

Long Covid What the Evidence Has Been Trying to Tell Us

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Begin Here: A Clinician's Frustration

You have a patient in front of you. She has been ill for eighteen months. She was fit, healthy, no pre-existing conditions. SARS-CoV-2 in early 2024, moderate acute illness, apparently recovered. Then: crushing fatigue, cognitive impairment, post-exertional malaise that can put her in bed for three days after a short walk, autonomic instability, unrefreshing sleep.

You have run the tests. Full blood count: normal. CRP: normal. Thyroid: normal. ANA: negative. Brain MRI: unremarkable. Cardiac workup: unremarkable.

You have nothing to give her. The guidelines offer graded exercise therapy — but every time she tries it, she deteriorates. You refer to the Long Covid clinic. They confirm the diagnosis and offer pacing advice. She already knows about pacing. She has been doing it for a year.

Somewhere in the literature you read about brain retraining programs — patients reporting dramatic recoveries. You mention it cautiously. She has tried one. It helped, then stopped helping, then seemed to make things worse.

You are a careful, conscientious clinician. You have done everything right. And you have nothing.

This paper is written for you.

Part One: The Anomalies Your Paradigm Cannot Explain

Before introducing any new framework, it is worth being precise about what the current framework cannot explain. Not what it explains poorly — what it **cannot** explain at all.

Anomaly 1: Normal tests in genuinely ill patients

The warfare model of immunology predicts that biological illness produces detectable biological markers: elevated inflammatory markers, identifiable pathogens, organ dysfunction. In Long Covid, standard panels return normal in a large proportion of patients who are clearly, severely unwell.

More sensitive measures do find abnormalities — persistent low-grade type I interferon elevation, reduced NK cell cytotoxic function, auto-antibodies against autonomic receptors, altered T cell subsets (Klein et al., 2022; Scheibenbogen et al., 2022). But these are not acute-phase findings. They are the signature of a system that is neither in crisis nor in health. It is in a third state that the warfare model has no category for.

Anomaly 2: Post-exertional malaise

PEM is the most diagnostically specific feature of Long Covid and the most theoretically troubling. Exercise in healthy individuals produces temporary fatigue followed by adaptation and improvement. Exercise in Long Covid patients produces a delayed, disproportionate deterioration — sometimes triggered by cognitive or emotional effort, not just physical.

The warfare model has no mechanism for this. If the problem is an ongoing infection or a dysfunctional immune response, why does a ten-minute walk produce three days of worsening? The only available explanation within the current framework is deconditioning — which is both empirically unsupported and inconsistent with the patient histories.

Anomaly 3: The exercise paradox

Graded exercise therapy produces consistent harm in a subset of Long Covid patients. Tryfonos et al. (2024) found that exercise response was broadly comparable between Long Covid patients and healthy controls at the group level — but this average conceals a subgroup for whom exercise is genuinely harmful. The warfare model cannot predict who will be harmed, and has no mechanism for the harm.

Anomaly 4: Brain retraining produces genuine physiological recovery

Multiple clinicians are now documenting recoveries through brain retraining and nervous system regulation approaches. These are not anecdotal outliers. Documented cases include patients who were bedbound for years and returned to full function. The warfare model response — these patients were not truly ill, or the recovery was placebo — is not scientifically serious. If a patient was bedbound for two years and is now running, something changed in their biology.

Anomaly 5: Non-specific vaccine effects

Live vaccines — BCG, measles, oral polio — reduce all-cause mortality in high-risk populations by 30–50%, far beyond protection against their specific targets (Aaby & Benn, 2019). Within the warfare model, a vaccine's effect should be limited to its target pathogen. Non-specific effects of this magnitude are documented, replicated, and largely unaddressed because the framework has nowhere to put them.

Anomaly 6: Radical individual variation

The same SARS-CoV-2 exposure produces outcomes ranging from asymptomatic infection to multi-year Long Covid. Pre-existing conditions and genetics explain some of this variation. They do not explain why fit, healthy young adults with no risk factors develop severe Long Covid while immunocompromised individuals sometimes recover without sequelae. The warfare model treats this residual variation as noise. It is not noise. It is signal.

Part Two: One Question

Six anomalies. Six observations that the current framework cannot explain. Each documented, replicated, and set aside.

