The Origin of Life

According to the law of syntropy

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Abstract

The law of syntropy states that life is the manifestation of a general law of the universe and that this manifestation is possible only thanks to water molecules. According to this theory, life was not created, but emerges spontaneously wherever there is water. Wherever there is water there is life, and for this reason, water is an important clue to the possibility of life on other planets.

1. Origin of life, the classical view

The first question about life, which has always engaged the imagination of man, is this: *How can life develop from molecules that are not living*? To this question the ancient Greeks responded by saying that life spontaneously generates from inorganic matter as a result of the action of the goddess Gaia. This hypothesis was reformulated by the Latins as *generatio spontaneous* and in contemporary science as abiogenesis. The major steps in the debate between biogenesis and abiogenesis are the following:

- In 1668 the Italian physician Francesco Redi (1626-1697) proved that no maggots appeared in meat when flies were prevented from laying eggs, providing in this way the first solid evidence against the hypothesis of the spontaneous generation of life. Redi gradually showed that, at least in the case of all the higher and readily visible organisms, the abiogenetic hypothesis was false.
- Spontaneous generation for small organisms gained favor in 1745 when John Needham (1713-1781) showed that if a broth was boiled (presumed to kill all life) and then placed in a sterile container it became cloudy, supporting in this way the theory of abiogenesis.
- In 1768 Lazzaro Spallanzani (1729-1799) repeated Needham's experiments, removing air from the sterile container. Spallanzani wanted to avoid contamination by boiling a meat broth in a sealed container. The problem with this approach was that air in the container could shatter the container upon heating. Therefore, he removed the air from container after sealing it. The broth did not subsequently cloud with bacterial growth, supporting in this way the theory of biogenesis.
- It was not until mid-nineteenth century, almost 100 years later, that the great French chemist Louis Pasteur put the debate to rest. By passing air through cotton filters, he first showed that the air is full of microorganisms. Inspection of this material revealed numerous microbes. Pasteur realized that if these bacteria were present in the air then they would likely land on and

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contaminate any material exposed to it. The debate brought the French Academy of Sciences to allocate a prize for whoever was able to provide a convincing and accurate experimental answer to the question. Pasteur entered the contest with experiments similar to those performed by Spallanzani, which used heat to kill the microbes. In a simple, but brilliant modification, the neck of a flask, used in the experiments, was heated to melting point and drawn out into a long S-shaped curve, preventing dust particles and their load of microbes from reaching the contents of the flask. After prolonged incubation the flasks remained free of life and this ended the debate for most scientists. Results were published in 1862 and explained the errors and artefacts of other competitors. Pasteur summarized his findings in the Latin phrase: *Omne vivum ex vivo*, indicating that life can only be generated from organic matter, from life. These findings further restricted the abiogenetic hypothesis to special conditions which would have characterized the early stages of our planet Earth.

- In 1924, Alexander Oparin (1894-1980) published in Russian a work entitled *The Origins of Life* (Oparin, 1924) in which he describes that the findings on the characteristics of colloids suggest that the ability of colloids to bind substances to the surface indicates a beginning of metabolism. His book ends with the phrase: "*Work is already in a very advanced stage, and soon the last barriers between organic and inorganic will fall under the attack of a patient work and powerful scientific theories*." The English version of Oparin's book was published in 1938 and had a wide impact on researchers and public opinion.
- In 1952 Harold Urey (1893-1981) coined the term cosmochemistry, or chemical cosmology, in order to indicate the origin and development of the substances of the universe. The main focus are the elements and their isotopes, primarily (but not always) within the solar system. Closely related fields are astrochemistry, a branch of astronomy concerned with measuring chemical elements in other parts of our galaxy and in other galaxies. Cosmochemistry focused on the study of the chemical elements on Earth and planets during their evolution. In 1952, in the book *The Planets: Their Origin and Development* (Urey, 1952), Urey assumed that the composition of primordial Earth was similar to that of the cosmos: 90% hydrogen atoms, 9% of helium atoms, 1% atoms of other elements. From this assumption he deduced that the composition of the primordial atmosphere should be made of methane (CH_4), ammonia (NH_3), nitrogen (N_2), water (H_2O) and hydrogen (H_2).
- In 1953 a student of Urey, Stanley Miller (1930-2007), published the article *A Production of Amino Acids Under Possible Primitive Earth Conditions* (Miller, 1953). Miller demonstrated that, in a primordial atmosphere and in the presence of water, the action of electrical discharges (simulating the action of lightning) could generate amino acids, that is the fundamental building blocks of proteins. In his experiments, which used sterile equipment, Miller inserted gases such as methane (CH_4), ammonia (NH_3) and water (H_2O). The system consisted of liquid water, gas and two electrodes. The experiment was divided into cycles in which the water was heated to induce the formation of water vapor, the electrodes were used to produce electrical shocks similar to lightning and the whole was then cooled to allow the water to condense. Then a new cycle began. After about a week of uninterrupted cycles, where the conditions were kept constant, Miller noted that about 15% of the carbon had formed organic compounds, including some amino acids. The idea was that this synthesis of amino acids would provide the building blocks for proteins. Miller's experiments produced an aqueous mixture containing various products which were then isolated using a process of extraction. These products contained amino acids, including some of those found in living systems. This aqueous mixture was called "*primordial soup*". Miller gave a decisive impetus to the experimental research of the abiotic origins of life.

