares with mutualism, in which both organisms benefit, amensalism, where one is harmed while the other is unaffected, and parasitism, where one benefits while the other is harmed.

- **Mutualism** is any relationship between individuals of different species where both individuals obtain some benefit in a common action. Mutualistic relationships may be either obligate for both species, obligate for one but facultative for the other, or facultative for both.

Similar interactions within a species are known as cooperation. Mutualism can be contrasted with interspecific competition, in which each species experiences reduced fitness, and exploitation, or parasitism, in which one species benefits at the expense of the other. Mutualism is only one type of symbiosis, as acting together.

A well-known example of is the relationship between ungulates (such as Bovines) and bacteria within their intestines. The ungulates benefit from the cellulose produced by the bacteria, which facilitates digestion; the bacteria benefit from having a stable supply of nutrients in the host environment. Mutualism is a metadynamics systemicity driver.

- **Cooperation** is an act or instance of working or acting together for a common purpose or benefit; it is a “joint action”. Socially, the cooperation activity is also shared for mutual benefit. In other words, cooperation is, for example, when human people or other species help each other’s out to achieve a common goal. The interactions between organisms largely become beneficial by all participating partners (immediate behavioral result, learning...

- **Alliance** is quite an interesting ecosystemic case observed in bromeliads<sup>28</sup> life: “many of them have stiff, overlapping leaves in form of buckets that hold rainfall. Leaves and debris fall into these reservoirs and help algae and other single-celled organisms to grow, which in turn feed mosquitoes, insect larvae and other organisms (Diane Jukofsky, 2002).

The bromeliad is like a small ecosystem in itself - animals such as tree frogs, snails, flatworms, tiny crabs and salamanders might spend their entire lives inside them. Their long, curved leaves overlap at the base, forming a tight little bowl - a perfect water tank! The leaves act as gutters to collect rain, and the tank holds the water. Many animals drink from the bromeliad water tanks and many others actually live in the water held by bromeliads. Even tiny frogs walk up depositing their offspring in the water, and bring them food which waste benefit to the plant. A survival necessity.

At least 250 different animal species live in the tanks of bromeliads, including frogs and tadpoles, insects and insect larvae, spiders, and worms. They are bringing nutrients to the plant in their droppings and when they die. The spiky leaves of bromeliads trap forest litter, too, and can absorb nutrients through special leaf pores, which other plants don't have.

- **Competition** is what effects organisms in a community have as challenging one another. In the natural world no organism exists in absolute isolation, and thus every one of them must interact with the environment and other organisms. An organism's interactions with its environment are fundamental to survival and the ecosystem functioning it is on the whole living in. For example, there is competition named “amensalism”<sup>29</sup> between walnut trees that harms neighboring plants from secreting a chemical from its roots. The mutualism interaction between the Red-billed Oxpecker and the giraffe

In ecology, biological interactions can involve individuals of the same species (intraspecific interactions) or individuals of different species (interspecific interactions). These can be further classified by either the mechanism of the interaction or the strength, duration and direction of their effects.

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<sup>28</sup> - **Bromeliads:** bromeliads are epiphyte, a plant that grows upon another plant (such as a tree) able to store water in their tightly-overlapping leaf bases structure

<sup>29</sup> - **Amensalism:** is a relationship in which a product of one organism has a negative effect on another organism. It is specifically a population interaction in which one organism is harmed, while the other is neither affected nor benefited. Usually this occurs when one organism exudes a chemical compound as part of its normal metabolism that is detrimental to another organism.

Species may interact once in a generation (e.g. pollination) or live completely within another (e.g. endosymbiosis). Effects range from consumption of another individual (predation, herbivory, or cannibalism), to mutual benefit (mutualism). Interactions need not be direct; individuals may affect each other indirectly through intermediaries such as shared resources or common enemies. Several factors (e.g. food disponibility) play into these fluctuating populations and help stabilize predator-prey dynamics.

A plant defense is a trait that increases plant fitness when faced with herbivory. It is measured relatively to another plant that lacks the defensive trait and a plant defense tool increases survival and/or reproduction (fitness) as plants under the predation pressure from herbivores.

Interspecific competition between species, defined as reciprocal negative effects of one species on another (either directly or indirectly mediated by changes in resource availability), has long been thought to be one of the more important processes determining the structure of natural communities (Morin 1999). The biological circumstances under which competition between species has influence on the characteristics of species, their population densities and overall community structure, are however sometimes not described. (Chesson & Huntley 1997) Predation is one of the factors believed to have a major impact on competitive interactions; the effects of predators in competition are known to have a notable effect between prey species. (e.g. herbivores, parasites).

### THE GENERAL MEANING OF SYMBIOSIS

In the complexity of naturalness, to think about cooperation rather than competition is related with the effect of symbiosis as a close and often long term driving effect between two or more different objects, things or biological species interactions. The term “complexity” is understood within the meaning of its etymology meaning “complexus” which is “what is woven together” in a tangle of interweaving (plexus). According to System Theory and the fact that “the whole is more than the sum of the parts”, it exists some emergent qualities, i.e. those which originate from the organization of a whole, and retroact on the parts. Moreover, according to E. Morin, 1982, “the whole is also less than the sum of the parts” since the parts may have qualities which are inhibited by the organization of the whole”.

However, the idea of Darwin saying that “the struggle for life” is the only spring of the livings evolution remain founding since it includes both the evolution of individuals as well as that of social groups, thus showing that “the whole is more than the sum of the parts” in a symbiotic therefore driving manner as to influence systemicity.

In the Universe as well as in the natural world, neither cosmic object nor organism exists in absolute isolation, thus every one of them interacts with the interstellar, stellar and planetary neighboring environment (gravitation effect, meteorite shocks ...) and other objects or things (atoms, molecules, proteins, genes, organisms like bacteria...). On Earth, organisms coping by interacting with their specific environmental components and status changes are the fundamentals<sup>30</sup> of their survival systems and of the functioning of their ecosystem as a whole. Interactions are therefore “intermediary drivers” participating in gigadynamics, metadynamics or even dynamics, which move or flux dynamical systemicity through the universe as well as in terrestrial natural, individual and social milieus.