What would a framework need to look like to explain all six simultaneously? It would need to explain why a system can be stably unwell without acute pathological markers; why small perturbations produce disproportionate and delayed deterioration; why the same perturbation helps

some patients and harms others; why a brain-based intervention produces genuine physiological recovery; why a live vaccine produces system-wide benefits beyond its specific target; and why the same pathogen produces radically different outcomes in different individuals.

There is one question that opens the door to all six answers at once:

What if the immune system is not a combat force, but a synchronisation apparatus?

Part Three: The Coherence Framework

Health as phase synchronisation

Living systems maintain coherence across multiple scales simultaneously: molecular, cellular, tissue, organ, organism. This is not a metaphor — it is measurable. Heart rate variability, cytokine oscillation patterns, circadian rhythms, brainwave synchronisation: all are expressions of multi-scale phase coherence.

Health, in this framework, is the maintenance of coherent phase relationships across scales. Disease is not primarily the presence of an enemy — it is the disruption of coherence.

This reframing does not abolish the warfare model. Pathogens disrupt coherence. Antibiotics and antivirals restore the conditions for coherence by removing disruptors. The warfare model is not wrong — it is incomplete. It describes one class of coherence disruption and misses the rest.

The immune system as coherence monitor

Grounded in the Free Energy Principle (Friston, 2010), the immune system maintains a **generative model** — a continuously updated internal representation of what the organism's tissues should look like. When observations deviate from this model, the system generates prediction errors and mounts a regulatory response.

In healthy function: the threat appears, the prediction error is generated, the response resolves the deviation, coherence is restored, the generative model updates.

In Long Covid: the acute threat is gone, but the generative model has not updated. The system is still predicting a threat state. Its predictions are self-confirming — the chronic low-grade inflammatory state confirms the threat signal, which maintains the inflammatory state. The system has found a locally stable equilibrium: not chaos, not acute illness, not health. A **false attractor**.

The false attractor: a precise definition

In dynamical systems theory, an attractor is a stable region of phase space toward which a system's trajectories converge. A false attractor is locally stable but is not the system's healthy baseline.

A system in a false attractor is not broken. It is not fighting anything. It has found the wrong stability.

This is why standard tests return normal: there is no acute pathology. The system is stable — wrongly stable.

This is why PEM occurs: the false attractor has low resilience. In graph-theoretic terms, the **spectral gap** of the immune-autonomic network — the difference between the first and second eigenvalues of the graph Laplacian — is reduced. A small perturbation displaces the system from its fragile false-attractor equilibrium. Recovery is slow because the restoring gradient is weak. This is a precise, testable, mathematical prediction. It is not a metaphor.

This is why brain retraining can produce genuine physiological recovery: it introduces structured counter-signals that update the generative model, providing the system with sufficient evidence against the threat-prediction to allow a phase transition back toward the healthy baseline attractor. This is a phase transition in an immune-autonomic network — as biological as any pharmacological intervention.

This is why non-specific vaccine effects occur: live vaccines provide a rich, multi-frequency perturbation that simultaneously challenges multiple regulatory networks, raising the spectral gap across the board.

Five of the six anomalies explained by one mechanism. The sixth — radical individual variation — requires one more step.

Part Four: Why You Are Different From Your Neighbour

The electromagnetic structure of the organism

Maxwell's original quaternion formulation of electrodynamics — before Heaviside reduced it to the familiar vector form — describes electromagnetic fields with full quaternion symmetry: a scalar component and three vector components forming a four-dimensional field structure. Rowlands' nilpotent quantum mechanics (Rowlands, 2007) extends this to the quantum level, showing that the stable states of matter arise from the nilpotent condition of the quaternion operator: $(\partial/\partial t + \nabla)(\partial/\partial t - \nabla)\psi = 0$.

A biological organism is an electromagnetic coherence field. Its stable states — the configurations to which its regulatory networks naturally return — are governed by the same quaternion geometry. This is not an analogy. The organism is a physical system embedded in an electromagnetic vacuum, and its coherence architecture reflects the symmetry structure of that vacuum.

To be precise about what this means physically: Rowlands' nilpotent condition states that the combined operator $(\partial/\partial t + \nabla)(\partial/\partial t - \nabla)\psi = 0$ produces only those states that are self-consistent with the vacuum. The nilpotent condition is not a quantum superposition claim — it is a stability criterion. It describes which electromagnetic field configurations are sustainable. A biological organism, as a sustained electromagnetic coherence field, must satisfy this criterion. Its regulatory architecture is therefore not arbitrary — it is constrained by the algebra of sustainable field configurations.