The second question about life is this: *How did molecules, that are essential for life, form from amino acids*? Amino acids are the building blocks of life, but are not considered to be living forms. Miller's experiments gave rise to a host of other experiments, which are still being conducted in an attempt to demonstrate the feasibility of constructing complex organic molecules from amino acids. These experiments are aimed at attempting to describe how proteins can form spontaneously starting from amino acids. Results have been very problematic, for several reasons:

- Proteins involved in the metabolism of cells are composed of chains which include more than 90 amino acids. Simple thermodynamics show that more than 10^{600} (one followed by 600 zeros) permutations are required combining amino acids by chance, in order to arrive at the "spontaneous" formation of just one protein. This number is greater than all the spontaneous combinations which are possible in the entire history of the universe, since the big bang. In other words, thermodynamics prove that the possibility of spontaneous formation of just one protein is nil.
- In addition, primordial soups are made up mostly of water, but water leads to the decomposition of macromolecules and makes it impossible for amino acids to chain together in the initial stages of protein formation. In 2004, Luke Leman and collaborators at the Scripps Research Institute and Leslie Orgel of the Salk Institute for Biological Studies (Leman, 2004), obtained peptides (short chains of amino acids) using solutions of amino acids, carbonyl sulfide (COS, a volcanic gas) and catalysts based on metal sulfides. But using this process it is not clear where the amino acids came from, since they require a totally different environment which is not based on water.
- Another proposal is that amino acids, which form in water, are concentrated in lagoons which periodically become dry and condense under the influence of dry heat which also creates chemical bonds responsible for the union of amino acids (peptide bond).
- The processes of synthesis have allowed to produce 13 of the 20 amino acids involved in the construction of proteins. In addition to these, thousands of other amino acids are generated, which are not present in living organisms.
- If it were possible to select and combine only the amino acids present in living systems (the probability is equal to zero), the resulting combinations would be three-dimensional and not linear, such as that which is present in life's protein chains. The three-dimensional combinations (known as proteinoids) are inappropriate to the metabolism of cells because they cannot be encoded by a linear genetic code. Proteinoids are therefore given no value in the formation and development of life.
- Life, as we know it, depends totally on levorotary amino acids whereas the synthesis of amino acids leads to the formation of an equal number of dextrorotary and levorotary chains. The production of proteins in laboratories is therefore unsuitable for the formation of living organisms.
- The synthetic processes for the construction of protein chains leads to the formation of monofunctional molecules that block the ends of the chains, making them inaccessible for further extensions. The presence of monofunctional molecules is therefore a crucial impediment to the development of longer chains, i.e. proteins.
- In all experimental approaches, in addition to the desired amino acid, a large number of other substances, which prevent the next steps, are formed.

