7.36/7.91/BE.490
Homework 4
Due May 6 at 1:00 PM

This assignment is designed to help you gain some basic familiarity with physico-chemical models of biological systems. You are not necessarily expected to understand all the details of how these models are developed or implemented. However, many scientists are choosing to develop models of biological systems to aid in their understanding of how systems work and so it is useful to have an idea how these models work.

In this assignment, you will be asked to manipulate a model of a synthetic biological system called the Repressilator that was developed by Elowitz and Leibler in 2000. The paper is also available from the website as a reference. Note that the model provided differs somewhat from the model presented by Elowitz and Leibler though most parameter values are taken from their paper. See the paper for a description of the Repressilator.

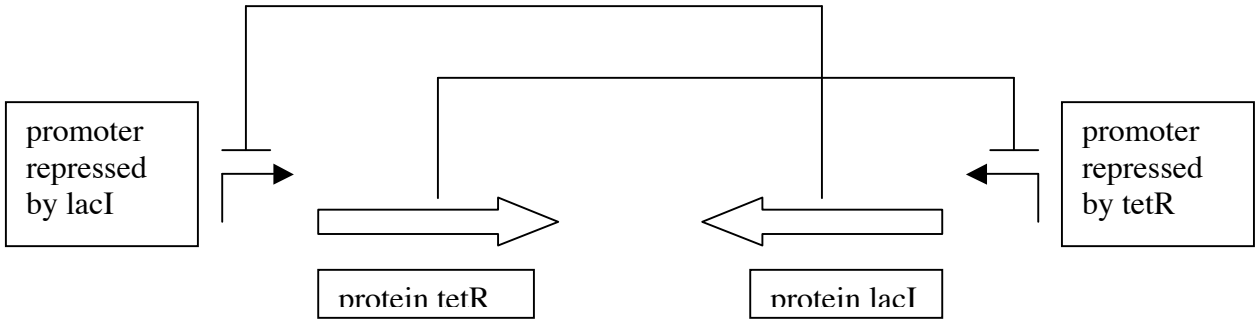
To run this model, open matlab and download and save the files hw4.m and repressilator.m to your matlab directory. These are matlab scripts that implement the model of the Repressilator. Make sure that your Current Directory is set to the place where you saved your two files. In Matlab the command window, type hw4 and then hit return. After a few moments, a graph should pop up showing the oscillatory behavior of the repressilator. To actually view the scripts yourself, go to File->open and navigate to the directory containing hw4.m and repressilator.m. Open these two .m files. hw4.m simply contains some commands that specify the length of simulated time and the initial conditions. It then runs the model and plots the output. The model itself is contained in repressilator.m. It is recommended that you look over this file though you don't necessarily need to understand every detail of what is going on in the model.

a. Try changing the values for the protein half-life. How does the oscillatory behavior of the repressilator change according to increases and decreases in the protein half-life? Speculate as to the reason for what you observe.

b. Try increasing the value for the transcription leakage rate by an order of magnitude. How does the behavior of the oscillator change? What implications does this have for the kinds of repressors you must use in a transcriptional repressor-based oscillator?

c. In the paper, Elowitz and Leibler observe that their constructed repressilator does not always behave as this model predicts. Discuss two possible reasons for this.

d. Say that instead of modeling the repressilator, you wanted to model a toggle switch as diagramed below.



Write out the set of 4 differential equations that describe this system using the Repressilator model as a guide. Use the same variable names as in the matlab file.