

Integrative Molecular and Cellular Bioengineering, SPRING '07
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Assignment 4: Due April 20, 2007

1. Calculate the steady-state uptake rate of epidermal growth factor ligand (EGF) following the development in class and assuming the following parameter values, for the following ligand concentrations: a) 0.1 nM, b) 1.0 nM, c) 10 nM.

Parameter	EGF
R_T (#/cell)	2.5×10^4
k_1 ($\mu\text{M}^{-1} \text{min}^{-1}$)	72
k_{-1} (min^{-1})	0.34
k_i (min^{-1})	0.03
k_r (min^{-1})	0.058

2. The area of one well in a 96 well plate is 0.328 cm^2 . Assuming a cell density of $5.0 \times 10^5 \text{ cells/cm}^2$ (near confluence) and the steady-state uptake rate calculated in 1b), calculate the amount of EGF that is consumed from the medium during one hour of exposure to 1.0 nM EGF. What fraction of the total amount does this represent? The volume of medium in one well is 100 microliters.

3. Consider a gene whose encoded protein activates its own transcription. This is called an autoregulatory gene. In this case, $i=j$ in the Elowitz and Leibler equations, so that

$$\frac{dm_1}{dt} = \alpha_0 + \frac{\alpha}{1 + p_1^n} - m_1$$

$$\frac{dp_1}{dt} = -\beta(p_1 - m_1)$$

- a) Does this protein have one or multiple steady-states, assuming the values of $\alpha_0 = 10$ protein molecules/s, $\alpha = 0.01$ protein molecules/s, $\beta = 5 \text{ s}^{-1}$, and $n = 2$?
- b) Are there any steady-states if the same parameters apply except $n=1$?