Now in our 21st century, the new methods of investigation of “The Living” highlight a new paradigm describing and understanding “the law of the jungle” (every one for itself) that is in

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<sup>30</sup> - **Fundamentals:** system of ideas or principals which serve as a base or foundation

ways of competing in the bottom of seas, under grounds, in intestines...The living beings survive well better whenever they weave cooperative and mutualistic relationships in between themselves. Globally, natural evolution must not be exclusively regarded as selective, quarrelsome and egoistic trends as in the 20th century, but also in the XXIst century as altruist, generous and cooperative traits.

In “primate ethology”, aggression, conflicts and war were the fields of research but now Systems research develops a real interest for altruism in general reference to social behaviors (e.g. insects, other animals and humans) Finally, a clear vision on empathy and the leading of equity are cooperation keys...in other terms a clear vision on how organisms find a societal dynamic balance means that “aggression” is nothing more but one subject among others.

Indeed today, “struggle for life” is not the only social motto since it is important to give significance to negotiation for a cooperation concept at least as equally to that of competition concepts. “The needs for survival” are not reduced to fighting behaviors and an elimination of rivals and is not an end in itself since using cooperation means and finding out beneficial alliances are survival keys. By knowing the whole range of interactions is not sufficient without considering selfishness and mutual aid, alliances and conflicts, and also social networks beyond individuals.

In all living networks, species of every kind are weaving secret and unsuspected alliances, one to others, as predation in violence or wild competition between individuals. Much more than just a subtle and vast cooperation balance reign at all level of ecosystems. Franz de Waal, 2006, describes the existence of extraordinarily complex systems of relationship and emotion among monkeys, implying empathy, a sense of equity, some premisses of morals, and a certain sense of politics (social survival systemicity).

In ethological studies, it is found that the evidence primates and other animals are returning favors. Crows have a certain sense of equity which means that the sense of cooperation within the same species is not endowed with vertebrate large brain.

Beyond what we know about social insects, already observed by Darwin but considered as a typical case, we now observe that bacteria species have surprising cooperative behaviors. In their forefront, they have individual capabilities to perceive the size of the population to which they belong. A perception that allows them lots of coordinated and systemic behaviors and energy for reproduction and ways to exchange signals or molecules of defense.

### **Symbiosis, a systemicity driver**

The discovery of hydrothermal sources and of its inhabitants, in the Eighties, awoke the notion of a symbiotic capacity for life to reign there. In quite hostile environments, down the level of ocean floors by several hundred even thousands meters of depth and where darkness reigns, some animals undergoing crushing pressures and high temperatures find systemic postures coping with such extremes together with a high acidity of the milieu. Such physicochemical conditions have proven to be true sources of unknown and odd survival metabolisms... and additionally, the source of multiple movements of association.

At such oceanic depth, the only available chemical energy appears in form of components as particular as sulfur. However, if some species of bacteria are only capable to extract this sulfur, a large group of organisms, mollusks, crabs, worms and other organisms are incorporating these bacteria in their tissue, sometimes going as far as growing specific organs to shelter them (see the large worm Riftia) showing a major example of symbiosis.

### **Symbiosis is Essential to Life's dynamic systemicity – survival cases**

The worm named Riftia lives without a digestive tract and mouth thanks to a “trophosome”, sort of a bacterium bag which occupies 15% of the mass of its body sheltering a powerful metabolism of a population of some 10 billion bacteria per gram of fabric. This population volume represents a 100 times more bacteria than in industrial biological engines built by Men! Rather than eating the bacteria, this worm chose to lodge them in order to ensure itself a biological success from surviving in the inferno of hydrothermal sources.

In terms of survival, the major asset of symbiosis and other cooperation behaviors is quite a logical response of Life to the more or less difficult conditions towards which organisms are confronted with. The example of the lichens, an organism mid-algae mid-mushroom is of a high systemic interest since it has become a pioneer as well in the deserts or in frozen environments as on altitudes.

Lichens would have even be the first forms of life to have conquered the shores, then continents well before plants. The biological link between the blue algae proliferation emerged from the benches of stromatolites and that of lichens is in their evolutionary forms since both organisms gradually colonized shores, adapting in contact with atmosphere and more particularly that of improved oxygen.

Blue green algae were used to be classified with the Algae, but now are considered closer to bacteria which are the simplest and oldest of living organisms.

Algae span the gap between bacteria and plants. However they are photosynthetic, like plants, they lack many distinct organs found in land plants and there is great variation in their structure and lifestyle: some are single celled organisms in pond water, others can be meters long in sea water, for instance giant kelp (all seaweeds are algae).

Parallely, lichens are currently classified as fungi that have captured and incorporated algae or blue-green algae, to provide them with photosynthetic products. In return, the algae obtain protection. The fungi are now so dependent on the algae that they are unable to survive in the field without them, although the algae can. This arrangement is similar to that in corals and shows how often symbiosis is a factual way surviving.

### **Symbiosis is a Source of Energy**

Organisms having an abundant source of chemical energy show well that symbiosis is one of the original actors of life to have appeared: it would have started from a series of molecular species alliances at various levels of the ecosystem worlds that represent a great omnipresence and variety of symbiotic social behaviors. For example, in forests and their undergrowth, there is actually no law of the jungle, at least not that in which one commonly think of. Scientists now found that in a forest, each tree is in symbiosis with some about 200 mushroom species, themselves connected to a large number of tree roots.

This whole exchange of myriads of nutrients and sugar sometimes on long distances shows that some plants deprived of chlorophyll are provided with sugar by mushrooms whose survival is established thanks to trees located much further. Such ecosystems develop “true networks” and not just a juxtaposition of individuals seeking to survive separately.

This “exchange of good processes (retroactivity) in terms of symbiosis is a pretty good example of harvesting energy for moving one of several terrestrial natural metadynamics. The “meta dynamic systemicity of inhabitants in the vicinity of an ecosystem” is found permanently sustained by many other drivers (cooperation, feedback, coevolution...).