The full quaternion symmetry group acting on a three-dimensional biological field generates **nine independent degrees of freedom** — nine functionally distinct regulatory domains, each with its own characteristic coherence properties. These are not arbitrary divisions. They follow necessarily from the algebra.

Each of the nine domains has a **spectral eigenvalue** — a measure of how tightly defined its coherence is. High eigenvalue: the domain is robustly fixed, rapid recovery after perturbation, high local spectral gap. Low eigenvalue: the domain is open and environmentally responsive, slower

recovery, lower local spectral gap, more vulnerable to false-attractor capture under prolonged entrainment.

The distribution of eigenvalues across the nine domains is the individual's **coherence topology** — their biological signature in the electromagnetic field structure of the vacuum. It is unique to each person.

The derivation of why this is so is straightforward veldfysica. A quaternion field equation of the form $(\partial/\partial t + \nabla)(\partial/\partial t - \nabla)\psi = \mathbf{0}$ has a unique solution for each set of initial conditions. The initial conditions of a biological coherence field are set at the moment the organism first becomes autonomous — birth. The local electromagnetic configuration at that moment — the field state of the environment into which the organism emerges as an independent coherence field — constitutes the boundary values from which the quaternion dynamics unfold. Different boundary values produce different eigenvalue distributions across the nine domains. This is not a metaphysical claim. It is the standard relationship between initial conditions and solutions in field theory.

The full formal derivation — including the algebraic mapping from Rowlands' nilpotent operator through the nine domain structure to individual eigenvalue distributions — is presented in Konstapel (2026c). The present paper assumes that derivation and draws only its clinical consequences. Readers who find the individual coherence topology claim too large a step are directed there before proceeding.

What chronobiology and circadian research have independently documented is consistent with this derivation: the electromagnetic environment at and around birth has measurable, lasting effects on biological regulatory architecture (Refinetti, 2006; Voeikov, 2006). The coherence framework provides the mechanism that these empirical observations have lacked.

The immune coherence centre

Of the nine regulatory domains, the one most directly relevant to Long Covid is the **somatic coherence monitor** — the domain governing real-time immune surveillance, survival signalling, and whole-body coherence assessment. It operates below the threshold of conscious cognition. It is the organism's primary interface between the immune network and the autonomic nervous system.

An individual whose somatic coherence monitor has a **high spectral eigenvalue** — a robustly defined domain — has a stable, rapidly self-correcting immune generative model. Prediction errors are detected and resolved quickly. The restoring gradient after false-attractor displacement is strong. Post-viral false-attractor capture is possible but recovery is more likely.

An individual whose somatic coherence monitor has a **low spectral eigenvalue** — an open, environmentally responsive domain — has an immune generative model that is exquisitely sensitive to its electromagnetic environment. This confers adaptability: such individuals are highly attuned to the coherence states of people and environments around them. It also confers vulnerability: under prolonged entrainment by an incompatible coherence environment, the somatic monitor's generative model is gradually conditioned away from the individual's own vacuum baseline. If this pre-conditioned state is the starting configuration when SARS-CoV-2 strikes, the system does not have a clear baseline attractor to return to. It captures into the false attractor more deeply, and the restoring gradient is weaker.

This is the mechanism for radical individual variation. It is not genetic noise. It is structured variation in coherence topology, derivable from first principles of quaternion electrodynamics.

Conditioning as false-attractor induction

The open regulatory domains — those with low spectral eigenvalues — are electromagnetically permeable. They are susceptible to entrainment by the coherence fields of people in persistent proximity. Over time, if an individual's open domains are continuously entrained by an incompatible coherence signature — a person whose eigenvalue structure is strongly defined where theirs is open — the generative model of those domains incorporates the foreign signature as its prior.

The result is a chronically maintained false-attractor state induced not by infection but by environmental coherence entrainment. The organism operates consistently away from its vacuum baseline. The immune-autonomic network runs the wrong prior.

When SARS-CoV-2 strikes a pre-conditioned individual, it deepens a false attractor that already exists. This predicts a clinical observation that has been reported but not explained: some Long Covid patients describe feeling, in retrospect, that they had not been fully well for years before their acute infection — that Covid completed a trajectory that was already underway.

