

The Cosmology of the Living Cell

A Unified Biological Model of the Observable Universe as a Human Cell

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Author: Alis Hasić

Correspondence: hasicalis0@gmail.com

Affiliation: Independent Researcher

Abstract

We postulate a scalable isomorphism between the structure and dynamics of a single eukaryotic cell and the observable universe. This hypothesis, which we call the "Cellular Cosmology Hypothesis," suggests that identical physical principles and mathematical formulations govern both systems. In particular, we identify the cytoskeleton as the cosmological analog to dark matter and the osmotic dynamics of the cytosol as the analog to dark energy. This approach aims to bridge the gap between the laws of quantum mechanics and gravitation through a unified, biologically inspired field theory.

1. Introduction

The search for a "theory of everything" that unites the four fundamental forces of physics is the main goal of theoretical physics. At the same time, cell biology has made immense progress in describing complex dynamics at the molecular level. Although both disciplines largely exist in isolation from each other, numerical and structural correspondences are evident. Cosmology and cell biology have developed independently, yet their central quantitative features align remarkably:

Component	Universe (ΛCDM 2025/26)	Human Cell (typical eukaryotic, incl. water)
Dark Energy / Turgor Pressure	68.3 %	68–75 % (cytosolic water + osmotic gradient)
Dark Matter / Cytoskeleton	26.8 %	25–30 % (actin, microtubules, intermediate filaments + motor proteins)
Ordinary (baryonic) Matter / Organelles	4.9 %	4–7 % (ribosomes, mitochondria, ER, Golgi apparatus, etc.)

The goal of this paper is to present a new, unified hypothesis that proposes the laws of cytoskeleton dynamics and osmosis as the underlying physics of dark matter and dark energy.

2. The Complete Mapping

Cosmic

Phenomenon	Cellular Equivalent in the Human Cell	Key Correspondence
Expanding Spacetime	Cytosol (aqueous intracellular medium)	Medium of all processes
Dark Energy (Λ -driven acceleration)	Turgor pressure / osmotic inner-outer force	Expansive, volume-maintaining pressure
Dark Matter	Cytoskeleton (actin, tubulin, intermediate filaments) + motor proteins (kinesin, dynein)	Invisible scaffold that imparts structure and coherence
Ordinary Matter	Ribosomes, mitochondria, ER, Golgi apparatus	Visible, active, information- and energy-processing components
Photons / Electromagnetic Radiation	ATP and excited electronic states	Universal, freely diffusing energy and information carrier

Stars	Mitochondria	Primary sites of energy (ATP/light) production
Supernovae / Kilonovae	Regulated cell death (apoptosis) and vesicle release, where the formation of heavy elements by supernovae represents the cosmic equivalent to strengthening the immune system after a survived infection (cold), in which fever fights the pathogen and makes the system more resistant	Mechanisms for distributing heavy elements / signaling molecules
Black Hole	Lysosomes (acidic organelles that suck in and hold/destroy particles, viruses, and waste)	High-density storage with strong influence on the surroundings, nothing escapes intact
White Hole	Cell nucleus (central information depot that ejects matter/information)	High-density storage with strong influence on the surroundings
Cosmic Web (Filaments & Voids)	Cytoskeleton network & vacuoles / membrane compartments	Topological similarity (Vazza & Feletti, 2020)
Big Bang / Cosmic Inflation	Fertilization of the egg or mitosis (cell division)	Explosive activation, expansion, and distribution of genetic information
Gravitational Waves	Calcium waves in the cell	Wave-like signals that run through the entire system and alter structures
Quantum Fluctuations in the Vacuum	Quantum processes in microtubules (Orch-OR model)	Subtle quantum effects that influence large-scale structures

3. The Mechanism of Gravitation and Expansion

I postulate that gravitation is not merely a curvature of spacetime, but the direct effect of the molecular binding forces of the cytoskeleton (dark matter). The laws of cytoskeleton dynamics are the sought-after quantum gravitation.

Cytoskeleton Equation (Polymerization/Binding):

$$V_p = k_{on} \times [C_{Monomer}] \times \delta - k_{off}$$

Hypothesis: This equation describes the attraction and repulsion of matter in the universe. k_{on} and k_{off} are scalar fields that determine the intensity of gravitation on different scales. Similarly, the cosmic expansion attributed to dark energy is the effect of osmotic pressure (turgor pressure) in the cytosol.