Among these, the symbiotic bacteria are at least 100 species in the tissue of plants, as well as the mutualistic bacteria<sup>31</sup> which are sometimes the pollinating ones. Birds and mammalian are disperse seeds and underground invertebrates recycle matter, etc.

In any ecosystem, there is obviously an enormous 3D constellation of interactions between competing predators, preys and parasites foraging around. Species biological populations finally maintain much more sets of negotiations (possibly muscular) and exchanges (not always equitable) than “war games” the Darwinians promote.

In oceans, the vast population of planktons is the site of narrow symbioses that feed out the unicellular algae with nitrogen that plays a planetary role in the carbon cycle. François Lallier shows that symbiosis spreads around as a strategy of nutrition as soon as an animal is unable to synthesize a chemical compound. Then incorporating a microbe that is able to make such synthesis is like what insects, generally having vitamin deficiency, particularly in amino-acids, do integrating one or more bacteria that produce the missing compounds, realizing them shelter and protection.

Symbiosis is not only an ordinary cohabitation, but a true biological interpenetration of partners. The same François Lallier observed in the labyrinth of metabolism diversities that thousands of symbiotic genes of bacteria migrate towards the nucleus of their hosts.

The molecular compounds, during the chemical chains of conversion they are undergoing, enter, and then come out from the bacterium or their host according to satisfying their respective needs. Far from the motto “every one for himself” (the famous “chacun pour soi”), the actors of such alliances chemically communicate with each others, cooperating, adapting and controlling themselves. In a word, they interact uninterruptedly within an incredible complex 3D world of interrelated networks of signals. Through such, one discovers the presence of microbes in animals or plants, which are not at all the effect of a pathology.

### **Russian networks and Matryoshka dolls**

The biological importance of a body “microbiome” was discovered within animals and humans being as a colossal microbial community settled in the digestive tract that counts at least 10 times more cells than the body itself.

This flora is of a considerable influence on metabolism and takes part in the cerebral development, but may involve diabetes and allergies, as well as influencing the immune system. The extraordinary dialog between the hosts and the organism show that living beings prove to be genuine Russian Matryoshka dolls encasing mutualism. For example, some unicellular symbionts in the intestines, being themselves in symbiosis with bacteria are a manifestation of such mutualism. Even in this case, some viruses appear, in their majority, to be useful to the metabolism of many animal and vegetable species. While judiciously associating, organisms get at considerably increasing their survival resources and energy from alliances, cooperation and competition.

Indeed, these two faces of reality are the same complementary survival strategies that change one into the other: e.g., a parasite, which gives a metabolic hand to its host in order to stand for his own survival, would then become a cooperator.

Ultimately, the fact of thinking “network” and 3D dimension, in science, made it possible to show that isolating an individual and explaining everything through its individual standpoint is a retrograde way of seeing the reality of things.

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<sup>31</sup> - **Mutualistic bacteria:** “in a mutualistic relationship, both the bacteria and the host benefit. For example, there are several kinds of bacteria which live inside the mouth, nose, throat, and intestines of humans and animals. These bacteria receive a place to live and feed while keeping other harmful microbes from taking up residence.

The holistic approach, which endeavors to consider sets of worldly events and behaviors, is the powerful and new paradigm of a modern Biology as assumed by Franz de Waal. The result of his experiments of empathy, collaboration, equity and reciprocity shows how much human moral traits are actually common with of most animals (Empathy and consolation – Pro-social tendencies - Reciprocity and fairness).

The whole of this chapter is well illustrating the reality of symbiosis, mutualism, and commensalism... as driving the survival metadynamics systemicity of objects, things and species relationships. Synergy is also one of such drivers.

### **SYNERGY AS A SYSTEMICITY DRIVER**

#### **The difference between systemicity and synergetics**

At first, the notion of “synergy was postulated as the interactions of multiple elements in whatever system that were to produce a different effect or greater than the sum of their individual ones (Greek: synergos = working together).

Richard Buckminster Fuller, 1983, studied “*systems in transformation*” having a total behavior unpredicted by the behavior of any isolated components including humanity's role as both participant and observer. He then assumed to name “synergetics” a discipline embracing a vast range of scientific and philosophical fields identifiable at every level of the universe and of living organisms' species and humans.

Inspired with the laser theory, Herman Hayek developed the notion of “synergetics” as to be an interdisciplinary science explaining the formation and self-organization of patterns and structures in open systems far from thermodynamic equilibrium. Such physical status means the equilibrium of a metabolic milieu as being together mechanical, radiative, chemical, and biological is in a state of relative survival balance. However, the relative impermanence of a dynamic balance shows that over a certain threshold value, it steps in for new amplitudes while confronted with the permanency of endemic condition changes.

Some scientists consider milieus and environments as “systems”, without mentioning their nature which is rather that of ecosystems in which networks of forces, fluxes and moves of gas, particles, objects and things (e.g. star systems, living creatures predation systems) are meant not to be in a metastable equilibrium. Indeed, since they are permanently confronted with the universe thermodynamic chaos, they tend to a static equilibrium that sustains dynamic for a certain differential time.

Ecosystems usually are of a self-organization nature that requires the “convergence<sup>32</sup>” of non-linear dynamics co-driving the systemicity of gigadynamics and metadynamics which order-parameters depend on external conditions. Being subject to both the law of thermodynamics and of its second law<sup>33</sup> stating that the entropy of an isolated system never decreases, it induces the system to tend to such equilibrium, sustaining for a long time.

Within ecosystems, all living beings installed and interacting, are subject to survival metadynamics, which systemicity from positive retroactivity slow down their thermodynamic entropy effect and provokes individual replication or reproduction as adapting from energetic new resources and beneficial evolution characters.

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<sup>32</sup> - **Convergence:** manner of approaching a limit, such as a point, line, function, or value.

<sup>33</sup> - **Laws of thermodynamics:** The four laws of thermodynamics define fundamental physical quantities (temperature, energy, and entropy) that characterize thermodynamic systems. The laws describe how these quantities behave under various circumstances, and forbid certain phenomena (such as perpetual motion).



