Title: A Novel Approach to Disease Modeling and Treatment: Integrating Systems Biology, Chaos Theory, and Deep Learning to Quantitatively Characterize and Resolve Hair Loss Pathologies.

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This project builds on pre-existing research and theory to address a pervasive challenge in biology: effectively characterizing complex biological systems that exhibit a degree of deterministic, chaotic behavior. These systems continue to evade canonical statistical modeling, in spite of their relevance. One such system is the human hair follicle interactome (HHFI), a network of topological signaling between the HHF mini-organ and associating cells, tissues, and organ systems. This dynamic network has import as a model for regenerative medicine and stem cell research, but even more so as the arena for alopecia, a class of hair loss diseases which continue to thwart treatment. Therefore, this project proposes a novel multi-pronged approach yielding a robust, mathematical model of this HHFI that accurately predicts the health, pathology, and optimal therapeutic intervention for any individual. We achieve this by developing a biological system diagram to parametrize the HHFI, characterizing its relationships via ODEs, and ultimately establishing it as a combination of equilibrium, periodic, quasi-periodic, and deterministically chaotic subsystems, that integrate to a quasi-periodic system as a whole. We then use deep learning algorithms to minimize/analyze discrepancies between the modeled network and empirical data. Evaluation of model-directed therapy is enhanced by the Researchkit app, a clinician-patient interface that streamlines the process of conventional study. Success of the project presents a powerful road map for accurate modeling of non-linear, high-dimensional biological systems, and the resolution of hair loss through personalized medicine.

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