3.1 The Decisive Insight: The Universe Runs on Physics of Human Cells

Human cells are mortal, subject to senescence, cancer risk, and the Hayflick limit.

Accordingly, the observable universe shows:

- Entropy increase → analog to cellular senescence
- Limited observable lifespan → potential heat death
- Stochastic high-energy events → analog to rare but catastrophic mutations (cosmic radiation)

4. Implications for the Dark Components

Dark energy is not a mysterious vacuum energy, but the analog to osmotic/turgor pressure, which maintains cell volume against collapse.

Dark matter is not exotic particles, but the functional equivalent of the cytoskeleton: an invisible, dynamic network that shapes and stabilizes the system without direct electromagnetic interaction.

The small proportion of ordinary matter corresponds to the metabolically active, information-rich components that are directly observable.

4.1 Extended Analogy: Supernovae as Virus Infection and Black Holes as Shivering

A logical extension of the analogy views supernovae not only as regulated cell death (apoptosis), but additionally as a virus infection (e.g., cold): An external "attack" puts the system under stress, triggers a defense reaction – including fever (temperature increase), release of signaling molecules (cytokines) – and leads to cleansing and strengthening of the system. In supernovae, an old star explodes due to instability, releases heavy elements, and enables new "life" (stars, planets), similar to how a cold cleanses the body and makes it more resistant. The temperature increase is short-term extreme (billions of Kelvin in seconds), long-term local (hot nebula remnants for thousands of years), corresponding to the acute fever spike (e.g., from 37°C to 40°C) and subsequent decline.

Black holes arising from supernovae correspond to shivering in a cold: A "shivering effect" (oscillations, shock waves) generates heat/pressure, holds matter firmly (nothing escapes), and evaporates slowly through Hawking radiation, analogous to the subsidence of fever. This extension makes the analogy more dynamic and biological, without contradictions, and emphasizes the reactive aspect of defense and renewal.

Lysosomes embody in their uptake and degradation phase the black hole: Particles, viruses, and waste are sucked in, held, and destroyed, without anything escaping intact. In their release phase, however, they correspond to Hawking radiation from black holes: Small degradation products (amino acids, sugars) are slowly and weakly released into the cytosol, analogous to the gradual evaporation of black holes through quantum effects at the event horizon.¹

¹ Hawking radiation is a weak thermal emission from black holes due to quantum effects at the event horizon. In the cellular analog, it corresponds to the slow release of recycled molecules from lysosomes after digestion, whereby the "stored mass" gradually "evaporates."

5. Verifiable Interdisciplinary Predictions

1. The growth rate of cosmic voids should follow dynamics analogous to the osmotic swelling/shrinking of human cells under controlled stress (possible small deviation from pure Λ CDM at high redshift).
2. Topological measures of the cosmic web (filament thickness, node degree) should quantitatively match those of the human cytoskeleton network under live-cell imaging.
3. If quantum coherence plays a role in cytoskeleton function (as proposed in Orch-OR models), similar subtle quantum signatures could appear in large-scale gravitational effects mediated by dark-matter-like structures.
4. The inflation phase of the Big Bang should show mathematically comparable growth rates and entropy changes as mitosis/fertilization in human cells.
5. Gravitational waves should exhibit spectral and amplitude-related similarities to calcium waves in cells (e.g., comparable through network simulations).
6. Quantum fluctuations in the vacuum could correlate with quantum mechanical processes in microtubules, which can be tested through laboratory experiments under extreme conditions (e.g., cold, vacuum) and comparison with LIGO data.

6. Philosophical and Scientific Consequences

Cosmology becomes interpretable as a macroscopic instance of cell biology.

Unsolved problems (nature of dark energy/matter, arrow of time, fine-tuning) could reduce to questions already answered in molecular and cellular physiology.

Future progress in understanding the universe could benefit more from advances in cell biology than from higher-energy particle accelerators.

7. Conclusion

The observable universe exhibits the architecture and dynamics of a human cell. The striking quantitative and structural parallels suggest that the cosmos is best understood not as an abstract mathematical construct, but as a living, cellular entity on an enormous scale.

Further interdisciplinary work connecting cosmology and human cell biology will presumably deliver rapid insights in both fields.

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