The increase in order as in the formation of patterns, structures and the adoption of proper behaviors capable to sustain a survival period of time, induces synergetic results in the many parts of physicochemical and biological worlds, as for example in:

- Physics: combination of quarks producing protons and neutrons,
- Chemistry: water as a compound of hydrogen and oxygen,
- Biology: genes cooperative interactions in the genome or the division of labors in bacterial colonies,
- Sociology: social groups of honeybee colonies or wolf packs or human societies,
- Technology: tools that enable animal and men evolving.

These synergies illustrate the diversity of synergetic move effects that sustain phenomena and entities as to survive for a certain period of time, then on replaced by new generations of individuals and societies. The elements or parts of cosmic, galactic, stellar, planetary and terrestrial, either individual or societal, participate in the specificity of their self-organizing level as well as that of other metadynamical levels in the scale of their systemicity cycles.

### **Synergy: a Collective Intelligence and of Behaviors**

In the natural world, within glocal environments, individualities and social groups develop specific structures, behaviors and abilities to survive as long as they acquire a sufficient intelligence and a sustainable experience at interacting with the different components of their glocal ecosystem.

As they are individually and collectively submitted with the effect of many drivers of the survival metadynamics systemicity (food search, energy acquisition, dwelling, reproduction, cooperation, symbiosis...) the number of their reactions along fluxes and moves during survival through years of living is immense. Collective behavioral contexts emerge from the synergy of permanent interactions within the social group and are different than specific motivations and needs permanently expressed by individuals confronted with daily or convenient necessities. Both moves have the same metadynamics systemicity in a sense that individuals and the group survival, being synergetic, induces a symbiotic effect from the retroactive expression of both the individuals and the group motivations and needs consequently with environmental events pressure. In reference with social and individual moves, one finds very many organism groups having synergetic survival behaviors such as: ants agriculture, ban fish defense, bats night flying for feeding, wolves' cooperation at hunting, human's cooperation at productions, manifestations, wars and revolutions...).

### **The “Primordial Soup” and the Synergetic drive of Life**

The apparition of protocells self-replicating molecules or their components came into existence under waters from the retroactivity of the survival metadynamics systemicity, which symbiotic and synergetic mechanisms drove organic molecules as interacting and adapting.

They could have been created in an anoxic atmosphere through the action of sunlight which A. Oparin, 1924, reasoned, saying they would combine in evermore complex ways until forming coacervate droplets (coalescence as one of the drivers of the survival metadynamics systemicity).

These droplets under coalescence would "grow" by fusion with other droplets, and "reproduce" through fission into larger daughter droplets, and so have a primitive metabolism, the primordial soup of interacting inorganic and organic molecules playing then a synergetic role by producing a combined effect greater than the sum of molecules separate effects.

### **Synergy, self-organization and the order-parameter**

The order-parameter concept (Ginzburg-Landau, 1950) describes phase-transition in thermodynamics as the transformation of a thermodynamic system from one phase or state of matter to another.

When a system reaches an unstable state, it splits itself over a threshold into the beginning of different phases with different properties though each other's staying in a dynamic equilibrium. The order-parameters are then interpreted as being the "amplitude of an instability mode determining other patterns. Consequently, the self-organization of a system confronted with entropy represents a reduction of its degree of freedom<sup>34</sup> due to its acquiring a macroscopic increase of order from a new pattern.

Self-organization is a universal principle that shows differential aptitudes according to patterns processing in its moves, an increase of order together observed in physics, chemistry and biology. In some form of a global order (e.g. coordination) self-organization spontaneously initiates a new pattern out of local interactions between system's components.

Survival metadynamics systemic moves of self-organization may be triggered off by random fluctuations, getting amplified by a positive feedback provoking their stepping over a threshold value. Once over, the systems stay robust and adaptive to new conditions, able to survive and occasionally to self-repair from initial perturbations. In other terms, when considering the neural structure of living beings, it is observed that neuron networks, confronted with complex reaction perturbations, are most of the time learning how to find pathways to a new pattern. Enabled from their synergetic behaviors, i.e. having "an effect arising between two or more neural factors", they produce a new pathway which effect gets greater than the sum of initial components in the previous neural move.

### COALESCENCE AND METADYNAMICS SYSTEMICITY

#### Cosmic, Stellar, Planetary and Terrestrial Coalescence

Coalescence is a systemic process by which two or more particles, molecule droplets or bubbles merge during their contact to form another single bigger one. These processes occur in the universe and in nature as drivers sustaining the evolution of neighboring particles and molecules along pathways of survival benefit emerging from their metadynamics systemicity. They are observed in the following disciplines:

**In meteorology:** the formation of rain is an emergent phenomenon when droplets are carried by both updrafts and downdrafts within clouds: they coalesce from colliding to form larger rain drops. When temperature conditions are under 0°, then a transformation of particles, molecules or particularly water produce icy forms like more or less large snowflakes hailstones or freezing drizzle. Such phenomena are crucial drivers of the systemicity of climate metadynamics without which Life would not exist on Earth.

The atmosphere conditions enable to have a large knowledge on weather events variables in terms of air pressure, temperature water vapor, gradients and interactions of each of them. Since local, regional and global geographic areas (terrestrial and oceanic) are permanently confronted with specific climates changes (cycles, air composition, natural physicochemical milieu metabolism, kinds of flows and fluxes, force of currents...), they are also submitted to the driving effect of other environmental changes such as the metadynamics systemicity of volcanism, pollution, sun activities, orbital variations...). In some sort of global weather coalescence, the impact of the permanency of its changes on ecosystems is much perceptible on its grounds and on the living beings structural components and behaviors.

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<sup>34</sup> - **Degree of freedom:** in a system it is the number of parameters that may vary independently

**In astrophysics:** physics of the universe and of its celestial components (cosmic particles, gas, objects and moves) are in permanent interactions then behave according to their variabilities driving a survival gigadynamics systemicity where other drivers come in the move (thermodynamics, density of molecular clouds, gravitation...).