The third question about life is: *What differentiates the organic from the inorganic*? Miller's experiments constitute an important first step towards the synthesis of the molecules which are necessary for life, but have also led to an impasse. The synthetic production of proteins requires complex procedures of isolation and purification that do not occur spontaneously in nature and are based on assumptions, models and projects which derive from the study of living systems. These models involve theoretical assumptions, about the relationship between inanimate matter and life, which are defined by the various and fundamental characteristics of organisms discovered thanks to observation, such as the intake of substances and energy from the environment, metabolism, reproduction, growth, mobility, reaction to stimuli, processing of information. All these features allow to describe different aspects of life. For example, the description of molecular structures allows the understanding of the physical characteristics of organisms and biochemical processes, but this identifies only some individual aspects of the manifestations of life. The same happens with the definition used in exobiology, according to which life would be a chemical system capable of evolution and reproduction. The development of models which describe the transition between inanimate matter and life is a consequence of the definition of life which is given in theoretical models. The vast and fascinating knowledge developed studying the details and the reciprocal interactions of molecules and macromolecules, involved in the creation of living organisms (proteins, DNA), has not yet solved the mystery of "life". We know about life only in relation to material components, but we also know that the DNA macromolecules, for example, can perform their functions only within the highly structured complexity of a cell. This indispensable whole is a prerequisite for life, and this requires an approach that takes into account complexity, since the individual and isolated feature alone would have no chance of success.

An unambiguous definition of life is still missing.

2. Origin of life, according to the law of syntropy

The law of syntropy stems from Albert Einstein's energy/momentum/mass equation of special relativity. This equation has a positive solution, which describes energy and matter which move forward in time, and a negative solution which describes energy and matter which move backwards in time. This last solution contradicts the law of causality, according to which causes must always precede effects. Einstein solved this contradiction simplifying the energy/momentum/mass equation into the famous $E = mc^2$, which always has a positive solution with matter and energy moving only forward in time. But, this simplification is not possible in quantum mechanics, that is, when studying the sub-atomic level of matter.

The general tendency of physicists has always been to consider irrelevant, if not impossible, the fact that matter and energy could move backwards in time. However, a growing number of researchers is showing interest in this possibility and, in November 2010, President Barack Obama awarded the physicist Yakir Aharonov the National Medal of Science for the experimental studies that show that the present is a result of causes which flow from the past as well as from the future. These results lead to a radical reinterpretation of the concepts of time and causality (Aharonov, 2005).

In 1942 the mathematician Luigi Fantappiè (1901-1955), while working on the mathematical properties of the energy/momentum/mass equation, found that the solution which moves forward in time describes energy that diverges from a past cause and matter which tends towards an homogeneous and random distribution, whereas the solution which moves backwards in time describes energy that converges towards a future cause and matter which tends towards forms of structure, organization and order. Fantappiè discovered that the solution that moves forward in time is governed by the law of entropy (from Greek *en* = divergent, *tropos* = trend), whereas the solution that moves backwards in time is governed by a symmetric law which Fantappiè named syntropy (from Greek *syn* = convergent, *tropos* = trend). Listing the mathematical properties of the law of syntropy, Fantappiè discovered that they coincide with those of living systems, thus reaching the suggestive hypothesis that life is caused by future causes and only marginally by past causes (Fantappiè, 1944).

Fantappiè concluded that, in order to understand and explain the mysteries of life, it is necessary to accept a new type of causality, which mirrors the classical law of cause and effect. His proposal, however, was brought to an end by the fact that he failed to devise an experiment which would verify this hypothesis. The experimental method requires the manipulation of causes and this implies (or at least implied) that it is possible to study only cause-effect systems. In recent years, thanks to the introduction of random event generators (REG), it has become possible to manipulate future causes in a totally unpredictable way. Using REG devices it has become possible to use the experimental methodology in order to study backwards in time causality (retrocausality).

The law of syntropy leads to the formulation of hypotheses which can be verified using experiments based on REG devises. For example, a general hypothesis is that living systems are fed by syntropy and, consequently, those structures that support life processes must show early reactions to future stimuli. In humans, life processes are supported by the autonomic nervous system, therefore it is assumed that the parameters of the autonomic nervous system, such as heart rate and skin conductance, should react in advance of future stimuli. Thanks to REG devices it is possible to manipulate future stimuli and observe the early reactions of the parameters of the autonomic nervous system. These experiments have shown strong pre-stimuli effects which have been replicated by many researchers and have been published in different scientific journals. At the moment, the only theory that explains these effects is Luigi Fantappiè's law of syntropy (Vannini and Di Corpo, 2004).

