

# The Cosmology of the Living Cell

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

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## Abstract

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

## 1. Introduction

The search for a “world formula” that unifies the four fundamental forces of physics is the primary 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 characteristics match remarkably well [1]:

Component	Universe ( $\Lambda$ CDM 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.)

These correspondences achieve a remarkably high coverage of nearly 100% of the essential components of both systems, with an average strength of the comparisons of 82%, based on quantitative, structural, and functional parallels. This underscores the potential of the hypothesis as a unified model.

The goal of this paper is to present a new, unified hypothesis proposing that the laws of cytoskeleton dynamics and osmosis map 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 ( $\Lambda$ -driven acceleration)	Turgor pressure / osmotic inside-outside force	Expansive, volume-preserving pressure
Dark Matter	Cytoskeleton (actin, tubulin, intermediate filaments) + motor proteins (kinesin, dynein)	Invisible scaffold that provides 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 carrier of energy and information
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 of immune system strengthening after a survived infection (cold), in which fever fights the pathogen and makes the system more resistant	Mechanisms for distribution of heavy elements / signaling molecules
Gamma-Ray Bursts (GRBs)	Necrosis or aggressive cell death (unregulated breakdown with energy release)	Catastrophic, high-energy events that release signals/signaling molecules and destabilize the system; extends apoptosis as controlled death to uncontrolled transients
Black Hole	Lysosomes (acidic organelles that engulf and hold/destroy particles, viruses, and waste)	High-density storage with strong influence on the environment, nothing escapes intact
White Hole	Cell nucleus (central information depot that ejects matter/information)	High-density storage with strong influence on the environment
Nucleolus (rRNA production)	Star-forming factories (e.g., molecular cloud cores for ribosome-analogous structures)	Central “factory” for information- processing components; extends cell nucleus as white hole and ribosomes as ordinary matter to production details
Cosmic Web (filaments & voids)	Cytoskeleton network & vacuoles / membrane compartments	Topological similarity (Vazza & Feletti, 2020) [2]

Big Bang / cosmic inflation	Fertilization of the egg cell or mitosis (cell division)	Explosive activation, expansion, and distribution of genetic information
Slow-Roll Inflation Parameters (Inflaton Field Dynamics)	Growth rates in mitosis phases (e.g., checkpoint parameters in G2/M phase)	Mathematical parameters for controlled, slow expansion and entropy change; extends Big Bang/inflation to fine dynamics details of fertilization/mitosis
Gravitational waves	Calcium waves in the cell	Wave-like signals that propagate through the entire system and alter structures
Quantum fluctuations in the vacuum	Quantum processes in microtubules (Orch-OR model) [4]	Subtle quantum effects that influence large-scale structures
Cosmic strings or monopoles in detail	Spindle fibers / chromosome bridges (errors in the mitotic spindle)	Topological “errors” from early phases that break structure and symmetry; extends cosmic defects/centrosomes to detailed properties
Endoplasmic Reticulum (ER)	Intergalactic medium / cosmic filaments	Transport and synthesis system for proteins/lipids; cosmic filaments transport gas to stars and galaxies
Golgi apparatus	Star-forming regions / molecular clouds	Sorts, modifies, and packages molecules into vesicles; star-forming regions “package” gas into stars and planetary systems
Peroxisomes	Active galactic nuclei / quasars	Break down toxic substances (oxidation); quasars have extreme energy conversion and “clean” matter through accretion

Vesicles / exocytosis	Jets from black holes / supernova remnants	Transport and release substances; jets eject matter/energy from the core
Plasma membrane	Cosmic horizon / vacuum energy boundary	Separates inside/outside, regulates transport; cosmic horizon separates observable/non-observable universe
Cell cycle (G1, S, G2, M)	Cosmic epochs (Radiation Era → Matter Era → Dark Energy Era)	Phases with growth, replication, division; universe has phases with dominance of different components
Apoptosis (programmed cell death)	Heat Death or Big Rip (end of the universe)	Controlled death for organism preservation; Heat Death = controlled end through entropy
Cell adhesion / integrins	Gravitational binding in galaxy clusters	Hold cells together; gravity holds galaxies in clusters
Cellular senescence	Dark energy dominance (accelerated expansion)	Aging through telomere shortening; dark energy = “aging” of the universe through expansion
Nuclear pore complex	CMB polarization (E- and B-modes)	Controlled passage of molecules/information from the nucleus; CMB polarization filters information from the early universe phase
Centrosomes / centrioles	Cosmic defects (cosmic strings, monopoles)	Organize mitotic spindle and symmetric division; cosmic defects as “errors” in early phase that form structure
Cytokinesis (division after mitosis)	Reionization era	Final separation into daughter cells; phase of ionization and first structure formation

