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PS-2

Q. 1) a)

For gene G_i° (mmol/gDW) which produces protein P_i°. The material balance equation governing the concentration of mRNA m_i° (mmol/gDW) transcribed from gene G_i°, which is then translated to produce protein P_i° (mmol/gDW) are given by:

$$\dot{m}_i^\circ = r_{X,i}^\circ u_i^\circ - (\mu + \theta_{m,i}) m_i^\circ + \lambda_i^\circ \quad i = 1, 2, \dots N \quad -(1)$$

$$\dot{P}_i^\circ = r_{L,i}^\circ W_i^\circ - (\mu + \theta_{P,i}) P_i^\circ \quad -(2)$$

Here, μ is the dilution term.

Now, $\mu = \dot{\beta} \cdot \beta^{-1}$

$\beta = V_L$

$\Rightarrow \dot{\beta} \cdot \beta^{-1} = \dot{V}_L^\circ \cdot V_L^{-1}$

Since it's a batch system and V_L is constant (i.e., 15 mL) $\cdot \dot{V}_L = 0$

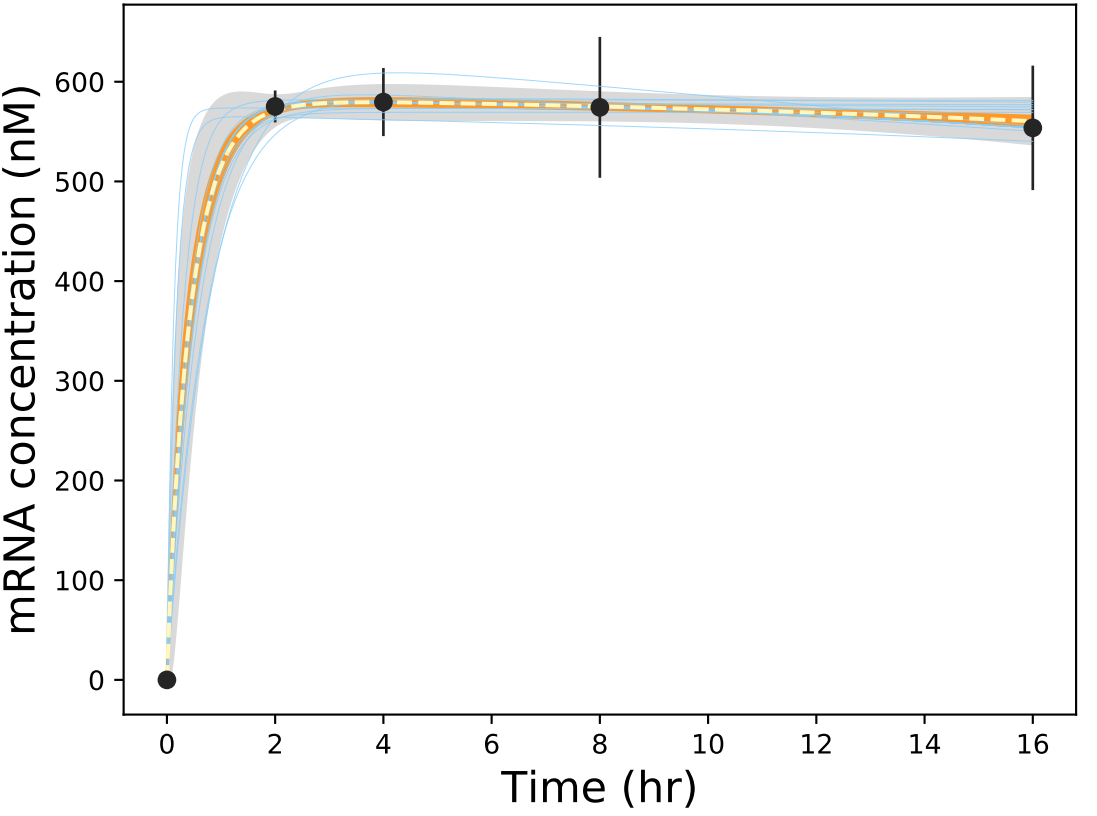
$\therefore \mu = 0$.

