Numerical modelling of the effects of cold atmospheric plasma on mitochondrial redox homeostasis and energy metabolism

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Index	Reaction	Rate v_i	Constant k_i	Ref.
	Pyruvic acid oxidation			
R01	$\rightarrow \mathrm{Pyr}$	k_{01}	38×10^{-6} [a]	35
R02	$\mathrm{Pyr}+\mathrm{NAD}^+ \rightarrow \mathrm{AcCoA}+\mathrm{NADH}$	$k_{02}[\mathrm{Pyr}][\mathrm{NAD}^+]$	152 [b]	35
	TCA cycle			
R03	$\mathrm{OAA}+\mathrm{AcCoA} \rightarrow \mathrm{Cit}$	$k_{03}[\mathrm{OAA}][\mathrm{AcCoA}]$	57142 [b]	35
R04	$\mathrm{Cit}+\mathrm{NAD}^+ \rightarrow \mathrm{KG}+\mathrm{NADH}$	$k_{04}[\mathrm{Cit}][\mathrm{NAD}^+]$	53 [b]	35
R05	$\mathrm{KG}+2\mathrm{NAD}^+ +\mathrm{ADP} \rightarrow \mathrm{OAA}+2\mathrm{NADH}+\mathrm{ATP}$	$k_{05}[\mathrm{KG}][\mathrm{NAD}^+][\mathrm{ADP}]$	82361 [c]	35
R06	$\mathrm{Pyr}+\mathrm{ATP} \rightarrow \mathrm{OAA}+\mathrm{ADP}$	$k_{06}[\mathrm{Pyr}][\mathrm{ATP}]$	40 [b]	35
R07	$\mathrm{OAA} \leftrightarrow \mathrm{KG}$	$k_{07}([\mathrm{OAA}]-[\mathrm{KG}]/k_{\mathrm{eq}})$	3.2×10^{-3} [d]	35
R08	$\mathrm{OAA} \rightarrow$	$k_{08}[\mathrm{OAA}]$	3.6 [d]	35
	Membrane reaction			
R09	$\mathrm{ATP} \rightarrow \mathrm{ADP}$	$k_{09}[\mathrm{ATP}]$	0.005–0.1 [d]	35
R10	$\mathrm{H}^+_{\mathrm{ex}} \rightarrow \mathrm{H}^+$	$k_{10}\Delta\psi$	0.426×10^{3} [e]	35
R11	$\mathrm{ADP}\ (+3\mathrm{H}^+_{\mathrm{ex}})+\mathrm{Pi} \rightarrow \mathrm{ATP}\ (+3\mathrm{H}^+)+\mathrm{H_2O}$	$f([\mathrm{ATP}],[\mathrm{Pi}],\Delta\psi)$	–	35
R12	$\mathrm{NADH}+\frac{1}{2}\mathrm{O_2}\ (+10\mathrm{H}^+) \rightarrow \mathrm{NAD}^+ +\mathrm{H_2O}\ (+10\mathrm{H}^+_{\mathrm{ex}})$	$f([\mathrm{NADH}],\Delta\psi)$	–	35
	ROS regulation			
R13	$\mathrm{NADH}+\mathrm{O_2}\ (+\mathrm{H}^+) \rightarrow \mathrm{NAD}^+ +\mathrm{H_2O_2}$	$k_{13}[\mathrm{NADH}][\mathrm{O_2}]$	3.0 [a]	33
R14	$\mathrm{H_2O_2}+\mathrm{Fe}^{3+} \rightarrow \mathrm{coI}$	$k_{14}[\mathrm{H_2O_2}][\mathrm{Fe}^{3+}]$	1.8×10^{7} [a]	33
R15	$\mathrm{coI}+\mathrm{ARH} \rightarrow \mathrm{coII}+\mathrm{AR}^*$	$k_{15}[\mathrm{coI}][\mathrm{ARH}]$	1.5×10^{5} [a]	33
R16	$\mathrm{coII}+\mathrm{ARH} \rightarrow \mathrm{Fe}^{3+}+\mathrm{AR}^*$	$k_{16}[\mathrm{coII}][\mathrm{ARH}]$	5.2×10^{3} [a]	33
R17	$\mathrm{NAD}^*+\mathrm{O_2} \rightarrow \mathrm{NAD}^+ +\mathrm{O_2^-}$	$k_{17}[\mathrm{NAD}^*][\mathrm{O_2}]$	2.0×10^{7} [a]	33
R18	$\mathrm{O_2^-}+\mathrm{Fe}^{3+} \rightarrow \mathrm{coIII}$	$k_{18}[\mathrm{O_2^-}][\mathrm{O_2}]$	1.7×10^{7} [a]	33
R19	$2\mathrm{O_2^-}\ (+2\mathrm{H}^+) \xrightarrow{(\mathrm{SOD})} \mathrm{H_2O_2}+\mathrm{O_2}$	$k_{19}[\mathrm{O_2^-}]^2$	2.0×10^{7} [a]	33
R20	$\mathrm{coIII}+\mathrm{NAD}^* \rightarrow \mathrm{coI}+\mathrm{NAD}^+$	$k_{20}[\mathrm{coIII}][\mathrm{NAD}^*]$	4.0×10^{7} [a]	33
R21	$2\mathrm{NAD}^* \rightarrow \mathrm{NAD_2}$	$k_{21}[\mathrm{NAD}^*]^2$	6.0×10^{7} [a]	33
R22	$\mathrm{Fe}^{3+}+\mathrm{NAD}^* \rightarrow \mathrm{Fe}^{2+}+\mathrm{NAD}^+$	$k_{22}[\mathrm{Fe}^{3+}][\mathrm{NAD}^*]$	1.8×10^{6} [a]	33
R23	$\mathrm{Fe}^{2+}+\mathrm{O_2} \rightarrow \mathrm{coIII}$	$k_{23}[\mathrm{Fe}^{2+}][\mathrm{O_2}]$	1.0×10^{5} [a]	33
R24	$\mathrm{AR}^*+\mathrm{NADH} \rightarrow \mathrm{ARH}+\mathrm{NAD}^*$	$k_{24}[\mathrm{AR}^*][\mathrm{NADH}]$	7.0×10^{5} [a]	33
R25	$\mathrm{O_{2,eq}} \rightarrow \mathrm{O_2}$	$k_{25}[\mathrm{O_{2,eq}}]$	6.0×10^{-3} [d]	33
R26	$\mathrm{O_2} \rightarrow \mathrm{O_{2,eq}}$	$k_{26}[\mathrm{O_2}]$	6.0×10^{-3} [d]	33

