

Exam 16.10.2020

BMT-52407 Models of Gene Networks

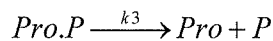
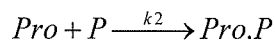
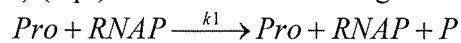
Course Responsible: Andre S. Ribeiro

Calculators and other devices are not allowed. The exam sheet may be kept.

1) (4 pt) Compute the propensity of the following reactions when: $A = 2$, $B = 8$, $C = 10$, $D = 0$.

- a) $\xrightarrow{12} A$
- b) $A \xrightarrow{2} B$
- c) $A + B \xrightarrow{10} D$
- d) $2C \xrightarrow{2} D$

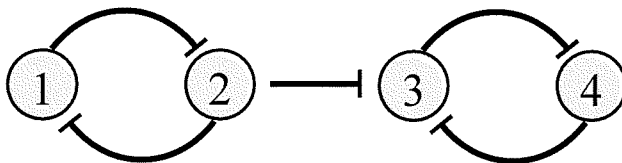
2) (4 pt) Assume the following model of a self-repressing gene:



Add one reaction to the system that forces protein numbers to reach an equilibrium. Next, propose two different methods to make repression stronger, causing these protein numbers at equilibrium to be reduced. Finally, add a pair of reactions to allow the proteins to form and disassociate dimmers.

3) (4 pt) Describe and draw the structure of the Repressilator. Select one of the parameters that can be used to increase the period of oscillation and explain how that occurs.

4) (4 pt) Consider the following Boolean network with 4 nodes. Here, each interaction represented by a black line is a repression (i.e., it's a NOT function) such that if the node state is 0, it will become 1 and if it is 1, it will become a 0. How many stable states does the circuit have? Which ones?



5) (4 pt) Describe how a sequence-dependent long pause in transcription can cause bursty RNA production. Draw an example plot of the number of RNAs over time, assuming RNA degradation.