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From the book of nature to the PVS, a syntropy that comes from afar [1]

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"*The book of nature is written in the language of mathematics*."
Galileo Galilei, 1623

For a long time, science viewed nature through a mechanistic lens: the physical world as a machine governed by material causes that drive the present from the past, while conscious experience remains an external spectator. But in the twentieth century, this framework began to crumble: quantum mechanics demonstrated that the observer, and more generally the measurement process, entered the description of physical phenomena. At the same time, biology discovered that a list of molecules was no longer sufficient to understand how an organism lives, organizes itself, and heals; bridges were needed between chemistry and physics, between form and process, between developmental biology and force fields. [1-2].

The Prime Vascular System (PVS) sits squarely at this crossroads. On the one hand, it is a concrete anatomical proposal, namely a fine network of ducts and nodes (Primo Vessels, Primo Nodes) distinct from the blood and lymphatic systems; on the other, it is a powerful conceptual hypothesis: a possible informational channel integrating biochemistry, mechanics, electricity, and perhaps ultra-weak light (biophotons). [7–11].

On the Prime Vascular System, there is no shortage of "papers", in fact there are histological observations, selective stainings, data on hyaluronic acid, DNA, stem cells, innate immune functions (HAR-NDS) [8–13]. The difficult thing is no longer listing them, but putting them in line within a theoretical framework that respects the constraints of physics and thermodynamics and that makes use of explicit mathematical models; that produces falsifiable hypotheses and not just seductive metaphors.

This is where two references come into play: Stephen Hawking's method and Luigi Fantappiè's syntropy. It should be noted that the reference to Hawking and Fantappiè is only methodological, not necessarily content-related.

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[1] Taken from the eleventh chapter of the book "*Primo Vascular System, La via di trasmissione biofotonica dell'Uomo*" available at the address:
https://www.researchgate.net/publication/398609877_Primo_Vascular_System_La_via_di_trasmissione_biofotonica_dell'Uomo#fullTextFileContent

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Hawking reminded us that a physical theory, however bold, is first and foremost a mathematical model; it must be consistent with known laws, describe available data, and produce testable predictions. As long as these predictions hold up to the test of experiment, the theory "works"; when they are falsified, it must be corrected or abandoned. This is precisely the approach proposed here for PVS: moving beyond pure qualitative description and formulating explicit biophysical hypotheses, with variables, parameters, and boundary conditions, that clearly state what should happen if the model is correct. Only in this way can PVS be discussed in the same logical space as other scientific theories. [2].

Applied to biology, the message is clear: even "difficult" hypotheses, such as the functional existence of the PVS, or the role of biophotons, become science only if translated into models with measurable predictions. It is in this spirit that it is worth rereading Luigi Fantappiè's syntropy and asking whether it can offer a mathematical framework for discussing order, life, and the Prime Vascular System without slipping into metaphysics.

1 A syntropy that comes from afar

Hawking and Fantappiè aren't the only ones looking at syntropy through a special lens. Let's start with Einstein, with his complete equation and the "removed" solution. The famous formula $E = mc^2$ is, in fact, a simplified version of a more general equation that Einstein included in 1905 within special relativity. In its complete form, the energy-mass-momentum relationship admits two time-symmetric solutions: one corresponds to energy propagating forward, from the past to the future, and the other to energy that, mathematically, behaves as if it were propagating backward in time. To make the equation compatible with classical causal intuition (first the cause, then the effect), Einstein assumed that for ordinary physical bodies the momentum is negligible and thus reduced everything to $E = mc^2$, effectively eliminating the "negative time" solution. That part of his own theory that would have opened the way to retrocausality is, so to speak, "cut away" for reasons of conceptual acceptability rather than out of real mathematical necessity.