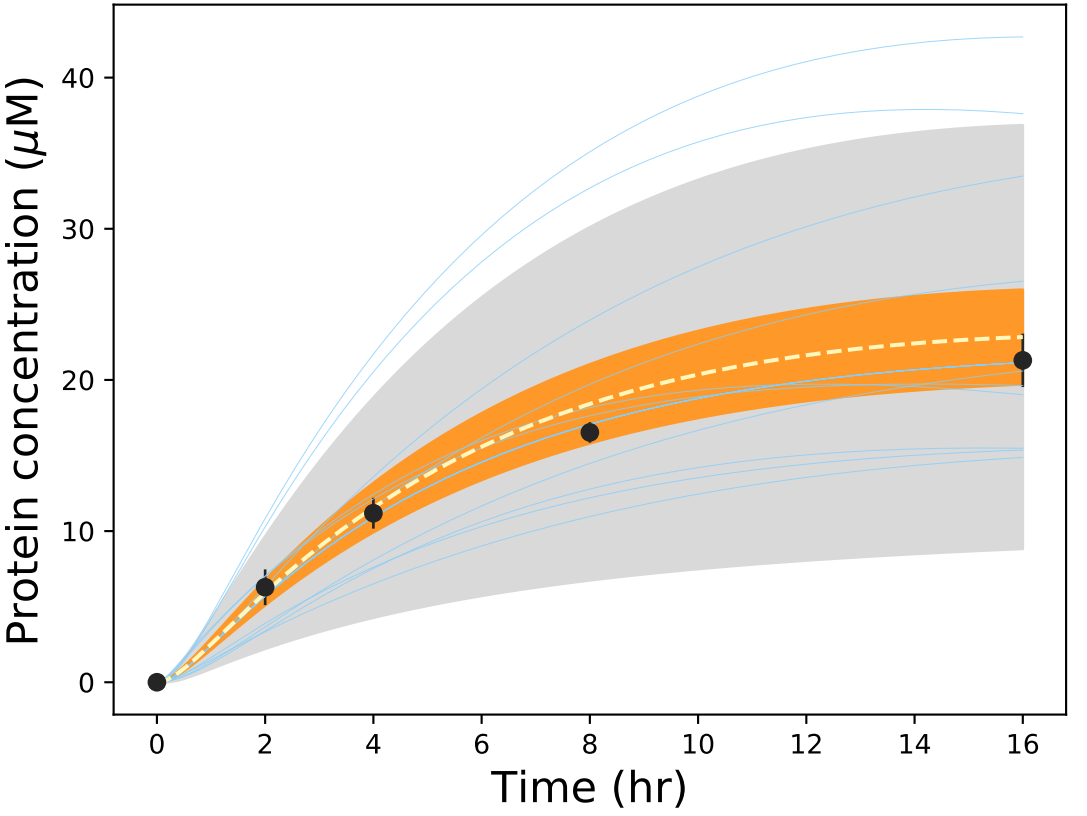
Thus the balance equations governing mRNA (m) (eq → 1) and protein (p) (eq → 2) will become -

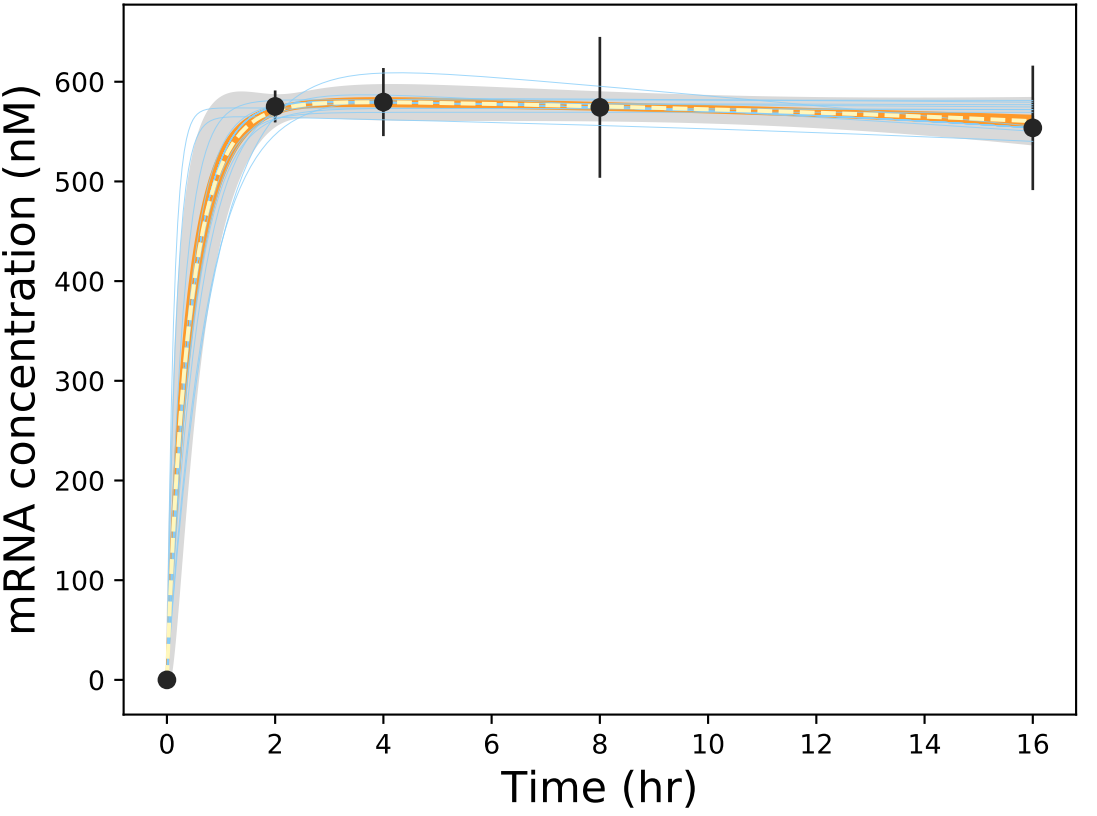
$$\dot{m}_i = r_{x,i} u_i - \theta_{m,i} \cdot m_i + \lambda_i$$

$$\dot{p}_i = r_{L,i} w_i - \theta_{p,i} p_i .$$

(Proved)


mRNA concentration (nM)
0
100
200
300
400
500
600
0
2
4
6
8
10
12
14
16
Time (hr)


Protein concentration (μM)
0
10
20
30
40
0
2
4
6
8
10
12
14
16
Time (hr)


mRNA concentration (nM)
0
100
200
300
400
500
600
0
2
4
6
8
10
12
14
16
Time (hr)