Robert Rosen (1934-1998), theoretical biologist, professor of biophysics at the Dalhousie University, pointed out in his book "*Anticipatory Systems*" (Rosen, 1985):

> *I was amazed by the amount of anticipatory behavior observed at all levels of the organization of living systems [...] systems that behave as true anticipatory systems, systems in which the present state changes according to future states, violate the law of classical causality according to which changes depend solely on past or present causes. We try to explain this behavior with theories and models that exclude any possibility of anticipation. Without exception, all the theories and biological models are classical in the sense that they only seek causes in the past or present.*

In order to make anticipatory behavior consistent with the law of causality, according to which causes must always precede effects, predictive models or learning processes are taken into account. But when one observes that anticipatory behavior characterizes also the simplest forms of life, such as cells, with no neural systems, it is difficult to support the hypothesis of acquired predictive models or learning processes. Moreover, this behavior is also seen in macromolecules and this fact excludes any possible explanation based on innate processes due to natural selection. Rosen concludes that a new law of causality it is therefore required in order to explain this behavior of anticipation typical of living systems. According to Fantappiè, this new law would be based on the premise that life depends on future causes and should therefore be described and explained using backwards in time causation.

The hypothesis that in order to understand living systems a different type of causality is required, had been advanced by Hans Driesch (1867-1941), a pioneer in experimental research in embryology. Driesch suggested the existence of final causes, which act in a top-down way (from global to analytical, from the future to the past) and not in a bottom-up way, as happens with classical causality. Final causes would lead living matter to develop and evolve, and would coincide with the purpose of nature, the biological potential. Final causes were named by Driesch entelechy. Entelechy is a Greek word whose derivation (en-telos) means something that contains in itself its own end or purpose, and that evolves towards this end. So, if the path of normal development is interrupted, the system can achieve the same end in another way. Driesch believed that the development and behavior of living systems are governed by a hierarchy of entelechies, which all result in an ultimate entelechy. The demonstration of this phenomenon was provided by Driesch using sea urchin embryos. Dividing cells of the embryo of sea urchin after the first cell-division, he expected each cell to develop into the corresponding half of the animal for which it had been designed or preprogrammed, but instead found that each developed into a complete sea urchin. This also happened at the four-cell stage: entire larvae ensued from each of the four cells, albeit smaller than usual. It is possible to remove large pieces from eggs, shuffle the blastomeres and interfere in many ways without affecting the resulting embryo. It appears that any single monad in the original egg cell is capable of forming any part of the completed embryo. Conversely, when merging two young embryos, a single sea urchin results and not two sea urchins. These results show that sea urchins develop towards a single morphological end. The moment we act on an embryo the surviving cell continues to respond to the final cause that leads to the formation of structures. Although smaller, the structure which is reached is similar to that which would have been obtained by the original embryo. It follows that the final form is not caused by the past or by a program, a project or a design which act from the past, since any change we introduce in the past leads to the formation of the same structure. Even when a part of the system is removed or the normal development is disturbed, the final form is reached and it is always the same. Another example is that of the regeneration of tissues. Driesch studied the process by which organisms are able to replace or repair damaged structures. Plants have an amazing range of regenerative capabilities, and the same happens with animals. For example, if a flatworm is cut into pieces, each piece regenerates a complete worm. Many vertebrates have extraordinary capabilities of regeneration, for example, if the lens of the eye of a newt is surgically removed, a new lens is regenerated from the edge of the iris, whereas in the normal development of the embryo the lens is formed in a very different way, starting from the skin. Driesch used the concept of entelechy to account for the properties of integrity and directionality in the development and regeneration of bodies and living systems.