When, in the 1920s, quantum mechanics intertwined with Einstein's relativity (the Klein–Gordon equation), the double solution in time naturally reemerged: the equations describing relativistic particles predict propagation both toward the future and the past. This structure could have provided a mathematical foundation for the dual

face of quantum phenomena (wave/particle, field/event), linking it to a double arrow of time. But the retrocausal solution continued to be rejected; to eliminate it, Schrödinger constructed his equation by abandoning the very relativistic component that generates the double temporal direction. "Official" quantum mechanics, in the Copenhagen interpretation (Bohr–Heisenberg), retained only the arrow from the past to the future and shifted the mystery to the role of the observer called upon to "collapse" the wave function. In this historic choice, the part of Einstein's structure that would have naturally interacted with syntropy and the idea of attractors from the future was essentially removed from the standard framework.

During the same period, Einstein also explored cyclical models of the universe, in which the cosmos alternates phases of expansion (like the Big Bang) and phases of contraction (the Big Crunch) under the action of gravity. In a syntropic reading, the expansive phase can be associated with the entropic arrow: matter-energy disperses, structures expand, and causality "from past to future" dominates. The contraction phase, on the other hand, can be seen as a sort of "syntropic side" of the cosmos: the universe refocuses, trajectories converge, and evolution seems goal-driven, rather than driven by initial conditions. In this framework, Einstein's universe already potentially contains both tendencies that Fantappiè would formalize as entropy (divergence) and syntropy (convergence), and which Di Corpo and Vannini would interpret as two complementary arrows of time: one originating from the past, the other coming from the future in the form of attractors.

Albert Szent-Györgyi, Nobel Prize winner for Physiology or Medicine (1937), reflecting on living systems that exhibit increasing order, organization, and complexity over time, emphasized how their behavior was "in open contrast" with entropy. To describe this tendency toward increasing order and structure, he hypothesized the existence of a force symmetrical and complementary to entropy, capable of pushing systems toward greater organization.

A decisive step toward a mathematical formalization of this insight was taken by Fantappiè, who, working on the solutions to equations combining quantum mechanics and special relativity, realized that 1) the solution forward in time describes energy and matter tending toward a homogeneous and random distribution, in accordance with the second law of thermodynamics and the "heat death" of the universe (the law of entropy); 2) the solution backward in time, instead, exhibits a mirror-image behavior: energy, rather than dissipating, tends to concentrate, generating order, structure, and information. Fantappiè called this second law syntropy. From a mathematical

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perspective, syntropic solutions are characterized by the concentration of energy; increased differentiation and complexity; reduced entropy; the formation of structures; and increased order and information.

Since the 2000s, Ulisse Di Corpo and Antonella Vannini have taken up and updated Fantappiè's intuition, building a truly "modern" reinterpretation of syntropy that connects mathematics, physics, psychology and life sciences.[3] Di Corpo and Vannini are today the main operative continuators of the Fantappiè–Arcidiacono line, developing theoretical models (new thermodynamics, vital needs, syntropic models of consciousness); producing experimental data on anticipatory and retrocausal phenomena; and maintaining, through the Syntropy Journal, a research community exploring the implications of syntropy in physics, biology, psychology, and economics.

In 2007, Antonella Vannini formulated a very clear experimental hypothesis: if life is sustained by syntropy, then the parameters of the autonomic nervous system that supports vital functions should react in advance to stimuli. In other words, variables such as heart rate and skin conductance could show changes before a stimulus is actually presented. This hypothesis fits into a line of research opened by experiments such as those of Dean Radin, in which autonomic parameters (heart rate, skin conductance, etc.) are monitored while subjects are first shown a blank screen and then randomly shown a calm or emotionally intense image. In these protocols, systematic differences are observed in the period preceding the presentation of emotional images compared to neutral ones. A review of these experiments, together with the description of four studies conducted by Di Corpo and Vannini themselves, is presented in Retrocausality: experiments and theory (2011), where the authors interpret these phenomena as possible effects of syntropic attractors acting from the future on the present through the autonomic nervous system.