The thermodynamics reigning in molecular clouds produce energy in form of electromagnetic radiations that are at the origin of stellar system baby birth becoming stars from particles and gas accretion (coalescence) which systemicity joins that of neighboring galaxies. The researchers found these molecules near the center of the Milky Way inside a hulking interstellar molecular cloud known as Sagittarius B2. Many reactions in the interstellar medium occur in the gas phase and on 'dusts' and the relationship between chemistry and some of the grand challenges of the universe reaction dynamics (systemicity) is including the formation of complex and even organic molecule species. Furthermore, one are then on learning and recording the details of stellar and planetary formation, the variations in chemistry among galaxies and different lapse of time since the Big Bang.

**In oceanography:** molecules, particles and gas are circulating in oceans currents and surface waters (water in rivers, lakes, oceans...). They form the global water cycle (hydrologic cycle) that has a survival metadynamics systemicity, which cycle produces rain precipitations, evaporation/transpiration, and runoff. Water that does not get absorbed into the soil or rise back into the atmosphere as water vapor will run off surfaces and be collected in varied locations (low-lying areas, floodplains, etc.). Since water molecules collide and coalesce forming larger bubbles enclosing other molecules and chemicals, they form true micro-ecosystems sustaining molecular interactions, they also interact with the environments they come across.

Becoming larger, bubbles, encountering lipids and phospholipids that act as building blocks of the biological cell membranes in virtually all organisms, become an in-out filter able to communicate with the milieu. The membrane participates in the transduction of biological signals across its cell wall. In other terms, forming a universal natural or virtual filter, the latter "wall" is also considered as a metaphor transcribing a human idea into a conceptual theory or behavioral rule.

### THE EARLY EARTH'S PREBIOTIC PERIOD OF EVOLUTION

A Timeline of Earth Evolution Premices

*Hadean eon (-4,567 to 3,800Go/ya)*

- Earth's original hydrogen and helium atmosphere escapes Earth's gravity.
- Earth day is 6 hours long.
- Minus 3,9Go/ya: Cataclysmic meteorite bombardment.
- Earth's atmosphere becomes mostly carbon dioxide, water vapor, methane, and ammonia.
- Formation of carbonate minerals starts depleting atmospheric carbon dioxide.
- No geologic record for the Hadean Eon.

*Archaean eon (- 3,8 to -2,5Go/ya)*

- Minus 3,8Go/ya: Surface of the Earth changed from molten to solid rock,
- Water started condensing in liquid form,
- Earth day is 15 hours long,

## The General Theory of Systemicity

- Minus 3,6Go/ya: Monocellular life started (Prokaryotes). First known oxygen producing bacteria: cyanobacteria (blue-green algae) form stromatolites,
- Minus 3,0Go/ya: Atmosphere has 75% nitrogen, 15% carbon dioxide,
- Sun brightens to 80% of current level.

### The Earth's Prebiotic Environment: a Systemic "Primordial Soup"

The heavy meteorite<sup>35</sup> and comet bombardment of the early Earth (-3.9 Go/ya) brought down immense quantities of inorganic and organic materials comparable to inorganic and prebiotic ones produced by other energy sources (volcanism...). On Earth, then on, the surface of the cooling medium received inorganic and prebiotic materials such as nucleic acids, proteins and enzymes that came to interact producing the essential of macromolecules to forming biological processes from new chemical pathways.

Both aqueous and mineral, ecosystemic<sup>36</sup> medium (the systemic "soup") produced, under specific environmental physicochemical conditions and the systemicity of metabolism, those "proto-organisms" or protobionts. Protobionts were originated by the convergence of microspheres of proteins, carbohydrates, lipids, nucleic acids (RNA and DNA), and other organic substances, precursors of the first living creatures (proto-viruses, prokaryote and unicellular organisms as micro virus, virus and bacteria).

These prebiotic reactions produced endemic capacities for enzymatic reactions and regulations from interaction feedback and yielded cascades of positive ago-antagonistic "differential biological values" resulting in Life's early stage. Since ecosystems media – "the soup"- were being top-down run around with currents because of temperature gradients change, the circulation from downstream of prebiotic molecules, and proto-organisms could be mixed with other upstream molecule species, in quickly evolving cycles from the extreme rapidity of replication modes, then forming varieties of microorganisms.

### Life's Planetary and Terrestrial Premises and the Survival Metadynamics Systemicity

In low oceans, shoal rather than ponds, along different type of coasts and shores according to the move of tectonic plates and under lava, sulfur fumes and an early atmosphere of carbon dioxide, nitrogen, and water vapor, produced the milieu and metabolic conditions for most of the prebiotic organisms as precursors to develop and thrive by trillions.

Coming from different spaces and Earth areas, forming with water the "primordial soup", they became neighbors, assembling thanks to water, "*the universal solvent*"<sup>37</sup>, where they structured new chemical pathways that went cooling down from different current types

It seems that on early Earth, the abiotic synthesis of organic molecules was supported with three complementary scenarios saying that organic molecules:

- were synthesized from inorganic compounds in the atmosphere,
- rained down on earth from interstellar medium,
- were synthesized at hydrothermal vents on the ocean floor.

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<sup>35</sup> - **Carbonaceous chondrites:** meteorite groups that contain high percentages (3% to 22%) of water, as well as organic compounds, mainly silicates, oxides and sulfides, and some minerals (olivine and serpentine).

<sup>36</sup> - **Ecosystem:** "the complex of a community of organisms and its environment functioning as an ecological unit."

<sup>37</sup> - **Solvent:** When addition of water to an organic molecule cleaves the molecule in two, hydrolysis is said to occur. Examples of hydrolysis are saponification of fats and digestion of proteins and polysaccharides.

Furthermore, the “primeval soup” required the atmosphere of the early earth to be rich in methane and ammonia so that small molecules would associate to become living things. However, since it is asserted that carbon dioxide, nitrogen, and water vapor were in early atmosphere, then it becomes significant to link things together because of the interdependency of flux and moves metadynamics systemicity for survival.

