$\boxed{\text{Problem \#1}}$ CHEME 7770 - Prelim

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a) $\beta = \langle m_c \rangle \hat{N}_c V$ $\quad$ $OD600 = 0.1 \approx 1\times10^{8}\ \frac{\text{cells}}{\text{mL}} = \hat{N}_c$

Sample size $(V) = 1\text{mL}$

weight / 1 unit OD600 $\quad$ $0.33\ \frac{g}{L}$ or $0.00033\ \frac{gDW}{mL}$ $\quad$ BNID 109838

$$\langle m_c \rangle = \left(3.3\times10^{-4}\ \frac{gDW}{mL}\right)\left(\frac{1\ mL}{1\times10^{8}\ cells}\right)\underbrace{(0.1)}_{\text{since } OD600 = 0.1}$$

$$\langle m_c \rangle = 3.3\times10^{-13}$$

$$\beta = \langle m_c \rangle \hat{N}_c V = (3.3\times10^{-13})(1\times10^{8})(1) = 0.000033\ gDW$$

OR

$3.3\times10^{-5}\ gDW$

conversion for excel: $\langle n \rangle = \frac{mRNA}{cell}\left(\frac{1\ mol}{6.022\times10^{23}}\right)\left(\frac{1\times10^{9}\ nmol}{1\ mol}\right) = \frac{nmol}{cell}$

$$\frac{nmol}{\cancel{cell}}\underbrace{\left(\frac{\cancel{cells}}{gDW}\right)}_{1/\langle m_c \rangle} = \frac{nmol}{gDW}$$

See excel for table.

b) $\dot{m}_i = r_{x,i}\bar{u}_i - (\mu + \theta_{m,i})m_i = 0$ at steady state

$$0 = r_{x,i}\bar{u} - (\mu + \theta_{m,i})m^* \quad \therefore \quad \boxed{m^* = \frac{r_{x,i}\bar{u}}{(\mu+\theta_{m,i})}}$$

$= K_X$

where

LN2 $\left[\ r_x = k_E R_{x,T}\left(\frac{G}{\tau_{x,j}K_{x,j} + (\tau_{x,j}+1)G}\right)\right.$

$$u(I) = \frac{w_1 + w_2 f_I}{1 + w_1 + w_2 f_I} \quad , \quad f_I = \frac{I^n}{K_D^n + I^n}$$

LN3

c) estimate $K_x(G, k)$ and $u(I, \theta)$

we know : $u_i = [0, 1]$

$\tau_d = 40min$ $\quad \tau_{1/2} = 5min$

K_x = constant as I is the only changing variable

$\therefore$

$I = 0 \quad f_I = \frac{0^n}{K_D^n + \theta^n} = 0$

$u(0) = \frac{w_1}{1+w_1}$ and $m^*(0) = K_x \frac{w_1}{1+w_1} = 0.096$

$u = 1$ for large I :

$m^* = K_x \quad \approx 0.468$ from excel sheet

$K_{E,j}^* = 25\ nt/s$ (given 1000nt) $\therefore 0.025 s^{-1}$ (PS2)

$K_{x,t} = 5000$ (for $\tau_D = 40$) BNID 101440

$G = 2$ copies / cell [Problem Statement]

$I_{x,j} = \frac{K_{E,j}}{K_I} = 0.625$

$K_{x,j} = 0.0136$ [PS2]

$K_I = 4 \times 10^{-2} s^{-1}$ [McClure]

others listed in excel

Least Squares Gives:

$W_1 = 0.263$

$W_2 = 199.959 \approx 200$

$K = 6884.19$

$n = 1.54$

d) the model fits the data very well although I'm not certain I did any of this right. I think the values of all of the parameters play a role in fit and shape. The log plot doesn't have the correct shape. I believe this may have to do with my K and W values.