[3] Ulisse Di Corpo is an experimental psychologist and social researcher; he has been studying syntropy since 1977 and developed the Theory of Vital Needs, which links entropy/syntropy with material and immaterial needs, proposing a "syntropic" interpretation of anxiety and depression. He is the author of several books (including The Theory of Vital Needs, Introduction to Sintropy, and Apocalypse and Syntropy) and has been the editor and lead author of the online Syntropy Journal since 2005. Antonella Vannini is a psychologist, psychotherapist, cognitive psychologist, and hypnotherapist. She earned a doctorate from La Sapienza University in Rome with a thesis on "A Syntropic Model of Consciousness," in which she applies syntropy to models of consciousness and time (delayed/advanced waves). She is the author of works such as From Mechanical to Life Causation (Syntropy 2005) and co-author, with Di Corpo, of volumes such as Entropy and Syntropy. Causality and Retrocausality in Physics and the Life Sciences and Retrocausality: Experiments and Theory.

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In their theoretical work, Di Corpo and Vannini also apply syntropy to the theory of evolution, distinguishing two levels:

1. *Microevolution*, which Darwinian theory successfully describes: natural selection, genetic drift, speciation, optimization, and specialization. These processes, however, tend to reduce genetic diversity in the long term (loss of information, potentially more fragile species).
2. *Macroevolution*, or the emergence of entirely new forms (organs, leaps in complexity, radically original structures). According to the authors, invoking random mutations and natural selection is not enough: new structural information is needed, which the theory attributes to syntropic attractors.

From this perspective, the universe is governed not only by an entropic arrow (from the past to the future, toward disorder and homogeneity), but also by a "future side" populated by hierarchically organized attractors that send "designs of form" to the physical world. When these attractors interact with entropic systems, fractal geometries often emerge: coronary ramifications; bronchial trees; neuronal arborizations; all forms that can be interpreted as imprints of syntropy in living things.

Drawing on Rupert Sheldrake's ideas on morphogenetic fields, Di Corpo and Vannini translate those "fields" into morphogenetic attractors: not just fields that organize space, but actual future projects toward which the system tends. In this framework, the gene loses its exclusive role as a "hard disk" storing the past and becomes, above all, an antenna that connects to the species attractor, receiving its form and design.

This reinterpretation allows, according to the authors, to give a syntropic reading to three classical phenomena:

1. the surprising stability of species over time.
2. The apparent evolutionary convergence toward similar forms in independent lineages.
3. Hans Driesch's findings: in some experiments, a single sea urchin cell at the bicellular stage can develop into a complete individual, as if there were a global "blueprint" from which the cell continually draws.

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Sheldrake's experiments on learning in mice and on crystallization can be reinterpreted in the same light: when many individuals of a species learn a task, it becomes easier for their offspring; similarly, once a new crystal has been formed several times, its future crystallization is facilitated.

The proposed explanation is that collective experience is "written" into the species attractor (e.g., attractor humanity, attractor mice), and individual organisms connect to it through their genes, which function as interfaces with the future, not just with past heritage.

The central proposal is that life is the meeting point between these two tendencies: evolution would not only be the result of randomly selected mutations, but also the progressive unfolding of attractive "projects" that act "retrocausally".

2 Watterson: water, entropy and syntropy

John Grant Watterson of Griffith University (Queensland, Australia) begins with a radical critique of the traditional image of the cell as a "bag of enzymes" immersed in a dilute solution and governed by random collisions. In his works, particularly "The Entropy–Syntropy Inversion in Water Part II: From Physics to Biology," he argues that classical thermodynamics, centered solely on entropy and molecules colliding randomly in solution, is insufficient to convincingly describe living systems. The key is water, which is not a simple passive solvent, but a gelled and structured medium that occupies 70–80% of the cell's volume. In aqueous gels, matter appears macroscopically solid but is dynamic at the molecular level. In this framework, living systems can be reinterpreted as "coupled entropic-syntropic machines." On the one hand, they dissipate energy outward (entropic arrow "outward"); on the other hand, thanks to gelled water and hydrophilic interfaces, they transform part of that flow into internal organization, into ordered and functional structures (a sort of "inward" syntropic flow). Hydration forces and interfacial water thus take on a central role. Between hydrophilic surfaces, such as lipids or silica, local pressures of up to ~10^3 atm develop, solute exclusion zones form, and an orientational order extending over tens or hundreds of nanometers appears: clear signs that the medium is anything but random. The same holds true for the cytoplasm: gel–sol transitions, directional flows along actin and microtubules, and "molecular clutch" mechanisms demonstrate a spatiotemporal control of forces that contradicts the idea of a purely diffusive dynamics.