*Organic molecules identified in the interstellar space are numerous: methane (CH<sub>4</sub>), methanol (CH<sub>3</sub>OH), formaldehyde (HCHO), cyanoacetylene (HC<sub>3</sub>N) a precursor to the pyrimidine cytosine); polycyclic aromatic hydrocarbons as well as such inorganic building blocks as carbon dioxide (CO<sub>2</sub>), carbon monoxide (CO), ammonia (NH<sub>3</sub>), hydrogen sulfide (H<sub>2</sub>S), and hydrogen cyanide (HCN), water (H<sub>2</sub>O)... Exposed to a temperature close to the space one (near absolute zero) and intense ultraviolet (UV) radiation, many molecules formed amino acids (protein synthesis), purine and pyrimidines (nucleic acid synthesis), then pyrimidine ribonucleotides .*

We find then that terrestrial physical and chemical metadynamics processing the organic synthesis of biomolecules are being driven by action/reaction, impact of shocks and other energy sources such as ultraviolet light or electrical discharges (e.g. Miller's experiments). Some extraterrestrial molecules are delivered by cosmic objects (e.g. inorganic and organic materials as carbonaceous chondrites...) or from the gravitational attraction of organic molecules or primitive life-forms from space.

Recently, some completed the scenario by adding the heavy bombardment of matter on Earth before 3.5 Go/ya saying the early atmosphere made available quantities of organics comparable to those produced by other energy sources like volcanism, geothermic vapor and atmospheric rains.

### *The "Soup" Theory Today: Subsequent Works*

- Aleksandr Oparin (1924) suggested that the organic compounds could have undergone a series of reactions leading to more and more complex molecules. He proposed that the molecules formed colloid aggregates, or “coacervate<sup>38</sup>”, in an aqueous environment. They were able to absorb and assimilate organic compounds from the environment in a way reminiscent of metabolism. They would have taken part in evolutionary processes leading to the first life forms.
- John Haldane (1929) said the sea became a 'hot dilute soup' containing large populations of organic monomers and polymers that acquired lipid membranes, and further evolving developments that led to the first living protocells.
- Robert Shapiro (2007) said the early Earth had a chemically reducing atmosphere exposed to energy in various forms that induced to producing simple organic compounds ("monomers") that accumulated in the "primordial soup".

By further transformation, more complex organic polymers - and ultimately living things - developed in a cooling soup.

- Joan Oró (~ 1960) developed the prebiotic synthesis of the nucleobase adenine (a key component of nucleic acids) with demonstrating the nucleic acid purine base, “adenine”, was formed by heating aqueous ammonium cyanide solutions.

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<sup>38</sup> - **Coacervate**: a colloid-rich viscous liquid phase which may separate from a colloidal solution on addition of a third component.

## The General Theory of Systemicity

In support of abiogenesis in eutectic ice, was demonstrated the formation of s-triazine (alternative nucleobase), pyrimidines (including cytosine and uracil), and adenine from urea solutions subjected to freeze-thaw cycles under a reductive atmosphere (with spark discharges as an energy source). By so, he revealed the most important chemical pathways of Life as an evolution of its building blocks: hydrogen, oxygen, nitrogen, and carbon.

Finally, the "prebiotic soup" relies on the assumption proposed by Darwin that in an environment with no pre-existing life, organic molecules have accumulated and provided an environment for chemical pathways evolution.

The spontaneous formation of complex polymers from abiotic monomers under the conditions posited by the "soup" is not at all a straightforward process: however, the gigadynamics systemicity and immense velocity<sup>39</sup> of molecular assembly pathways induced to from environmental conditions and the colliding of organic building blocks.

By accentuated polymerization it forms more complex structures, interacting in consistent ways to form protocells. For example, in an aqueous environment hydrolysis of oligomers /polymers into their constituent monomers would be favorable over the condensation of individual monomers into polymers.

However, the studies of ancestral chemical reactions provide pathways to the synthesis of organic building blocks from simple gaseous compounds, saying some of these originated in the interstellar molecular world. Deep sea vents, or hydrothermal vents where hydrogen-rich fluids emerge from below the sea floor and interface with carbon dioxide-rich ocean water are at the origin of diverse organisms to survive in harsh conditions.

Sustained chemical energy in such areas is derived from redox reactions, in which electron donors, such as molecular hydrogen, react with electron acceptors, such as carbon dioxide (see the iron-sulfur world<sup>40</sup>, a theory developed by Günter Wächtershäuser, as the early evolution of life, 1988 to 1992).

### **A General Life's Survival Systemicity under Early Earth Conditions**

Life arose within the limits of particular sets of flux, moves and forces in specific local physicochemical milieus integrating a common liquid medium, water where molecules circulated forming relatively short strands of RNA, viroid-like particles as small virus, with a great accuracy to replicating at a great velocity fork (mean 0.7 kb/min, maximum 2.0 kb/min).

The convergence of Cosmo-planetary forces in the Sun system (thermodynamic pressure, energy, cosmic radiations, magnetism, gravitation...), the Earth-Moon accretion, its mass gravitation, its orbiting and new terrestrial conditions (geologic, geochemical, geophysical, geo-climatic...) were retroactively sustaining the Earth within its "habitable zone" where the livings emerged from their own survival meta-dynamics systemic means (replication, biotope equilibrium, local ecosystems biodiversity, food chains, sustainable behaviors, reproduction means ...) enabled evolution processes with a "re-seeding" ability. The mass and velocity of molecules replication forming proto-organisms was a matter of energy, space, and building blocks, which soon became limited, inducing the proto-organisms to compete, bringing a process of natural selection favoring efficient molecules at replication.

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<sup>39</sup> - **Velocity**: rate of change of a moving body position in relation to its speed and direction of travel

<sup>40</sup> - **Iron-sulfur world**: life may have formed on the surface of iron sulfide minerals.

At the livings' level, the set of meta/intra-median/dynamics systemicity sustained and still sustains temporal survival within biological, physiological and psychological intrication at different body sublevels. Consubstantial (atomicity and molecularity) and interrelated with the cosmic<sup>41</sup>, galactic, stellar, planetary and terrestrial meta-dynamics, the biological general principle of Life and its "survival metadynamics systemicity" are participating in the whole of the planet Earth and living organisms to function and temporally survive, that J. Lovelock named "Gaia".