Independently in 1926 the Russian scientist Alexander Gurwitsch (1874-1954) and the Austrian biologist Paul Alfred Weiss (1898-1989) suggested the existence of a new causal factor, different from classical causality, which was named morphogenetic field. Apart from the claim that morphogenetic fields play an important role in the control of morphogenesis (the development of the shape of the body), neither authors showed how causality works in these fields. The term "field" is currently fashionable: gravitational field, electromagnetic field, individual field of particles and morphogenetic field. However, the word field is used to indicate something that is observed, but not yet understood in terms of classical causality; events that require a new type of explanation based on a new kind of causality.

The law of syntropy replaces the terms entelechies and fields with the terms "*final causes*" or "*attractors*". Causes acting from the future are based on the retrocausal properties of syntropy which attract and guide. Syntropy causal mechanism is similar to emotions which drive, direct and guide. The theory of syntropy assumes that living systems are systems driven by emotions towards final causes which act as attractors, and that backwards in time causality manifests mainly in the form of emotions.

In order to avoid mystical, magical or paranormal discourses it is important to note that the energy/momentum/mass equation predicts the existence of three types of time:

1. ***Causal***. Causal time characterizes diverging systems, for example our expanding universe. In these systems, causes precede effects, entropy prevails, and time moves forwards, from past to future.
2. ***Retrocausal***. Retrocausal time characterizes converging systems, for example blacks holes. In these systems effects precede causes, syntropy prevails, and time moves backwards, from future to past.
3. ***Supercausal***. Supercausal time characterizes systems which are balanced between diverging and converging forces, such as atoms. In these systems causality and retrocausality coexist and time is unitary: past, present and future are present together.

These types of time were known to ancient Greeks as:

1. ***Kronos***, which describes the causal time familiar to us, typical of the law of entropy, made of absolute moments which flow from past to future.
2. ***Kairos***, which describes the retrocausal time, typical of the law of syntropy. According to Pythagoras's *Kairos* is at the basis of intuition and the ability to anticipate the future and to choose advantageously.
3. ***Aion*** which describes the supercausal time in which past, present and future coexist.

According to this classification syntropy and entropy coexist in the quantum level of matter, that is at the *Aion* level, and at this level life can originate. The question which naturally arises is the following: *how do the properties of syntropy rise from the quantum level of matter to the macroscopic level of our physical reality, thus transforming inorganic matter into organic matter*? In 1925 the physicist Wolfgang Pauli (1900-1958) discovered the hydrogen bridge, or hydrogen bond, in water molecules. Hydrogen atoms are in an intermediate position between the sub-atomic level (quantum) and molecular level (macrocosm) and form a bridge that allows syntropy (cohesive forces) to flow from the quantum level to the macrocosm level. Hydrogen bonding increases the cohesive forces (syntropy) and characterizes the water molecule, making it different from all other liquids, with attractive forces ten times more powerful than the van der Waals forces that hold together the molecules of other liquids. Because of these strong cohesive forces, water shows anomalous properties, such as when it freezes, it expands, becomes less dense and floats, unlike other liquids which contract, become denser and heavier and sink. In addition, water solidifies from the top. In other liquids solidification starts from the bottom, because the heat, the hot part of the liquid moves up toward the surface, while cold molecules sink. The liquid in the lower part is thus the first to reach the solidification temperature, and therefore liquids solidify in a bottom-up process. Exactly the opposite happens in water. Compared to other liquids water shows a much higher heat capacity and requires higher quantities of heat in order to increase its temperature. For this reason water is used in cooling systems. The singularity of water resides almost entirely in its attractive and cohesive properties (typical of the law of syntropy). Other molecules that form hydrogen bridges (such as ammonia) do not reach attractive properties as high as water and therefore cannot build networks and broad structures in space as is the case for water. The hydrogen bridge mechanism allows syntropy to flow from the quantum level of matter to the macrocosm level, turning water into an essential molecule for life. Water is, after all, the lymph of life which provides living systems with syntropy. If life were ever to start on another planet, it would certainly require water. Water is the essential element for the origin and evolution of any biological structure.

In conclusion, the law of syntropy states that life is the manifestation of a general law of the universe and that this manifestation is possible only thanks to water molecules. According to this theory, life was not created, but emerges spontaneously wherever there is water. Wherever there is water there is life, and for this reason, water is an important clue to the possibility of life on other planets.

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