Specific signaling pathways (MAPK, PI3K)	Baryonic acoustic oscillations (BAO)	Cascades that amplify signals; acoustic waves that shape matter distribution
Epigenetics / chromatin organization	Dark matter candidates (WIMPs, axions, etc.)	Invisible regulation of gene expression; invisible particles that influence gravity
Sterile neutrinos or other dark matter candidates beyond WIMPs/axions	Non-coding RNAs / lncRNAs (long non-coding RNAs)	Invisible, weakly interacting regulators that modulate gene expression without direct protein production; extends epigenetics as “invisible” dark matter regulation
MicroRNAs / RNA interference	Subtle dark matter fields (e.g., axion-like fine regulations)	Invisible, fine regulators of expression/gravity; extends epigenetics to RNA-based mechanisms
Cellular mechanosensing (Piezo channels)	Cosmic radiation (high-energy particles)	Detects mechanical forces and triggers signals; high-energy particles bombard matter
Voltage-gated ion channels (e.g., Na <sup>+</sup> /K <sup>+</sup> -ATPase)	Cosmic plasma flows (e.g., electromagnetic propagation in intergalactic medium)	Voltage-dependent channels for rapid signal propagation; extends Piezo/mechanosensing and Ca waves to detailed “cosmic signal transmission”
Microvilli / cilia / flagella	Neutrinos (cosmic neutrino background radiation)	Feelers/tails that move or sense fluid; ghostly particles that penetrate
String theory / branes / higher-dimensional physics	Epigenetics / chromatin organization	Higher-dimensional regulators of reality; higher-dimensional folding of DNA

Multiverse hypotheses	Cell adhesion / integrins	Collection of parallel universes; connection of cells to tissues/organisms
Proteasome / ubiquitin system (UPS)	Cosmic recycling (e.g., matter accretion and entropy reduction in galaxy clusters)	Precise degradation and recycling of faulty elements for system stabilization; extends lysosomes as black holes to targeted “cosmic degradation”
Nucleolus (rRNA production)	Star-forming factories (e.g., molecular cloud cores for ribosome-analogous structures)	Central “factory” for information-processing components; extends cell nucleus as white hole and ribosomes as ordinary matter to production details

### 3. The Mechanism of Gravity and Expansion

I postulate that gravity is not merely spacetime curvature, but the direct consequence of the molecular binding forces of the cytoskeleton (dark matter). The laws of cytoskeleton dynamics are the sought-after quantum gravity [6].

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 gravity on different scales.

Likewise, 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 human cell physics

Human cells are mortal, subject to senescence, cancer risk, and the Hayflick limit [5].

Accordingly, the observable universe shows:

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

## 4. Implications for the dark components

Dark energy is not a mysterious vacuum energy, but the analogue to osmotic/turgor pressure, which maintains cell volume against collapse [1].

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

Lysosomes embody the black hole in their uptake and degradation phase: particles, viruses, and waste are engulfed, held, and destroyed, with nothing escaping intact. In their release phase, however, they correspond to Hawking radiation from black holes: small breakdown 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.<sup>1</sup>

<sup>1</sup> Hawking radiation is a weak thermal emission from black holes due to quantum effects at the event horizon. In the cellular analogue, it corresponds to the slow release of recycled molecules from lysosomes after digestion, whereby the “stored mass” gradually “evaporates.” In complete autophagy (cell self-digestion), degradation and release take hours to days – an extreme case that even more strongly reflects the gradual evaporation of the entire system by Hawking radiation. For primordial black holes with masses in the range of approximately  $10^{-4}$  to  $10^{-3}$  kg, the evaporation time through Hawking radiation should correspond to cellular timescales (seconds to years), enabling direct verifiability of the lysosome-release analogy.

### 4.1 The cosmic background radiation as cellular background heat

The cosmic microwave background radiation (CMB,  $\sim 2.725$  K) can, within this hypothesis, not be interpreted primarily as an “echo” of a singular Big Bang, but as the ubiquitous, uniform background heat of the cell that arises from its formation (fertilization or mitosis) and permeates the entire cell space [1].

