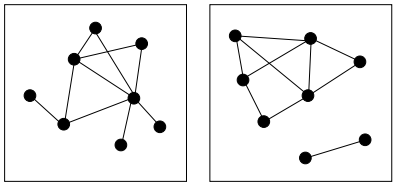
BNF079
Fall 2005

Exam Wednesday, January 18, 2006, 09.00-13.00

24 points in total feasible - roughly half of the 24 points required for pass.

1. The figures show two different networks. Name two observables that differ in the two networks. [2p]

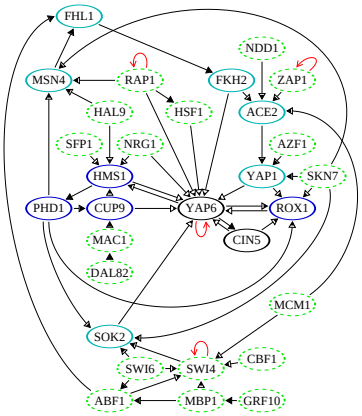


2. Consider the formation of a dimer, where two proteins of the same kind form a complex according to the reactions

$$A + A \underset{k_2}{\overset{k_1}{\rightleftharpoons}} C.$$

Assume a mass action formalism. Write down the differential equations for the time evolution of the concentrations of A and C. [2p]

3. The figure shows a part of the gene regulatory network in *S. Cerevisisae* (yeast). In the shown network, there are many feed forward loops and feed backward loops.



a) Identify one of each kind! [1p]

The partly filled arrow heads illustrate sophisticated details that are not part of this exam question. More common are the following interaction symbols in network pictures.

b) What do these symbols mean? [1p]

c) With these two interaction symbols, and three nodes, draw one coherent feed forward loop and one incoherent feed forward loop! [2p]

Experimental data suggest that these kind of feed forward loops are overrepresented in many regulatory networks. One reason could be that they efficiently solve important tasks.

d) Discuss a possible function of one of the feed forward loops you drew in question (c)! [2p]

4. Describe some of the steps included in a systems biology dynamical modeling project where a rate equation approach is assumed. [4p]

5. Consider the *Drosophila* segment polarity network discussed during the lectures.

a) What is the whole point of the rate equation investigation of the *Drosophila* segment polarity problem? [1p]

b) Describe some key components of this system. How many cells are used in the simulations? [1p]

c) Roughly how many components (proteins, protein complexes) and parameters are used in the investigation? [1p]

d) How is the system initialized and what fraction of the solutions turn out to be good ones? [1p]

e) How does this translate into parameter sensitivity for the variables one by one? [1p]

6. Assume a protein inactivating its own production, and a simple degradation proportional to the protein concentration. The inactivation is governed with the Michaelis-Menten formalism.

a) Write down the differential equation for the time evolution of the protein concentration. [2p]

b) What happens for the protein concentration equal to zero? [1p]

c) Analyse the dynamics. [2p]