

SGN-6186 Mathematical modeling of cellular systems
Exam 21.10.2009
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No calculator. Can be answered either in English or in Finnish.

1. a) Write down the deterministic differential equation model using the law of mass action for the system of chemical reactions



(3 points)

- b) Explain shortly how you would solve a differential equation model using the Euler method. Use the model from a) as an example.

(3 points)

2. a) Discuss shortly the need for stochastic modeling in cellular systems.

(3 points)

- b) Explain shortly the basic idea of Gillespie algorithm.

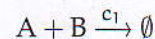
(3 points)

3. a) If a system consists of 20 molecules of A and 30 molecules of B, how many variables (chemical) are in

- Brownian dynamics modeling,
- reaction-diffusion master equation modeling with 15 subvolumes (Gillespie algorithm), and
- chemical master equation modeling (Gillespie algorithm)?

(3 points)

- b) Write down the propensity functions for reactions



Which of the reactions have different formats in the propensity functions compared to the deterministic reaction rates?

(3 points)

4. Draw and explain the equivalent circuit representation of a cell membrane.

(6 points)

5. Discuss reaction and reaction-diffusion methods to model intracellular pathways. Discuss also the decision between exact and approximative stochastic methods and deterministic methods.

(6 points)