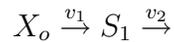


Linking Genome to Physiome

Multistationarity: Lab 1

The purpose of this exercise is to explore the dynamics of a very simple but common motif found in genetic and signaling pathways.

Consider the following simple system:



where the rate for the first step $v_1 = X_o + 10 \times S_1^n / (15 + S_1^n)$

and the rate for the second step, $v_2 = k_1 \times S_1$.

Set $n = 4$ and k_1 to a value of 2.0. X_o is assumed to be a boundary species with a value of $X_o = 0.5$. Since the second step is irreversible X_1 has been omitted from the pathway diagram (It has no influence). v_1 might represent the gene expression rate for a protein S_1 and v_2 the protein degradation rate.

Question 1. Using Excel, create three columns, the first column should contain values from zero to fifteen in steps of 0.1. This column will equal the concentration of S_1 . Let the second column equal the reaction rate, v_1 and the third column v_2 . Add the rate law for v_1 to the second column and the rate law for v_2 to the third column, compute the rates using the S_1 values in the first column. When entering the third column, it will be convenient to reference the value of the rate constant, k_1 , from another cell. This will allow you to easily change k_1 later on and observe its effect.

Plot v_1 and v_2 versus S_1 . Sketch the plot here, make sure you label the x and y axis so that you know what the axes represent.

Question 2. How many times do the lines intersect?

Question 3. What do the intersection points represent?

Question 4. Change the value of k_1 to 4.0. How many times do the curves intersect now?

Stop here for a Software Demo of Jarnac

Question 5. Enter the simple model into Jarnac with all values initialized as described at the beginning of the assignment. You will use Jarnac to compute the time evolution of the system.

Start S_1 at a value of 1.0. Run a time simulation for 4 time units or until steady state is reached. Record the final value of S_1 .

S_1 :

Question 6. Reset S_1 to a value of 1.5 and repeat the simulation, record the final value of S_1 .

S_1 :

Question 7. If there is a difference in the final values in question 5) and 6), what is the explanation? Note that the 'genotype' (parameter values), is identical in each case.