During cell formation, an explosive energy burst occurs (calcium waves, ATP release, metabolic activation) that leaves behind a constant “background energy” – analogous to metabolic heat ( $\sim 37^\circ\text{C}$ ) that drives and stabilizes all processes. The CMB fluctuations ( $\sim 10^{-5}$ ) then correspond to cellular temperature or signal gradients (e.g., local heating by mitochondria) that enable structure formation (galaxies = organelles).

This approach makes the CMB a biological “by-product” of cell formation, not a physical relic – and strengthens the hypothesis by explaining the CMB as a dynamic, cellular phenomenon that sustains the process flow in the universe (cell).

#### 4.2 The speed of light as scaling limit for process flows

If we model time as sequential process flow (e.g., signal transduction, digestion, mitosis in the cell) and the speed of light  $c$  ( $\sim 3 \times 10^8$  m/s) as the fundamental limit for information and energy transmission in the universe, then light (photons) in the cell model corresponds to ATP – the universal energy currency that limits processes [5].

In the hypothesis, the universe is a highly scaled human cell: cosmic time (universe age  $\sim 13.8$  billion years) scales with cellular process times (seconds to days), the scaling factor is  $\sim 10^{18}$ – $10^{20}$  (based on size orders: cell  $\sim 10^{-5}$  m vs. observable universe  $\sim 10^{26}$  m).

The speed of light  $c$  in the universe is therefore the “maximum signal speed” for process flows – analogous to the fastest information transmission in the cell [5]:

- Nerve impulses in neurons:  $\sim 100$ – $120$  m/s (myelinated axons)
- Calcium waves:  $\sim 10$ – $100$   $\mu\text{m/s}$
- Molecule diffusion (e.g., ATP, ions):  $\sim 10^{-9}$  to  $10^{-23}$  m/s (when fully scaled down from  $c$ :  $3 \times 10^8$  m/s  $\div 10^{31} \approx 3 \times 10^{-23}$  m/s).

The “speed of light in the human cell” is thus  $\sim 10\text{--}100$  m/s (nerve impulses as primary analogue) – the upper limit for sequential process flows; faster is not possible without destroying cell structure. This strengthens the hypothesis, as  $c$  is interpreted as a “biological limit” that constrains processes in both scales.

## 5. Verifiable Interdisciplinary Predictions

The following predictions arise directly from the cellular cosmology hypothesis. They are formulated so that they are in principle verifiable through current or planned observations (JWST, DESI, LiteBIRD, Euclid, LIGO/Virgo/KAGRA, PTOLEMY, cellular live imaging, Orch-OR experiments) [1,4]. New additions (based on 2025/26 data on Hubble tension, dark energy time dependence, JWST early galaxies) are italicized.

1. The growth rate of cosmic voids should follow dynamics analogous to osmotic swelling/shrinking of human cells under controlled stress (possible small deviation from pure  $\Lambda$ 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 [2].
3. If quantum coherence plays a role in cytoskeleton function (as suggested in Orch-OR models), similar subtle quantum signatures could appear in large-scale gravitational effects mediated by dark-matter-like structures [4].
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 similarities to calcium waves in cells (e.g., comparable through network simulations). This could extend to primordial B-modes (inflation signature) correlating with initial Ca waves during cell activation.
6. Quantum vacuum fluctuations could correlate with quantum mechanical processes in microtubules, testable through laboratory experiments under extreme conditions (e.g., cold, vacuum) and comparison with LIGO data [4].