ATP synthase and many other "molecular machines" work in a vectorial fashion, exploiting anisotropies of the medium that cannot be explained if we assume that thermal energy is the only relevant parameter.

Even large modeling efforts, such as the IBM Blue Gene project, based on free energy minimization to explain protein folding, have not solved the problem without involving the cooperativity of the medium and coherent phenomena (also from a QED perspective).

Frey-Wyssling, between the 1930s and 1950s, had already observed that the cytoplasm of many cells does not appear as a homogeneous liquid, but shows birefringence, directional optical index and ordered streaming.

In muscle, myofibrils are organized into repeating sarcomeres with aligned thick and thin filaments; X-ray diffraction reveals sharp, periodic reflections, a sign of mesoscopic order extending across tens to hundreds of nanometers. "Mesoscopic order" means that the alignment extends far beyond the individual protein, "structural coherence" means that many units maintain the same phase and geometry, like synchronized gears. [20-20e].

If the cytoplasm were truly a soup of randomly colliding molecules, these coherent patterns would not appear; the diffraction signals would be blurred and disordered. In practice, the architecture of the medium—protein lattices, hydrated gels, membranes—channels energy and reactions, reduces the randomization due to thermal energy, and vectorizes processes (contraction, intracellular transport, signal transduction).

In this context, water near biological surfaces acts as a real actor. Hydrophilic interfaces, glycocalyx, and glycosaminoglycans (especially hyaluronic acid) gel water even at low concentrations, creating stable physical barriers—consider the gastric mucosa, which can withstand enormous pH gradients without the "collisions" predicted by a rigidly kT-centric interpretation destroying the structure.

Classical and modern studies show anisotropy, facilitated flow, solute exclusion, and the collapse of dielectric fluctuations at the nanometer scale: all indications of a medium with a much richer physics than that of a simple solvent. In parallel, work such as Pollack's on "EZ-water"[4] and on the coherence of interfacial water have opened up suggestive scenarios, but not yet fully recognized by the mainstream; for this reason Watterson insists on the need for rigorous replications, double-blind protocols and metrological traceability, to distinguish what belongs to conventional chemistry and mechanics from what would really require a "new" physics of living things. [21-23a].

[4] Gerald Pollack. The Fourth Phase of Water: Beyond Solid, Liquid, and Vapor. 2013

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His research agenda is, in this sense, very concrete: using innovative techniques (e.g., the Surface Force Apparatus) to measure force-distance curves in the cytoskeleton and gel of the extracellular matrix; Brillouin mapping and microrheology to define elastic moduli and local viscosities; and dielectric spectroscopy (kHz–GHz), Raman, and IR to probe orientational order and relaxation times of confined water. The goal is to reimagine cellular biophysics by placing the medium—water, gels, polyelectrolyte matrices—at the center as an active agent generating forces, anisotropies, and coherences essential for cellular function. In this vision, the cytoplasm, membrane, and extracellular matrix are no longer "inert backgrounds," but active media that channel energy and information, favoring preferential pathways for charges, protons, and solutes, and enabling weak but directional physical biases, synergistic with classical chemistry.

Compared to Fantappiè's syntropy, Watterson remains on the level of proximal causes: surfaces, local fields, rheology of the medium, dissipative structures in the Prigoginian sense. Fantappiè, on the other hand, introduces an arrow "from the future" and an intrinsic finality (anticipated waves, attractors), offering a broad mathematical framework, but still poorly connected to specific experimental protocols.

Both, however, emphasize order and coherence, and challenge the idea that biological organization arises solely from random collisions in dilute solutions. Where Fantappiè speaks of a "tendency converging toward form," Watterson shows how surfaces, hydration, and gels can convert thermal energy into directional work in a completely local manner, without invoking retrocauses.