The entire body of the Universe is the provisional achievement of interdependent physicochemical and intricate mechanisms, moves, processes and streams of atomic and molecular particles (molecular velocity, massive clouds, accretion disk, stellar system, gravitation ...) that interacts retroactively giving out replication abilities to objects.

Without the sustainability of the global evolution gigadynamics systemicity, the processes, interwoven in systemic "3D networks", gave "survival abilities and performances", epigenetically provided with the resulting effects of the gigadynamics systemicity of particles and molecular worlds retroactions. Diversity and velocity and gravitation were and still are driving phenomena as to sustain the thermodynamics evolution of the Universe and consequently that of Earth.

### **"METADYNAMICS SYSTEMICITY" AND EVOLUTIONARY MECHANISMS**

#### **Effects of Systemicity Emergent Results**

Emergence is the "door of evolution", a threshold as being *"the gradual development of something into a more complex or better form"* or patterns that arise out of multiple interactive feedback effects.

In other terms, the metadynamics systemicity at any environmental level, e.g. at the universal and terrestrial level induces in emergent new statuses, conditions, properties and behaviors. Being central to a coherent integration of sustainable survival means, a complex dynamic milieu is like that of the metabolism of the Earth or of organisms. The emergence of livable functions to grow and reproduce, maintain structures, and propitiously respond to environments as the keystone of survival. A metabolism is homeostatic and positively results from catabolism breaking down organic matter, e.g. as harvesting energy in cellular respiration.

Complementarily, it results in anabolism<sup>42</sup> that is the use of energy to construct components of cells such as proteins and nucleic acids. The emergent properties, in biology, are the combination of individual atoms to form molecules such as polypeptide chains, which in turn possess behavioral properties folding and refolding to form proteins and reshuffling reactions.

Assuming their functional status (eg. enzymes for survival sustainability) from a spatial conformation, these proteins interact together thus achieving higher biological levels of survival functions in form of organelles..., cells..., thereby inducing to sustainable tissues, organs, organ systems, organisms, all holding with behavioral reflexes of protection (fight or fly, habit...) and of survival efficiency.

Cascading phenotype reactions, arising from individual genes replication, mutate bringing about biological communities in the world to form the biosphere, where living systems, e.g. ants..., and humans participate in becoming interactive societies, and meta-social systems

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<sup>41</sup> - **Cosmic:** the essence of the general relativity is in the space-time that has a general dynamic cause and its effect properties.

<sup>42</sup> - **Anabolism:** synthesis of simple matter into more complex substances, process by which food is transformed into tissue (in plants and animals).

such as ecosystems (or the global stock-market).

As being open systems, "if the condition is left random, the result of conditioning is also random", and the effect of the environmental metadynamics systemicity drives forth evolving and adaptive behaviors inducing endo-exogenous changes. Evolution is a notion considering the Darwinian natural selection as a driver, and is also, and more broadly, the result of the permanency of change in one or several directions.

### **Domino effects**

Among the metadynamics systemicity moves, some of its components are to be mentioned here in the way their asymptotic effects are usually deviant or perverse. Domino effects indicate the multiplying risk constituted with several events and behaviors at risks present on the same site and tending to evolve, spread and settle well beyond the initial condition of its appearance. The expression of "the domino effect" is used as a physical metaphor or analogy to represent the propagation by "contagion" (biomedical metaphor) of a local event or of an ideology throughout groups, areas or space-time.

It refers to the concept of "coevolution" in ecology where a change at a specific level can promote and facilitates cascading changes at another one. The domino effect suggests that some change, small in itself, will cause a similar change nearby, which then will cause another similar change, and so on, in different sequences, by analogy to a falling row of dominoes standing on end.

For example, the food chain networks are very fragile since if one element, predator or prey, matter or water, miss, then the global ecosystemic conditions becomes hectic and nears death for many species, if not also that of humans, which very serious and deleterious thermodynamic effect drives towards mass extinction.

### **Butterfly effect**

Besides differential emergent results, an effect of amplification of a phenomenon may occur well beyond the place of its apparition named a "butterfly effect". In other words, "the butterfly effect is a notion of sensitive dependence on initial conditions" and happens in the course of some chaotic events.

The behavior of chaotic systems usually shows such exponential growth of perturbations as of in nature, small variations of initial conditions of a dynamical move may produce large variations in the long term behaviors of the system as for example winds or a population genetic drift or stress.

### **Coevolution**

Coevolution takes the form of different aspects of dualism, often ago-antagonistic between living species that have reciprocal influence from their interactions. For example, the keystone of survival is in the predator-prey dynamic, host-parasite, symbiosis between two species, or associations of several species as being systemic phenomena much significative of the "survival principles" mostly common to living species.

The biology of evolution makes it possible to observe these dual forms and the importance of coevolution in the history of species and sexual conflicts. Some biologists, as Thierry Lodé and Richard D. Alexander, 1990, describe the effects of these antagonistic interactions, particularly at the sexual level, and the evolutions of characters as leading to an antagonistic coevolution of entities.



### **Kinetic factors and chemical reactions**

As Earth is an open system, it interacts with a part of Cosmos and Sun system forces and moves and from their metadynamics systemicity, it brings down on Earth energy-filled light rays which retroactive effects are differential in climate cycles and in living systems survival potentialities. Cascading, this excess of energy is minored from the dynamic balance of gravity, the Moon effects and atmospheric pressures. However, this resulting energy is adequate to overcome the negative effect of entropy on emergent chemical reactions results as keeping up sustainability requirements and adaptation abilities for living systems to cope with the permanency of environment changes.

### **Kinetic factors as decisive in multi-step processes**

The origin of Life was a matter of convergence and interactions between chemical systems during interrelated processing as adequate with survival moves (e.g.: replication, photosynthesis and autotrophic capacities of cyanobacteria to assemble for). Emergent results build up chemical structures acting like proto-living systems and having a chemical evolution, a molecular self-organization and a biological adaptation reproducing and change.

The chemical environment initiated the assembly of chemicals that formed the first polymers (repeating structural units) able to provide information for others to assemble (proto-nucleic acids?) leading to reproductive polymers and catalytic activities.

