

CHEME 5440

$$(1) a) \dot{n}_{x,acc,i} = \dot{n}_{x,in,i} - \dot{n}_{x,out,i} + \dot{n}_{x,gen,i}$$

$$\dot{n}_{x,in,i} = \dot{n}_{x,out,i} = 0$$

$$\dot{n}_{x,acc,i} = \dot{n}_{x,gen,i}$$

$$\frac{d}{dt} \int_B x_i dB = \int_B \underbrace{(\dots)}_{\text{generation term}} dB$$

will make assumption

$$\frac{d}{dt} (x_i B) = (\dots) B \rightarrow \dot{x}_i = (\dots) - x_i B^{-1} \dot{B}$$

Since cell free don't have to deal with cell mass conc. (concentration of machinery is unchanging)

$$B = V_R \underbrace{C}_{\text{molar volume}} \rightarrow \text{concentration of machinery}$$

$$B^{-1} \dot{B} = C^{-1} \dot{C} + V_R^{-1} \dot{V}_R$$

Both C and V_R are constant

$$\therefore B^{-1} \dot{B} = 0$$

→ no dilution terms in cell free

$$\therefore \dot{x}_i = (\dots)$$

generation term for mRNA (...)

regulated rate transcription + unregulated rate - degradation

$$r_{x,i} u_i + \lambda_i - \theta_m m$$

$$\therefore \dot{m}_i = r_{x,i} u_i + \lambda_i - \theta_m m$$

generation term for protein

regulated rate of translation - degradation

$$\dot{p} = r_{L,T} W_i - \theta_{pp}$$

b) Estimating parameters
need to find

- mRNA half life in hours

median mRNA half life (2.1-6.0 min)

$$2.1 \text{ min} \left(\frac{1 \text{ hr}}{60 \text{ min}} \right) = 0.035 \text{ hr} - 0.1 \text{ hr}$$

tested both
ends →
experimental
data lies
somewhere
in the middle

from paper 16-17 min → 0.266

- protein half life in hours

BIND given ~ 20 hrs

- characteristic initiation time translation

BIND given 15s

- translation elongation rate 16 aas - 9 aas/s

- transcription elongation rate

@ 37°C

42 nt/s

- characteristic initiation time transcription

- RNAP II concentration

from supplementary
materials

60 - 75 nM

0.06 μ M - 0.075 μ M

- ribosome concentration

from supplementary
materials

< 2300 nM

2.3 μ M

had to increase
by factor of 10 to
match data