

a. For \underline{S} use code Hw#3 with $\$V$

$$\$V = \begin{cases} \text{Balance.JL for balanced } \underline{S} \\ \text{out Balance.JL for unbalanced } \underline{S} \end{cases}$$

b. Not balanced originally added in a

" $H_2O \rightarrow$ " - export rxn

" $ATP \rightleftharpoons ADP$ " - Exchange rxn or coupled rxn need to provide energy for other rxns.

This check is performed in the same code for a.

and the Matrix whose sum is 0 when balanced elementally is called ebs,

c. optimal value is contained in opt-value, produced by code Hw #3 FBA.jl, used balanced \underline{S} here, Also used given assumptions in Pset #3,

- For V-boundaries they were calculated as

if only $\Rightarrow \Rightarrow 0 \leq V_{\#} \leq \underbrace{k_{cat}}_{\text{given}} E \underbrace{\left(\frac{a}{k_m + a} \right)}_{\substack{\text{calculated in excel file} \\ \text{nChem bio} \text{ and matched} \\ \text{The usual definition of } k_m}} \quad \text{substrate/metabolite}$

if $\rightleftharpoons \Rightarrow -k_{cat} E \left(\frac{a}{k_m + a} \right) \leq V_{\#} \leq k_{cat} E \left(\frac{a}{k_m + a} \right)$

if not an exchange flux else it is;

$$0 \leq V_{\#} \leq 10 \frac{\text{mmol}}{\text{gDW} \cdot \text{hr}} \quad \text{if } \rightarrow$$

or

$$-10 \frac{\text{mmol}}{\text{gDW} \cdot \text{hr}} \leq V_{\#} \leq 10 \frac{\text{mmol}}{\text{gDW} \cdot \text{hr}} \quad \text{if } \rightleftharpoons$$