Part Four B: Addressing the Hard Evidence — Viral Persistence, Microclots, and Mitochondrial Damage

A serious objection must be addressed before proceeding to clinical implications. Leading Long Covid researchers — Putrino, Proal, Pretorius, Kell — have documented physical, structural findings in Long Covid patients: viral RNA and spike protein persisting in tissue reservoirs months after acute infection; microclots of amyloid fibrin physically occluding capillaries and causing tissue hypoxia; mitochondrial damage in muscle biopsies after exertion, with disrupted citric acid cycle function and anaerobic metabolic switching.

These are not soft findings. They are reproducible, peer-reviewed, and constitute the strongest biological evidence in the Long Covid field. Any coherence framework that cannot account for them is inadequate.

The coherence framework not only accounts for them — it integrates them as mechanistic detail that the framework itself predicts must exist.

Viral persistence as attractor maintenance

In the coherence model, the immune generative model is maintained in its false-attractor state by ongoing prediction errors — signals that confirm the threat-prior. Persistent viral antigen in tissue reservoirs is precisely such a signal. It provides continuous low-level input to the immune surveillance network that prevents the generative model from updating toward a threat-free prior.

Viral persistence does not contradict the false-attractor model. It explains why some false attractors are deeper and more resistant to coherence-restoration interventions than others. A patient with active viral reservoirs needs the reservoirs addressed — antivirals, immune modulation — before coherence-restoration approaches can gain traction. The sequence matters: reservoir clearance is Phase 0, preceding the attractor-relaxation protocol.

This is not a concession to the warfare model. It is a refinement: identify the source of the ongoing prediction error, remove it, then restore coherence. The warfare model stops at step one and has no framework for steps two and three.

Microclots as spectral gap reduction

Pretorius and Kell's microclot findings describe amyloid fibrin deposits that physically occlude microvasculature, reducing oxygen delivery to tissues. This is a hardware finding with a direct coherence-framework interpretation: microclots reduce the coupling efficiency between network nodes. In graph-theoretic terms, they lower the edge weights of the immune-autonomic network graph — which directly reduces the spectral gap.

Post-exertional malaise, in this integrated model, has two simultaneous mechanisms: the network-level instability of a low-spectral-gap false attractor, and the cellular-level oxygen deficit produced by microvascular occlusion. Both are real. Both are present in the same patient. They are not competing explanations — they are coupled mechanisms operating at different scales of the same coherence architecture.

The clinical implication: anticoagulation and fibrinolysis protocols targeting microclots (currently being trialled) are coherence interventions at the vascular network level. They raise the spectral gap by improving node coupling. They should be combined with, not offered instead of, autonomic and neuroimmune coherence-restoration approaches.

Mitochondrial damage as cellular coherence disruption

Mitochondria are not passive energy factories. They are the primary oscillators of cellular coherence — maintaining the electrochemical gradients that drive cellular phase synchronisation across the tissue scale. Biopsy evidence of mitochondrial damage and citric acid cycle disruption after exertion is evidence of coherence disruption at the cellular level.

In the coherence framework this is expected: a system in a false attractor with reduced spectral gap, subjected to perturbation (exercise), is displaced from its fragile equilibrium. The displacement propagates across scales — from the autonomic network level down to the cellular metabolic level. Mitochondrial damage is not the primary cause of Long Covid. It is the cellular-scale expression of a system-level coherence failure under load.

This distinction matters clinically. Treating mitochondrial dysfunction in isolation — supplements, metabolic support — addresses the cellular symptom without restoring the network coherence that allows cellular function to stabilise. It may help at the margin. It will not produce recovery on its own.

The quantum decoherence objection

A technical objection will be raised against the quaternion derivation of the nine regulatory domains: that quantum coherence cannot be maintained in warm, wet biological tissue at 37°C, and therefore quaternion operators have no legitimate application to macroscopic biological systems.

This objection rests on a category error. The quaternion structure deployed here is not a claim about quantum superposition states in biological tissue. It is a claim about the **symmetry of the electromagnetic field** that the organism inhabits and constitutes. Maxwell's quaternion electrodynamics and Rowlands' nilpotent formalism describe field symmetries — the algebraic

structure of stable electromagnetic configurations. These symmetries operate at the classical field level, not at the level of quantum states in individual molecules.

The spectral eigenvalues of the nine regulatory domains are properties of the organism's electromagnetic field topology — measurable, in principle, through field-level instrumentation. They are no more subject to quantum decoherence than the electromagnetic field of a radio antenna is subject to quantum decoherence. The objection conflates two distinct levels of physical description.

