Genomic Imprinting and Sleep: Adaptation Across Close and Distant Evolutionary Lineages

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Genomic imprinting, the parent-of-origin–specific regulation of gene expression, exerts a pivotal influence on neurodevelopment, energy balance, and many physiological processes. Evidence from imprinting disorders, as well as targeted mouse models, demonstrates that imprinted genes modulate REM/NREM architecture, thermoregulation, and sleep homeostasis. At the cellular level, monoallelic expression generates genetic noise and entropy, amplifying phenotypic variability that may facilitate adaptive flexibility under environmental constraints. Imprinting itself is subject to recent evolutionary pressures, as exemplified by NPAP1, a primate-restricted imprinted gene under positive selection in humans. This gene links lipid metabolism with circadian oscillations and thermoregulation, and the humanized mouse model of the modern haplotype reveal lineage-specific regulation of REM sleep, underscoring the importance of studying imprinted genes across lineages closely related to humans. In parallel, paleogenomic analyses of ancient Europeans and modern Arctic populations reveal convergent adaptations of circadian entrainment during the colonization of extreme latitudes, with calcium signaling and chronotype-associated polymorphisms emerging as recurrent targets of selection. While imprinting and latitude-driven adaptations operate through distinct mechanisms, both lines of evidence converge on the central role of sleep and circadian regulation as evolutionary targets of adaptation to ecological niches with extreme light–dark environments. In my talk, I will show how these complementary perspectives not only illuminate the evolutionary roots of sleep, but also provide a framework to interpret inter-individual variability, disease susceptibility, and potential translational avenues in circadian and sleep medicine.

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BIOGRAPHY

Valter Tucci

Valter Tucci, PhD, FRSB, is Principal Investigator Tenured at the Istituto Italiano di Tecnologia (IIT), where he leads the Genetics and Epigenetics of Behavior (GEB) Laboratory. His multidisciplinary research focuses on the genetic and epigenetic mechanisms underlying sleep, circadian rhythms, and neurodevelopmental disorders. He pioneered the genomic imprinting hypothesis of sleep and developed experimental models for rare diseases such as Prader–Willi syndrome. He has held positions at MIT, Oxford, and Tohoku University, and is a Fellow of the Royal Society of Biology.