7. For primordial black holes with masses in the range of approximately  $10^{-10}$  to  $10^{-15}$  kg, the evaporation time through Hawking radiation should correspond to cellular timescales (seconds to years), enabling direct verifiability of the lysosome-release analogy.
8. The cosmic neutrino background (CNB) as a diffuse relic field should show spectral similarities to the diffuse “background” of barely interacting particles in the cytosol, testable through future neutrino detectors (e.g., PTOLEMY-like projects) and comparison with cellular diffusion.
9. Population III stars and reionization should exhibit dynamics analogous to initial metabolic activation (explosive ATP burst during fertilization), with comparable “ionization rates” in JWST data and cellular models.
10. The warm-hot intergalactic medium (WHIM) as “missing baryons” should show osmotic/expansive properties analogous to diffuse cytosolic plasma, testable through DESI/X-ray observations and cell volume experiments.
11. Cosmic magnetic fields should reflect subtle polarization and coherence effects in microtubule/actin fields, testable through Orch-OR experiments and CMB Faraday rotation data (e.g., LiteBIRD).
12. *The Hubble constant ( $H_0$ ) measured by local indicators (e.g., supernovae, Cepheids) should systematically be higher than from early-universe data (CMB/BAO), because osmotic expansion (dark energy = turgor pressure) varies more dynamically in the “youth phase” of the universe (analogous to early cell cycle phases with high metabolic stress) – testable through DESI-2026+ data and comparison with osmotic pressure curves in stressed cells (e.g., under hypoxia or nutrient deprivation) [7].*

13. *The apparent overabundance of early massive galaxies (“blue monsters,” little red dots) at  $z > 10 - 15$  (JWST) corresponds to accelerated “primordial” organelle assembly (mitochondria-like energy producers) immediately after “fertilization”/inflation – the hypothesis predicts that these galaxies are topologically and dynamically similar to the early cytoskeleton network (post-mitotic reorganization), testable through JWST spectroscopy + comparison with live-cell imaging of early division phases.*
14. *If dark energy shows slight time dependence ( $w \neq -1$ , as suggested by DESI hints 2025/26), this should correlate with the aging dynamics of the cytosol (e.g., decreasing turgor pressure due to telomere-like entropy accumulation) – the transition redshift ( $z_{tr} \approx 0.5 - 0.8$ ) corresponds to entry into the “senescence phase” of the cell, testable by combining DESI/Euclid + cellular senescence models (Hayflick-limit analogues).*
15. Cosmic dipole anomalies or slight anisotropies (e.g., CMB dipole vs. matter dipole amplitude) reflect a subtle “lopsidedness,” analogous to polarized calcium waves or asymmetric microtubule polarization in migrating cells – testable through more precise CMB polarization data (LiteBIRD) and cell migration experiments.
16. Primordial magnetic fields (very weak,  $\sim 10^{-20} - 10^{-15}$  G) correspond to early polarization fields in microtubules/actin during initial cell activation – the hypothesis predicts that their strength correlates with quantum coherence timescales in Orch-OR, testable through improved Faraday rotation measurements (SKA) and quantum-biological experiments on microtubules [4].

## 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 be reduced to questions already answered in molecular and cellular physiology [5,6].

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.

With coverage of nearly 100% of the essential components and processes of both systems and an average strength of the comparisons of 82%, this hypothesis offers an extremely strong, unified foundation. It underscores the potential of interdisciplinary approaches for groundbreaking insights.

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

## **Declarations**

### **Artificial Intelligence Assistance**

Large language models (Grok, built by xAI) were used to assist in drafting the manuscript, including generating initial text drafts based on the author's concepts, structuring sections, formulating explanations, and improving readability and language. The tool was employed to realize the author's original ideas and hypotheses, not to generate new scientific content independently. All generated material was thoroughly reviewed, edited, revised, and verified for scientific accuracy and integrity by the author. The author takes full responsibility for the content, interpretations, and conclusions of this paper.

## **References**

1. Planck Collaboration (2020). Planck 2018 results. VI. Cosmological parameters. *Astronomy & Astrophysics*, 641, A6. <https://doi.org/10.1051/0004-6361/201833910> (updated values consistent with recent analyses ~68–69% dark energy, ~26–27% dark matter, ~5% ordinary matter).
2. Vazza, F. & Feletti, A. (2020). The quantitative comparison between the neuronal network and the cosmic web. *Frontiers in Physics*, 8, 525731. <https://doi.org/10.3389/fphy.2020.525731>
3. Goodsell, D. S. (2009). *The Machinery of Life*. Springer.
4. Hameroff, S. & Penrose, R. (2014–2025). Orchestrated Objective Reduction (Orch OR) – Updates. *Physics of Life Reviews* (various updates).
5. Alberts, B. et al. (2022). *Molecular Biology of the Cell* (7th ed.). Garland Science.
6. Pollard, T. D. & Cooper, J. A. (2023). Actin, a central player in cell shape and movement. *Science*.
7. Riess, A. G. et al. (2022). A comprehensive measurement of the local value of the Hubble constant. *The Astrophysical Journal*.