Summary: one framework, multiple scales

Finding	Warfare model	Coherence framework interpretation
Viral	Ongoing infection requiring	Persistent prediction-error signal maintaining false
Microclots	Vascular pathology requiring anticoagulation	Reduced node coupling lowering network spectral gap; coherence intervention at vascular scale
Mitochondrial damage	Cellular energy failure requiring metabolic support	Cellular-scale expression of system-level coherence failure under perturbation
Normal standard	No disease / psychological	System in stable false attractor; no acute pathology detectable by acute-pathology tools
PEM	Deconditioning / unknown	Low spectral gap + microvascular hypoxia under perturbation; coupled multi-scale mechanism

The warfare model and the coherence framework are not competing explanations of different findings. They are descriptions of the same pathophysiology at different levels of abstraction. The warfare model describes the parts. The coherence framework describes what the parts are doing together.

Part Five: What This Means in Practice

For the clinician: three immediate changes

1. Stop asking "what is wrong with this patient's immune system" and start asking "which attractor state is this patient in."

The distinction matters because it changes what you do. If the system is in a deep false attractor, perturbation-based interventions will deepen the attractor rather than restore coherence. The first clinical task is attractor relaxation, not treatment.

2. Assess coherence architecture before prescribing.

Heart rate variability spectral analysis is non-invasive, inexpensive, and available now. A 5-minute resting HRV recording gives you the spectral gap — a direct measure of autonomic network resilience. Patients with very low HRV spectral gap and sympathetic dominance are in deep false-attractor states. They need Phase 1 intervention before any perturbation-based therapy is introduced. Prescribing graded exercise to these patients is not evidence-based — it is paradigm-based, and the paradigm is wrong for this population.

3. Take brain retraining seriously as a biological intervention.

When a patient reports improvement through brain retraining and then deterioration when they push too hard, they are describing a system that briefly found the gradient back toward its baseline attractor and then lost it again. This is mechanistically coherent. The clinical response is not scepticism — it is to understand why the phase transition did not complete, and to support the conditions under which it can.

A sequenced treatment framework

Phase 0 — Reservoir Clearance (where indicated) Before attractor relaxation can succeed, ongoing sources of prediction-error signal must be identified and addressed. Where viral persistence is suspected — based on symptom trajectory, response to prior antiviral trials, or tissue biopsy where available — targeted antiviral or immune-modulation protocols should be initiated. Microclot burden should be assessed (fibrinogen, D-dimer, platelet-poor plasma staining where available) and fibrinolytic support considered. Phase 1 will have limited effect if the false attractor is continuously reinforced by active peripheral pathology. *Checkpoint: symptom trajectory stabilising? If yes, proceed.*

Phase 1 — Attractor Relaxation (weeks 1–8)

Strict energy envelope management. Environmental simplification — remove chronic sources of incompatible coherence entrainment. Sleep architecture restoration. No perturbation-based therapies.

Checkpoint: HRV spectral gap improving? Orthostatic tolerance improving? If yes, proceed.

Phase 2 — Coherence Restoration (weeks 8–24)

Heart coherence practices (HeartMath protocol or equivalent), 2x daily. Graduated sensory engagement. Brain retraining at minimum tolerated dose with 24-hour post-session monitoring. PEMF or vagal stimulation if available.

Checkpoint: PEM threshold rising? Cognitive function improving? If yes, proceed.

Phase 3 — Vacuum Baseline Restoration (ongoing)

Identify and modify chronic sources of coherence entrainment incompatible with the individual's electromagnetic topology. Build coherence practices matched to the individual's regulatory eigenvalue structure. Support the patient in distinguishing their own vacuum baseline state from conditioned states.

For the researcher: the stratification hypothesis

The Long Covid treatment literature is characterised by inconsistent, non-replicable effect sizes. The coherence framework predicts that this is not noise — it is the predictable result of mixing patients in different attractor states and treating them as a uniform population.

The most urgent research task requires no new patients and no new funding: **retrospective stratification of existing trial data by HRV spectral gap.**

If the coherence framework is correct, treatment effects in completed trials will be heterogeneous across HRV-stratified subgroups, with effect sizes within subgroups substantially larger than in mixed-population analyses. This would immediately explain the inconsistency in the literature and provide the basis for prospectively stratified trials.