If we remain on a strictly physical level, what is sometimes described as "syntropy"—that is, the ability of living things to generate order and differentiation—can be interpreted as a phenomenon of dissipative self-organization in open systems. The second law of thermodynamics remains fully valid: the total entropy of the system plus its environment continues to increase, but local entropy can decrease thanks to the flows of matter and energy that pass through the system. In this context, syntropy remains an effective metaphor for describing the tendency toward order, while Watterson's work provides a practical way to measure, with the tools of continuum physics, how structured water and biological gels concretely enable the gain in organization we observe in living matter.

3 Water, Epigenome, and the Prime Vascular System

In the framework inaugurated by Fantappiè, syntropy is the complementary tendency to entropy: instead of dispersing energy and information, it tends to concentrate them in ordered and stable structures. In living systems, this process does not occur in the abstract, but seems to find a privileged "physical locus" precisely in water, particularly in the structured water of biological gels that constitute the majority of the cytoplasm and extracellular matrix. In these gel-like phases, water oscillates between more ordered (cluster) and more disordered (anticluster) states, generating not only pressure gradients (entropic side) but also internal tensions capable of performing "inward" work, that is, a true syntropic work of concentration and organization. From this perspective, living systems can be interpreted as coupled entropic-syntropic machines, that is, on the one hand, they capture energy "downstream" (photons, nutrients, concentration differences) and dissipate part of it; on the other hand, thanks to the gelled water and its cohesive properties, they transform a portion of this flow into an increase in structural and functional complexity.

At the molecular level, this transformation is reflected in the epigenome—that is, DNA methylation, histone modifications, and chromatin remodeling—which are how the cell fixes over time the outcomes of the energy and information flows that pass through its liquid microenvironment. In a syntropic interpretation, epigenetic patterns become stable yet reversible traces of concentration and organization processes: a regulatory memory that translates physical and chemical signals into response programs consistent with the history of the living system.

If we broaden our gaze to the tissue and system scale, a working hypothesis is that structures rich in organized aqueous gel, such as the specialized extracellular matrix or the Prime Vascular System, may act as "syntropic conduits," that is, networks capable of conveying mechanical tensions, electrical gradients, and photonic signals over long distances, reducing dispersion and promoting alignment and coherence between distant regions of the body.

In this sense, the PVS could represent an anatomical candidate for an intermediate level between the Fantappiè equations, which formulate syntropy as a general mathematical principle, and the fine biochemistry of the epigenome, where syntropy means a local increase in order and functional information.

Where the gelled water and the architecture of the PVS are able to contain entropy and transform part of the energy flow into organization, the cell can "read" this gain in order and translate it into specific epigenetic choices, modulating gene expression in a

way that is consistent with its own history and the "possible future" of the living system.

The connections proposed here between syntropy, gelled water, the epigenome, and the Prime Vascular System are working hypotheses, not finished theories; they can be considered falsifiable in at least three directions:

1. Experimentally verifying whether and to what extent the physical properties of structured water (cluster/anticluster, internal tensions, electrodynamic coherence) are actually capable of reproducibly modulating epigenetic processes.
2. Using histological, molecular, and imaging techniques, mapping whether PVS truly possesses unique mechanical, electrical, and photonic conduction characteristics that distinguish it from conventional extracellular matrix.
3. Testing whether quantitative models inspired by syntropy (starting with Fantappiè's formulations) better describe, than entropic laws alone, the emergence and maintenance of highly organized states in real living systems.

From this perspective, syntropy is not assumed as a metaphysical "vital force," but as a mathematical and physical framework to be tested, capable of generating precise experimental predictions on the behavior of biological water, PVS networks, and epigenetic patterns.

4 Fantappiè and syntropy

Luigi Fantappiè (1901–1956) holds a singular place in the twentieth-century Italian scientific landscape, as a great mathematician (theory of analytic functionals), but also the author of an ambitious "Unitary Theory of the Physical and Biological World." His key idea is syntropy, introduced in the early 1940s, in dialogue with d'Alembert's wave equation and the two families of solutions it admits: 1) retarded potentials (causality from past to future), the basis of ordinary, dissipative, and entropic physics; 2) anticipated potentials, formally admitted, but usually dismissed as "unphysical."

