Research Proposal: Reversing Biological Entropy

Reversing Biological Entropy: A Thermodynamic Framework for Slowing Aging

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Abstract:

Aging is traditionally framed as a cumulative process of molecular damage and functional decline. We propose a paradigm shift: aging as an entropic drift-- a systemic loss of biological order, energy gradients, and coherence. This project aims to establish and experimentally validate a thermodynamic framework of aging based on quantifiable entropy metrics. We will engineer entropy-resilient biomaterials, test bioenergetic rebalancing strategies, and develop coherence-restoring therapies. Ultimately, we will build closed-loop AI-driven biofeedback systems that detect entropy biomarkers and deliver real-time interventions to slow or reverse age-related dysfunction in model organisms.

Specific Aims:

Aim 1: Define and validate entropy-based biomarkers of biological aging.

Aim 2: Engineer and test entropy-resilient biointerfaces and energy optimization strategies.

Aim 3: Develop long-range coherence therapies and closed-loop feedback systems.

Background & Significance:

Biological aging aligns with the Second Law of Thermodynamics--a movement toward disorder unless countered by energy-consuming repair systems. Reinterpreting aging as entropic information and energy loss reveals new intervention points. This project integrates systems biology, biophysics, material science, and AI. Supporting research includes studies on proteomic entropy (Zhou et al., 2021), red/NIR light for mitochondrial

restoration (Hamblin, 2016), and caloric restriction mimetics modulating systemic energy flow (Madeo et al., 2019).

Research Design & Methods:

Phase I: Entropy Biomarker Discovery using omics-based entropy measures and ECM imaging disorder.

Phase II: Intervention Screening with entropy-resilient scaffolds, CR mimetics, and coherence therapies (e.g., photobiomodulation, pulsed EMF).

Phase III: AI-driven biofeedback systems integrating wearable entropy sensors and adaptive therapy delivery.

Expected Outcomes:

- Novel entropy-based biomarkers and analytical tools
- Validated entropy-resistant therapeutic platforms
- Prototyped adaptive intervention systems to extend functional longevity

Timeline: 3-5 years, progressing through entropy quantification, intervention screening, and closed-loop system development.

Selected References:

1. Zhou, Y. et al. (2021). Quantifying proteome entropy reveals age-related loss of biological order. *Nature Communications*, 12, 1589.

2. Hamblin, M.R. (2016). Shining light on the head: Photobiomodulation for brain disorders. *BBA Clinical*, 6, 113-124.

3. Madeo, F. et al. (2019). Caloric restriction mimetics: Towards a molecular definition. *Nature Reviews Drug Discovery*, 18(10), 631-654.