Five research priorities:

1. Validate attractor-state biomarkers (HRV spectral gap, cytokine network topology, PEM threshold) against each other and against clinical outcomes
2. Reanalyse existing trial data with coherence stratification
3. Design a Phase 2 sequenced-intervention trial with coherence endpoints as primary outcomes and stratification by baseline HRV spectral gap
4. Investigate BCG revaccination with pre-stratification by HRV — the coherence model predicts efficacy in open-eigenvalue patients and inefficacy or harm in deep false-attractor patients
5. Develop an open individual coherence profiling protocol: HRV + autonomic response profile + cytokine panel + electromagnetic topology assessment, standardised across sites

Conclusion: The Answer the Evidence Points To

Return to the patient at the beginning of this paper. Eighteen months ill. Normal tests. No treatment that works.

The warfare model tells you: if there is no enemy, there is no biological disease. You are stuck.

The coherence framework tells you something precise: her immune-autonomic system found a locally stable state after the acute infection and cannot find its way back to her baseline attractor. Her tests are normal because there is no acute pathology — but her HRV spectral gap is reduced, her autonomic network is rigid, and her system has a weak restoring gradient. She is not imagining her illness. She is not deconditioned. She is in the wrong stable state.

Furthermore — and this is what explains why she responded differently from the patient in the next room — her coherence topology is individual. The spectral eigenvalue structure of her nine regulatory domains, determined by her electromagnetic environment at birth and modified by decades of coherence entrainment, defines both her vulnerability to false-attractor capture and the path back to her own baseline.

What she needs is not a drug that targets a pathogen that is no longer there. She needs the conditions under which her system can find its own way back to its own vacuum baseline — the coherence state that is uniquely and precisely hers.

Those conditions are knowable. The path back is possible. It is grounded in the geometry of Maxwell's quaternion electrodynamics, in Rowlands' nilpotent vacuum mechanics, in Friston's Free Energy Principle, and in forty years of accumulated clinical observation that the warfare model could never quite explain.

Six anomalies. One mechanism. One question:

What if health is not the absence of enemies, but the presence of your own electromagnetic rhythm?

The first step costs nothing and takes five minutes: measure the HRV of your next Long Covid patient. Let the spectral gap tell you where their system is. Then decide what it needs.

References

- Aaby, P., & Benn, C.S. (2019). Developing the concept of beneficial non-specific effect of live vaccines with epidemiological studies. *Clinical Microbiology and Infection*, 25(12), 1459–1467.
- Davis, H.E., McCorkell, L., Vogel, J.M., & Topol, E.J. (2023). Long COVID: major findings, mechanisms and recommendations. *Nature Reviews Microbiology*, 21(3), 133–146.
- Friston, K. (2010). The free-energy principle: a unified brain theory? *Nature Reviews Neuroscience*, 11(2), 127–138.
- Klein, J., et al. (2022). Distinguishing features of Long COVID identified through immune profiling. *medRxiv*. DOI: 10.1101/2022.08.09.22278592.
- Konstapel, J. (2026). Immunity as coherence: a field-theoretic paradigm beyond the warfare metaphor. *Constable Research Working Paper*.
- Konstapel, J. (2026). The 19-Layer Quaternion Vacuum Model. *Constable Research Working Paper*.
- Konstapel, J. (2026). Right-Brain Computing and the Resonant Stack Architecture. *Constable Research Working Paper*.
- Levin, M. (2021). Bioelectric signaling: reprogrammable circuits underlying embryogenesis, regeneration, and cancer. *Cell*, 184(8), 1971–1989.
- Matzinger, P. (2002). The danger model: a renewed sense of self. *Science*, 296(5566), 301–305.
- McCraty, R., Atkinson, M., Tomasino, D., & Bradley, R.T. (2009). The coherent heart. *Integral Review*, 5(2), 10–115.
- Pretorius, E., et al. (2021). Persistent clotting protein pathology in Long COVID/post-acute sequelae of COVID-19 is accompanied by increased levels of antiplasmin. *Cardiovascular Diabetology*, 20, 172.
- Proal, A.D., & VanElzakker, M.B. (2021). Long COVID or post-acute sequelae of COVID-19 (PASC). *Frontiers in Immunology*, 12, 698169.
- Rowlands, P. (2007). *Zero to Infinity: The Foundations of Physics*. World Scientific.
- Scheibenbogen, C., et al. (2022). Autoantibodies against β -adrenergic and muscarinic acetylcholine receptors in Long COVID. *Journal of Translational Autoimmunity*, 5, 100162.
- Tryfonos, A., et al. (2024). Exercise response in Long Covid: a randomised controlled trial.