Tutorial 10

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July 17, 2019

Exercise: Chemotaxis

Implement the simplest chemotaxis model:

- The probability that a methylated receptor is active is

$$p = \frac{L}{L + K_L}$$

  with ligand concentration L and Michaelis-Menten constant K_L.

- The concentration of activated receptors T_a is given by :

$$T_a = p\,T_m$$

  with T_m the concentration of methylated receptors.

- The dynamics of the concentration of methylated receptors is given by

$$\dot{T}_m = k_R R - k_B B \frac{T_a}{K_B + T_a}$$

  The expression means that the methylating enzyme R is present in and that the demethylating enzyme B only acts on active receptors. Notice the difference and relationship between T_a and T_m.

- Dynamics of the phosphorylated $CheA_p$:

$$\dot{A}_p = k_A(A_{tot} - A_p)T_a - k_Y A_p(Y_{tot} - Y_p)$$

- Dynamics of the phosphorylated $CheY_p$:

$$\dot{Y}_p = k_Y A_p(Y_{tot} - Y_p) - \gamma_Y Y_p$$

Simulate the system

- with the parameters: $K_L = 1$, $k_R = 1$, $k_B = 10$, $K_B = 1$, $k_A = 10$, $k_Y = 1$, $\gamma_Y = 1$, $R = 0.01$, $B = 1$, $A_{tot} = 10$, and $Y_{tot} = 10$
- and a ligand concentration of

$$L = \begin{cases} 0.1 & \text{for } 0 \leq t < 50s \\ 0.3 & \text{for } 50 \leq t < 100s \\ 0.5 & \text{for } 100 \leq t < 150s \\ 0.3 & \text{for } 150 \leq t < 200s \end{cases}$$

- Consider the (appropriately scaled) time course of the ligand concentration and the single components and make the mechanism clear to you.