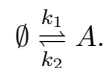


Exercises, Reaction dynamics

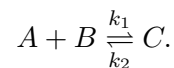
Exercise 1: Define the ordinary differential equations describing the time evolution of all molecules in the following reactions:

A. Production/degradation



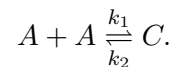
(Assume a mass action formalism).

B. Dimers



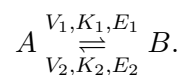
(Assume a mass action formalism).

C. Homodimers



(Assume a mass action formalism).

D. Enzymatic transformation



(Assume a Michaelis-Menten formalism with the enzymes E_1 , E_2).

E. Auto-activation Set up a model for a protein that activates its own transcription, and include a protein degradation term. (Assume a Michaelis-Menten formalism).

F. Auto-repression Set up a model for a protein that represses its own transcription, and include a protein degradation term. (Assume a Hill formalism).

G. AND gate Set up a model for a protein X that is activated if and only if both transcription factors Y and Z are present. (Assume a Michaelis-Menten formalism).

Exercise 2: Analyse the dynamics for two of the examples given in exercise 1.

Exercise 3: Describe in words or with reaction arrows plausible mechanisms leading to the following equations:

A.

$$\begin{aligned}\frac{d[X]}{dt} &= k_1 - k_2[X] + k_3[Y] - V_1 \frac{[X][E_1]}{K_1 + [X]} \\ \frac{d[Y]}{dt} &= -k_3[Y] + V_1 \frac{[X][E_1]}{K_1 + [X]}\end{aligned}$$

B.

$$\begin{aligned}\frac{d[X]}{dt} &= k_1 + \frac{k_2[Y]^2}{k_3 + [Y]^2} - k_4[X] - V_1 \frac{[X][E_1]}{K_1 + [X]} \\ \frac{d[Y]}{dt} &= -[Y] + V_1 \frac{[X][E_1]}{K_1 + [X]}\end{aligned}$$

C.

$$\begin{aligned}\frac{d[X]}{dt} &= k_1 + \frac{k_2[Y]^2}{k_3 + [Y]^2} - k_4[X] - V_1 \frac{[X][E_1]}{K_1 + [X]} \\ \frac{d[Y]}{dt} &= k_5 - [Y] - \frac{k_2[Y]^2}{k_3 + [Y]^2}\end{aligned}$$

D.

$$\begin{aligned}\frac{d[A]}{dt} &= a - (b + \beta)[A] + c[A]^2[B] \\ \frac{d[B]}{dt} &= b[A] - c[A]^2[B]\end{aligned}$$