

We have analyzed the stochastic dynamics of this system by the mathematical “Birth and Death” model often used in mathematical reliability theory. The calculations, based on the experimental data from the available literature, show that the probability of the slipping of $O_2^{\cdot-}$ through the mtSOD defense is about 1.9×10^{-5} , *i.e.*, about 2 radicals from every hundred thousand may penetrate the defense system.¹⁰⁻¹² It is noteworthy that $O_2^{\cdot-}$ can penetrate through lipid membranes.²⁸ Hence, with the intense electron transport fluxes in mitochondria and outside, the probability of $O_2^{\cdot-}$ -induced free-radical damages in cells can be high enough.

8.3.2 Free-Radical Redox-Timer of Aging

In the case of functional damages in LAS caused by the $O_2^{\cdot-}$ radicals, the following equation was derived for the maximum lifespan:¹¹⁻¹⁴

$$T = mc / [(qV/E)u + D] \quad (8.4)$$

In this equation, V is respiration rate, q is probability of the malfunction in electron transport nanoreactors leading to occurrence of $O_2^{\cdot-}$, E is the activity of SOD in LAS, and u is the probability of the free-radical failures to provoke functional violations. This parameter, u , is to take into account the next lines of defense, from special enzymes of reparation of DNA to other repair and renewal processes in cells and tissues. The higher the reliability of the defense, the less the value of this parameter is. In essence, the u parameter takes into account that deleterious effects of $O_2^{\cdot-}$, which slipped through the SOD defense, are of no concern if the preventive replacement of the damaged biological constructions is properly maintained. Lastly, D is the index to incorporate other damage factors that are not associated with oxygen free radicals. As a matter of fact, eqn (8.4) is the reliability explanation of the well-known “Rubner scaling relation”, that there is an inverse correlation between the species-specific resting metabolism and the maximum life spans of species.

The data on SOD activity in tissues of brain, liver and heart of men and animals of thirteen species were published by Cutler’s group in ref. 29. These data and the data on resting specific metabolic rates in the tissues of the species were used to plot the graphs of the reciprocal of the maximum life-spans ($1/T$) as a function of the ratio V/E values, according to eqn (8.4).

Figure 8.1 represents the graph for the brain tissues.

In line with the prediction of our model, the linear correlations were obtained for brain, liver and heart:

$$1/T = (0.0132 \pm 0.0002)(V/E) + (0.004 \pm 0.002), r = 0.997 \text{ (brain)} \quad (8.5a)$$

$$1/T = (0.0144 \pm 0.0003)(V/E) + (0.005 \pm 0.002), r = 0.997 \text{ (liver)} \quad (8.5b)$$

$$1/T = (0.0110 \pm 0.0009)(V/E) + (0.011 \pm 0.006), r = 0.981 \text{ (heart)} \quad (8.5c)$$