

BIOC 455/555

Fall 2016

Homework # 4

Due at the beginning of class on Tuesday, September 20th.

A transcription factor, x , acts as a dimer to repress transcription of another transcription factor, y . The transcription factor y , which acts as a monomer, can bind to two different operator sites on the promoter that regulates x in order to activate transcription of x . Assume that regulation by both of these transcription factors is perfect – *i.e.* y is not produced if x is bound to its promoter and x is produced only if both operator sites in its promoter are bound by y .

1. Write down a set of chemical reactions describing this gene circuit. You may ignore mRNA dynamics. In other words, you can assume that mRNA dynamics are in equilibrium.
2. Use the standard quasi steady-state approximation (QSSA) to derive a set of two ODEs that describe the dynamics of the circuit.
3. Find the total amount, T_x , of all forms of the transcription factor x , including any oligomeric and DNA-bound species.
4. Find the total amount, T_y , of all forms of the transcription factor y , including any oligomeric and DNA-bound species.
5. Using the results from above, write down a new set of 2 ODEs that include the “pre-factor” correction to the QSSA. Make sure you include dilution/degradation of all forms of protein.