Fantappiè was the first to give these anticipated solutions a physical and biological meaning, linking them to "constructive" phenomena oriented toward order, differentiation, and purpose. This gave rise to the entropy/syntropy pairing, where entropy describes the processes that degrade order, increase disorder, and lead to

thermal equilibrium; syntropy describes the processes in which order increases, forms organize, and an organism grows or heals.

In the famous autobiographical passage of 1941–42, Fantappiè recounts his intellectual "shock": "*It became clear to me that these syntropic, finalistic phenomena, which lead to differentiation and cannot be reproduced in the laboratory, were real and existed in nature, since I could recognize them in living systems.*"

His proposal does not erase known physics, rather it extends it, adding to causality (past→future) a form of "finality" (future attractors of order), formalized with the same tools as wave equations and symmetry groups.

In the following years, Fantappiè also developed "final relativity" and the theory of "physical universes", seeking a structure of symmetries in which entropy and syntropy are two sides of the same formalism.

Today, syntropy is not accepted as a new physical law, but it retains value as a conceptual lens and invites us to view living phenomena as processes that maintain order in open systems, far from equilibrium, exporting entropy to the environment. Prigogine's framework for dissipative structures is precisely this: [3–6].

To avoid becoming vague, we can translate syntropy into a language closer to systems science:

1. A living organism is an open system, meaning it receives energy and matter and exports entropy.
2. Internal order increases (or is maintained) only at the cost of dissipation towards the outside.
3. The processes of growth, regeneration, and embryonic development are trajectories in which the organism passes through increasingly structured states.

In informational terms, it can be said that a syntropic system reduces uncertainty about its future state (minimizes "surprise", free energy); increases the constraints and correlations between subsystems (higher mutual information, fewer effective degrees of freedom); selects, among the many possible trajectories, those that maintain the global structure and the capacity for adaptation. [3].

Fantappiè's syntropy can be read as a variational principle; meaning that living systems tend toward regions of state space where order (understood as structured information) increases, while still respecting global thermodynamics. In this language, there's no need to evoke "causes from the future," but rather to recognize that structural

constraints (genome, network architecture, tissue geometry) and force fields (chemical, mechanical, electrical) restrict the space of possible trajectories, so that certain configurations, more ordered and more functional, are selected.

It is precisely on this type of constraints that a system like the PVS can play.

5 Mathematics is useful for complex biology

Despite spectacular advances in molecular biology, a central question remains: how do cells exchange information, and when do they decide to respond to signals from the microenvironment?

Here, mathematics is not decoration, but the system for transforming intuitions into well-defined models, quantitative predictions, and falsification criteria.

A transferable method, inspired by both theoretical physics and systems biology, can be summarized in four points:

1. *Define the model*
   - What variables (concentrations, potentials, flow intensities)?
   - At what scale (molecule, cell, tissue)?
   - Under what symmetries and constraints (conservation, causality, boundaries)?
2. *Derive falsifiable predictions*
   - What should happen if the model is correct?
   - What key parameters can be measured?
3. *Check physical consistency*
   - Entropy production is ≥ 0?
   - Don't signals travel faster than light?
   - Doesn't the response violate mass/energy/charge balances?
4. *Comparison with data*
   - Targeted experiments, with controls and uncertainty estimates.
   - If the data contradict the model, it is modified or abandoned.

In modern biology, each cell can be viewed as a point in a very high-dimensional space (transcriptome, proteome, metabolome) [1,2]. Techniques such as PCA, UMAP, t-SNE allow us to compress these hyperspaces and recognize "attractors" (stable states, cell fates, functional subtypes). This is an example of how mathematics, used well, does not add confusion, but helps us see the hidden order in the data.

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When considering biophysical processes, proton tunneling, long-distance electron transfer, proton "water wires", spin-dependent reactions, chirality-induced spin selectivity, light propagation in turbid media, mathematics is indispensable to avoid falling into naive simplifications. [3–5].

