Systems Biology Tutorial 6: The kinetic model

1. **Simulating chemical equilibrium (a closed system)**

   (a) Download and save the `lin3.psc` model from the course website. Edit the PSC file to remove the fixed metabolites s_1 and p_1. Also remove the reactions that connect these to the model. *Save the model under a new name!*

   - Set the initial concentrations of x_2 and x_3 to 1 and 0 respectively. Simulate the time-course until the system reaches equilibrium and record the concentrations for x_2 and x_3.
   - Calculate the equilibrium constant for the reaction. Does it match the parameter value in the reversible Michaelis-Menten kinetics?

   (b) Re-edit the original model and turn s_1 and p_1 into time-varying metabolites (i.e. not fixed). *Save the model under another new name!*

   - Set the initial concentrations of s_1, x_2, x_3 and p_1 to 1, 0, 0 and 0, respectively. Set the equilibrium constants K_{eq1}, K_{eq2} and K_{eq3}, to 1, 2 and 3, respectively.
   - Simulate the model to equilibrium (find a suitable end time). Plot the simulation for both the species and the rates.
   - Determine the concentrations at equilibrium for the individual metabolites.
   - Show how the K_{eq}-values of the individual steps can be used to predict the equilibrium constant of the pathway as a whole.
   - Determine the values of the rates at equilibrium. Is this what you would expect?

2. **Simulating steady state (an open system)**

   (a) Re-edit the original `lin3.psc` model to set the equilibrium constants K_{eq1}, K_{eq2} and K_{eq3} to 1, 2 and 3, respectively, and set s_1 and p_1 to 2 and 1, respectively. s_1 and p_1 should *remain fixed* now as we are simulating an open system! *Save the model under another new name!*

   (b) Simulate the system from initial conditions to steady state (find a suitable end time). Plot the simulation for both the species and the rates.

   (c) Show that the mass-action ratio of the pathway equals the product of the mass-action ratios of the individual steps.

   (d) Determine the value of the steady-state flux. How does this compare to the rates of the closed system?