
B5.1: Examinable content

All material which was lectured (either in this course or one of its formal pre-requisite courses), or which appeared in any exercise sheet, is examinable.

If any material, including exercises and examples, appears in the additional lecture notes, you should assume it is examinable. You should assume that you may be asked to apply any techniques or tools we used to problems you have not seen before.

The following is a rough list of topics covered.

1. Elementary theory of chemical reaction systems, including reaction intensities (propensities); and deterministic and stochastic mass action kinetics.
2. Waiting times and transition probabilities for reaction systems.
3. Stochastic simulation algorithms, in particular, the Gillespie algorithm.
4. The Kolmogorov forward and backward equations, and the chemical master equation.
5. Solutions to the chemical master equation (“evolving distributions”) and the stationary chemical master equation (“stationary distributions”).
6. Differential equations for the evolution of moments and probability generating functions.
7. Switching in models with multiple steady states.
8. Stochastic differential equations (SDEs), including the “computational version”.
9. The forward (Fokker-Planck) and backward equations corresponding to SDEs.
10. The chemical Fokker-Planck equation.
11. Diffusion modelled by SDEs, and compartment-based models of diffusion. Diffusion to adsorbing surfaces.
12. Reaction-diffusion models. Derivation of basic formulas for the reaction radius.
13. Diffusion-advection, including basic models of chemotaxis.
14. First passage times.

This list of topics corresponds roughly to the following sections in the course text: 1.1–1.5, 2.1, 3.1–3.8, 4.1, 4.2, 4.4, 4.6 (techniques, but not all the detail), 6.1–6.3, 6.5, 6.6 (but not the part “SSA for larger time steps”), 7.1, 7.2, and the appendices.

There are other sections in the course text which you may find useful to read, although we did not cover much of the material in these sections. For example, Sections 2.2–2.4 are useful for helping you set up deterministic and stochastic versions of the same chemical system. We covered some techniques from Section 8.1, but not the particular model developed there.

Chapters 5 and 9 are *not* examinable, and the majority of Chapter 8 will not be examined (but see above). We discussed chemotaxis, but not the model in Section 7.3, so this is not examinable. The content in Sections 7.4–7.6 is also *not* examinable.