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23. Biología

Complex oscillatory redox dynamics with signaling potential at the edge between normal and pathological mitochondrial function

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The time-keeping properties bestowed by oscillatory behavior on functional rhythms represent an evolutionarily conserved trait in living systems. Mitochondrial networks function as timekeepers maximizing energetic output while tuning reactive oxygen species [ROS] within physiological levels compatible with signaling. In this work, we explore the potential for timekeeping functions dependent on mitochondrial dynamics with the validated two-compartment mitochondrial energetic-redox (ME-R) computational model, that takes into account (a) four main redox couples (NADH, NADPH, GSH, Trx(SH)2), (b) scavenging systems (glutathione, thioredoxin, SOD, catalase) distributed in matrix and extra-matrix compartments, and (c) transport of ROS species between them.

Herein, we describe that the ME-R model can exhibit highly complex oscillatory dynamics in energetic/redox variables and ROS species, consisting of at least five frequencies with modulated amplitudes and period according to power spectral analysis. By stability analysis we describe that the extent of steady state - as against complex oscillatory behavior was dependent upon the abundance of Mn and Cu, Zn SODs, and their interplay with ROS production in the respiratory chain. Large parametric regions corresponding to oscillatory dynamics of increasingly complex waveforms were obtained at low Cu, Zn SOD concentration as a function of Mn SOD. This oscillatory domain was greatly reduced at higher levels of Cu, Zn SOD. Interestingly, the realm of complex oscillations was located at the edge between normal and pathological mitochondrial energetic behavior, and was characterized by oxidative stress.

We conclude that complex oscillatory dynamics could represent a frequency- and amplitude-modulated H2O2 signaling mechanism that arises under intense oxidative stress. By modulating SOD, cells could have evolved an adaptive compromise between relative constancy and the flexibility required under stressful redox/energetic conditions.

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24. Matemática

Deriva estocástica en poblaciones de tamaño variable con individuos de dos tipos

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Desarrollamos una variante del modelo de deriva de Wright-Fisher para tipos A y a, en la que el tamaño de la población varía temporalmente. El tiempo se modela de manera discreta como en el modelo original de Wright-Fisher. El paso de una generación n a la siguiente consiste en un muestreo aleatorio con reposición donde el tamaño de la muestra sigue una función determinística uniformemente acotada que depende de n. Encontramos que el número de individuos de tipo A (o a) es un proceso de Markov no homogéneo con estados absorbentes que se alcanzan con probabilidad 1. Hallamos las probabilidades de fijación y extinción de A y una fórmula para