From then on, the whole environment flourished with properties which dynamic systemicity induced to replication and evolution into more adaptive polymers. Thereby, biological evolving conditions emerged originating different substrates (site of enzyme actions) where the RNA-like molecules formed and later engendered singled-celled organisms, some of them getting differentiated into multicellular systems in a proto-metabolic milieu.

Such overview of successive metadynamics systemicity phenomena supporting living systems must be understood having occurred during an immensely long period of time of about 800 million years and plus. While getting more inquisitive about the immensely long period from -4,6 Go/years (the Earth birth) up to + 2'009 years of nowadays, in the history of Life, it becomes highly important to get a general transdisciplinary learning at understanding the universal and natural interconnectivity of objects, livings and things.

## **THIS THEORY 5<sup>TH</sup> PART CONCLUSION**

As illustrating the permanency of existing universal gigadynamics and metadynamics systemicity is the formation of the different scales of cosmic molecules, particles, objects and things, and their being of certain survival duration in molecular clouds, galaxies, star systems, and planetary systems, terrestrial and biological ones.

Geophysics is a discipline studying the Earth existence and its terrestrial moves (or pulsations) and retroactive behaviors (Gaia) applying to physical and chemical principles of the Earth's subsurface and surface motions of tectonic plates in permanent kinetic subduction. Consequently, the internal and external structure of the Earth and of its survival metadynamics circular moves (magma convection currents sinking again, rock cycles, shallow deposits weight, orbiting...) provide for an important inventory of numerous systemic data and geological forms. Many resource basins providing for mineral deposits, groundwater wells, chemical sources..., were and are still exploited by living species. Some of them are at the origin of Life (molecules, minerals and water...) that are promoting its evolutionary capability as surviving.

## The General Theory of Systemicity

Domestication of fire, wood, petroleum oil, gas and charcoal reserves, at the origin of the industrial development of our modern humanity, induce in the surge of new survival consumption means, sometimes in form of their natural status or, for the many, in form of transformations increasing their purpose of utilization. Transformation of light and matter is basically a vital energetic necessity, primordial for living beings to fulfill their specific survival means. Required as direct from the Sun, or indirect from predation strategies among the multiplicity of food chains cycles, survival means are immensely diverse even though the metadynamics systemicity survival principles (food, habitat, fear, reproduction...) are differential and evolving but are basically common to all creatures.

“Survival giga and metadynamics Systemicity” and its drivers” are consubstantial (of the same essence) to the giga and metadynamics systemicity of cosmic forces and fluxes (universe systemic drivers) at the origin of planet Earth's. The “tick tock” of the biological clock that is sustaining life against entropy, is a phenomenon tuned with global, “glocal” and local planetary and terrestrial tick-tock pulsations of cosmic particles, molecules and objects. Maxwell predicted with metaphors that dynamics are inducing in the production of the "compost" for theories to emerge, which suggested to me the development of the "Theory of general dynamics systemicity ".

Sets of dynamics are structuring “Survival metadynamics systemicity drivers” as described in this part of the theory. Let’s recall them: among all drivers are the coalescence, conjunction, co-evolution, convergence, symbiosis, percolation, phase transition and threshold output, neighborhood adaptation that are analyzed.

Then, feedback results drive universal atomic, molecular and physicochemical worlds where forces, fluxes and moves permanently provoke the evolution of the several giga and metadynamics systemicity cycles.

Survival of the Earth for livings is in danger because mankind produces aggravating degradations of environments. A danger that is implicating the global society, its intelligence, actual human cultures, socioeconomic fulfilling attitudes and human systems as to protect the fruits of thinking, creativity, survival competition and a large set of political attitudes, as understanding the irreversibility of the obverse<sup>43</sup> side of entropy as per the second law of thermodynamics lessons.

In this work, dynamics interrelations are usually described in general, in other terms, the whole development of the theory is supported with an up-to-date science approach to a transdisciplinary point of view. In conclusion, it is here postulated and assumed that "Systemicity" is the universal propriety of giga and metadynamics fluxes, moves and forces, which feedback retroactive results make emerge specific forms and things driven by symbiosis, coevolution, synergistic and collateral effects inducing in the permanency of a general evolution. "The general systemicity" of cosmic objects milieu and environments is part of an entire universal metabolism which is in a dynamic equilibrium since it includes gravitational effects and retro-feeding capacities sustaining. At such a level and scales of observation, it is therefore assumed that "Systemicity", naturally involved in reality, is as well a form of metaphor, abstraction and theory.

Survival, issued from a world of thermodynamics within clouds of molecules, matter and energy, as confronted with gravitation and rays effects, was and still is inducing systemic

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<sup>43</sup> - **Obverse**: corresponding to something as its opposite or counterpart.

retro-active moves together with the second law of thermodynamic<sup>44</sup> effects that slow down space-time speed.

Next part of the theory to come, the 6<sup>th</sup>, will be a large approach about "surroundings" (neighborhoods), and the abiogenesis<sup>45</sup> which dynamic variations were confronted with entropic effects. The theory will enlarge the quality of any survival learning and expertise about their direct and collateral effects on species survival (e.g. surprising plants neighboring). Permanently emerging from the world of physicochemical and biological processes, vital survival behaviors usually result from sustainability, adaptability and endurance of Life's survival principles within a world context. Today, it requires an important effort for humanity to better update and govern new survival strategies and tactics compatible with a sustainable, adaptable and durable future.

The theory of "A primordial general systemicity" (a next stage of my works to come), will be the keystone at considering the "Systemicity of General Gigadynamics and Metadynamics" as universal retroactive phenomena.

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<sup>44</sup> - **Second law of thermodynamics:** states that the entropy of an isolated system never decreases, because isolated systems spontaneously evolve towards thermodynamic equilibrium.

<sup>45</sup> - **Abiogenesis:** the natural process by which life arises from simple organic compounds. The geologic era in which abiogenesis likely took place was the early Eoarchean era (between 4.0 and 3.6, i.e. the time after the Hadean era in which the Earth was essentially molten, with abiogenesis occurring between 3.9 and 3.5 billion years ago).

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A much abridged list of references.