Table S1. Biochemical reactions involved in the present simulation. Units. a: $\mathrm{M\cdot s^{-1}}(=\mathrm{mol\cdot L^{-1}\cdot s^{-1}})$, b: $\mathrm{M^{-1}\cdot s^{-1}}$, c: $\mathrm{M^{-2}\cdot s^{-1}}$, d: $\mathrm{s^{-1}}$, e: $\mathrm{M\cdot s^{-1}\cdot V^{-1}}$.

Reactant	Abbreviation	Initial concentration	Ref.
Phosphate	Pi	2.44 [a]	35
Pyruvate	Pyr	0.14 [a]	35
Citrate	Cit	0.40 [a]	35
Acetyl-CoA	AcCoA	0.07 [a]	35
α-ketoglutarate	KG	0.25 [a]	35
Oxaloacetate	OAA	0.50×10^{-2} [a]	35
Adenosine triphosphate	ATP	3.23 [a]	35
Adenosine diphosphate	ADP	0.93 [a]	35
Reduced nicotinamide adenine dinucleotide	NADH	0.13 [a]	35
Oxidised nicotinamide adenine dinucleotide	NAD^+	0.94 [a]	35
Nicotinamide adenine dinucleotide radical	NAD^*	0.9×10^{-3} [b]	33
Nicotinamide adenine dinucleotide dimer	NAD_2	1.07 [b]	33
Ferrous peroxidase iron(II)	Fe^{2+}	1.20×10^{-2} [b]	33
Ferric peroxidase iron(III)	Fe^{3+}	0.60 [b]	33
Enzyme intermediates compound I	coI	7.10×10^{-4} [b]	33
Enzyme intermediates compound II	coII	0.02 [b]	33
Enzyme intermediates compound III	coIII	0.77 [b]	33
Aromatic compound	ARH	2.99×10^{2} [b]	33
Aromatic compound free radical	AR^*	1.11×10^{-3} [b]	33
Oxygen molecule	O_2	6.85 [b]	33
Superoxide anion	O_2^-	8.60×10^{-4} [b]	33
Hydrogen peroxide	H_2O_2	0.90×10^{-2} [b]	33

Table S2. Initial concentrations. Units. a: mM, b: μM. ATP+ADP=4.16 mM. NADH+NAD^+=1.07 mM.