The same applies to tissues, structures such as collagen, hyaluronic acid, and polyelectrolyte networks that cannot be described by a single simple law (e.g., the Donnan effect). We need poro-electro-mechanical models that include ion transport, deformations, and mechanical constraints. [4].

In short, if we want to talk seriously about PVS, syntropy, biophotons, we must use this type of tools and not just analogies.

6 PVS as a syntropic subsystem: working hypothesis and tests

In light of mathematical models and the thermodynamics of open systems, we can propose, as a working hypothesis, the Prime Vascular System, which acts as a syntropic subsystem—that is, a network that helps maintain order and coherence in an open and dissipative organism by channeling flows of matter, energy, and information. What do we know today, in a relatively consolidated way?

- The PVS is described as a network of ducts and nodes (distinct from that of the circulatory and lymphatic systems) observed in several animal models and in some human studies [7–11].
- The Primo Fluid is rich in hyaluronic acid and contains nucleic acids, proteins, amino acids, mononucleotides, and stem cells; the HAR-NDS network suggests innate immunity and hematopoiesis functions [12,13].

If this network establishes a fine connectivity between tissue compartments, with flows of hyaluronic acid-rich fluid and molecular cargo (DNA/RNA, stem cells), then it could have three "syntropic" effects:

1. *Damping of local fluctuations*. This is possible thanks to the viscoelastic and hydraulic properties of hyaluronic acid, which "distributes stress" and stabilizes gradients.
2. *Selective routing of immuno-metabolic signals*. Facilitating faster and more precise coordination between tissue districts.

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3. *Facilitating repair/regeneration*. Hosting stem cells and genetic material capable of contributing to local reconstruction in the event of damage [9,13].

Translated into the language of syntropy, the PVS could reduce the production of local entropy while maintaining the same useful work (greater repair and maintenance efficiency); it could increase the information shared between districts (greater mutual information and dynamic coherence).

But all this remains a hypothesis unless it is translated into falsifiable predictions. So, what should happen if the PVS were truly syntropic?

To make the thesis presented more than a beautiful narrative, concrete tests must be identified. Such experiments, of course, must be designed with great caution and ethics, especially in animal models. Some examples follow.

Local entropy and pattern stability.

In the body districts where the PVS is more represented (e.g. along some meridians), all other things being equal and with the same "biological work" carried out (repair, remodeling), one should expect:

a) lower heat production (indirect estimate of entropy production).
b) Greater stability and robustness of dynamic patterns (metabolic oscillations, electrical potentials, proton gradients).

In practice, given the same stimulus, the tissue "connected" by the PVS should consume energy more efficiently and maintain more stable patterns than a control tissue.

Information and coordination

Multi-channel recordings, such as:

a) low-frequency electrical signals.
b) Mechanical microvariations (elasto-OCT, Brillouin).

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c) Ultra-weak photon emissions (UPE), which should exhibit greater mutual information and/or spectral coherence between regions connected by the PVS than between pairs of unconnected regions.

If the PVS were truly a coordination channel, its presence must be "visible" in terms of greater synchronization between signals from remote districts.

Reversible perturbation experiments

Targeted interventions on the architecture of developing countries, such as:

a) viscoelastic disruption using local hyaluronidase at controlled doses.
b) Reversible micro-occlusions of the ducts, which should increase dissipation (more heat, reduced repair efficiency) as well as reduce order indices (signal coherence, regenerative capacity).

In all three cases, if the data showed no significant differences, the syntropic hypothesis would have to be scaled back or abandoned. This is the price, and the value, of science.

Also worthy of mention are highly sensitive and specific methods, many of which are available today and which would allow us to move from the vague idea of a "thin information network" to quantitative tests; either the expected effects are observed, or we are forced to change our theory.

- *Label-free imaging for structure and mechanics* – elastic OCT, Brillouin microscopy, quantitative phase-contrast microscopy, confocal Raman.
- *Microfluidics and inert tracers* – to measure permeability and flow rate in PVS ducts, comparing them with arterial, venous, and lymphatic vessels.
- *First Fluid Omics* – quantification of hyaluronic acid, proteomics, nucleic acid analysis (free and vesicular), with blood/lymphatic contamination controls.
- *Local calorimetry and high-resolution thermography* – to estimate heat production (entropy) during repair processes or in response to stimuli.

