

Supplementary Table 2

Overview of kinetic constants used for the construction of the model.

Enzyme	EC number	Kinetic parameter	References	Rate Law
NADA	3.5.1.19	$K_M:9.6\mu\text{M}$ $K_{iP}:120\mu\text{M}$ $k_{cat}:0.65s^{-1}$	[1]	Product inhibition
NADS	6.3.5.1	$K_M:190\mu\text{M}$ $k_{cat}:21s^{-1}$	[2]	HMM
NMNAT	2.7.7.1 2.7.7.18	$K_{M_{NaMN}}:67.7\mu\text{M}$ $k_{cat_{NaMN}}:42.9s^{-1}$ $K_{M_{NMN}}:22.3\mu\text{M}$ $k_{cat_{NMN}}:53.8s^{-1}$ $K_{M_{NMN}}:59\mu\text{M}$ $k_{cat_{NAD}}:129.1s^{-1}$ $K_{M_{NaAD}}:502\mu\text{M}$ $k_{cat_{NaAD}}:103.8s^{-1}$	[3] ¹ [4] ² [4] ³	Substrate Competition
NMNT	2.1.1.1	$K_M:400\mu\text{M}$ $K_{iP}:60\mu\text{M}$ $k_{cat}:8.1s^{-1}$	[5] [6]	Product inhibition
NamPT	6.3.5.1	$K_M:5\text{nM}$ $k_{cat}:0.0077s^{-1}$ $K_{i_{NAD}}:2.1\mu\text{M}$	[7]	Competitive inhibition
NAPRT	2.4.2.11	$K_M:1.5\mu\text{M}$ $k_{cat}:3.3s^{-1}$	[7]	HMM
SIRT1	3.5.1.-	$K_M:29\mu\text{M}$ $K_{iP}:60\mu\text{M}$ $k_{cat}:0.67s^{-1}$	[8]	Product inhibition
NT5	3.1.3.5	$K_{M_{NaMN}}:3.5\text{mM}$ $k_{cat_{NaMN}}:2.8s^{-1}$ $K_{M_{NMN}}:5\text{mM}$ $k_{cat_{NMN}}:0.5s^{-1}$	[9]	HMM
PNP	2.4.2.1	$K_M:1.48\text{mM}$ $k_{cat}:40s^{-1}$	[10]	HMM
NRK	2.7.1.173	$K_M:3.4\mu\text{M}$ $k_{cat}:0.23s^{-1}$	[11]	HMM

¹Values for NMNAT1 used

²Keq used for calculation of turnover rate of reverse reaction

³Equilibrium constant used for calculation of turnover rate of reverse reaction

Amount of enzymes and import rates

The total enzyme concentration was set to 10 times the scaling factor, for all enzymes except NamPT and NMNAT, for which the concentration was set to 100 times the scaling factor. As enzyme concentrations here have an arbitrary unit a scaling factor of $0.1\mu\text{M}$ was applied to all enzymatic reactions to achieve consumption rates that are in the range of reported values [12]. Concentration of potential co-substrates were assumed to be constant and not-limiting for the reaction. Thus being implicitly represented by maximal velocities consisting of total enzyme concentration times turnover rates. Nam import rates for import into the system was set to $0.1\mu\text{M/s}$ for all simulations, being in the range measured for Nam uptake in mammalian cells [13]. In addition to the reactions listed above an additional NAD consumption was simulated using HMM-kinetics with a substrate affinity of 0.3 mM and a turnover rate of 1. Furthermore, reversible NAD binding to proteins was simulated using reversible mass actions kinetics with an equilibrium constant of 0.1, which is in a range of values reported in the literature, dissociation and association constants were set to 10 and 100s^{-1} respectively. For the two compartment simulation, compartment size was equal for both compartments and set to $1\mu\text{l}$. The actual compartment size does not change the outcome of the simulations as long as both compartments have equal volumes. The Nam import rates were set to 100s^{-1} for both compartments. The amount of NADA present was set to 100. Thus equal to the amount of NamPT used.

Kinetic Rate Laws

Product Inhibition

$$v = \frac{E_T \cdot k_{cat} \cdot S}{K_M + S + \frac{K_M \cdot P}{K_{iP}}} \quad (1)$$

Competitive Inhibition

$$v = \frac{E_T \cdot k_{cat} \cdot S}{K_M + S + \frac{K_M \cdot I}{K_{iI}}} \quad (2)$$

Henry-Michaelis Menten for irreversible reactions (HMM)

$$v = \frac{E_T \cdot k_{cat} \cdot S}{K_M + S} \quad (3)$$

Substrate Competition at NMNAT

$$v = E_T \cdot \frac{\frac{k_{cat_A} \cdot A \cdot B}{K_{M_A}} - \frac{k_{cat_P} \cdot P \cdot Q}{K_{M_P}}}{1 + \frac{A}{K_{M_A}} + \frac{B}{K_{M_B}} + \frac{P}{K_{M_P}} + \frac{Q}{K_{M_Q}}} \quad (4)$$

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