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- *Information analysis* – estimation of entropy, mutual information, transfer entropy, and spectral coherence between time series of signals (electrical, mechanical, optical) in tissues connected or not by the PVS.

7 Biophotons, Biological Electricity, and PVS: Hypotheses and Cautions

In this scenario, biophotonics adds a fascinating piece. It has been known for decades that living cells and tissues emit ultra-weak photons (UPE) in the visible and near UV, linked to oxidative processes and excited electronic states [15]. So much so that Sung Jang Chung has proposed to read the PVS in a quantum key, imagining it as a network capable of conveying very weak signals of "biological light" [17]. The hypothesis, in simple form, is the following: small DNA granules (p-microcell, sanal), which when excited could emit biophotons; the latter would propagate along the Bonghan/Primo Vessels ducts; the propagation would influence internal organs and the brain; the stimuli used in acupuncture could modulate this signal, provided that a reliable map of the network is available.

Studies by Dotta and Persinger have shown, for example, increases in photonic emission from the skull in subjects imagining white light, with an intensity around 10^{-12} W/m² [16]. The resulting picture is suggestive: DNA as an antenna, PVS as a waveguide, acupuncture points as "access doors".

However, optical models of tissues require caution; in fact, biological media are turbid and absorb light; propagation is diffuse and not collimated; only in the presence of well-defined guiding structures (fibres, channels, cavities) can directionality be preserved [3].

In special cases, organized structures (tubes rich in collagen, hyaluronic acid, interfaces with different refractive index) could assume the function of soft waveguide; but this must be demonstrated with:

- direct measurements of UPE along PVS-like structures.
- Spectral filtering.
- Rigorous optical controls.
- Anisotropic radiative transport models.

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In syntropic terms, biophotons are interesting not so much as "magical energy" but as state markers: variations in intensity, spectrum, and coherence can reflect changes in metabolism, redox order, and, therefore, in the set of constraints that maintain the organism in dynamic equilibrium. If PVS truly contributes to organizing these constraints, biophotonics could provide a privileged observation channel for detecting them.

8 Embryology and fields: a syntropic perspective

The PVS is naturally close to embryology because it has often been linked to acupuncture meridians; to embryonic organizing centers; to areas of low electrical resistance and high density of gap junctions. From a syntropic perspective, these centers are not simply "points that respond well to needles," but field nodes through which information and constraints flow that orient form: during development, regeneration, and healing.

If, as Blechschmidt writes, "growth functions precede all more advanced functions," then systems like the PVS could be part of the physical infrastructure of these functions: a finely tuned fabric linking growth motion, nutrient distribution, tissue electric fields, biochemical signals, and perhaps ultra-weak photonic signals. In Fantappiè's terms, it would be one of the places where syntropy, understood as a tendency toward order and coherence, becomes visible and measurable.

In conclusion, the thread that unites the aforementioned scientists, PVS, biophotons, and mathematical models is an invitation to shift perspectives without losing rigor; to use concepts like syntropy to discuss order, apparent purpose, and coherence, but, at the same time, to translate these ideas into mathematical models and falsifiable hypotheses. It must be recognized that the purely mechanistic paradigm is no longer sufficient to describe living things.

Treating the PVS as a syntropic subsystem, in the thermodynamic-informational sense, is a plausible and fruitful theoretical framework: it suggests what to measure, what experiments to conduct, what type of signatures to look for in terms of entropy, information, and signal coherence. The thesis will become scientifically sound only if it is supported by robust quantitative measurements; if it is confirmed by perturbation and recovery experiments; and if it is replicated by independent groups.

Otherwise, some hypotheses will collapse, others will change. This is how syntropy, from a visionary word, could become, at least in part, a working concept for 21st-century biology: the hypothesized quantum biology.

The next step is not "believing," but measuring.

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