

Modelling and simulation

Lecture: Michel Kana

Practice: Daniela Müllerová

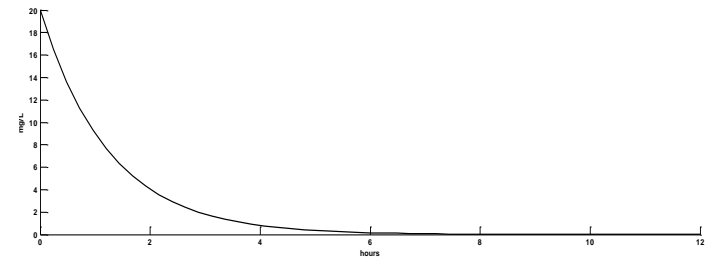
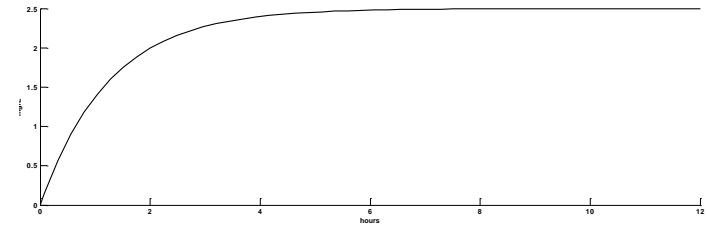
Pharmacokinetics models

- Compartmental approach
- DE: $C'(t) = -kC(t)$
- Solving: $C(t) = C_0 e^{-kt}$

Pharmacokinetics models

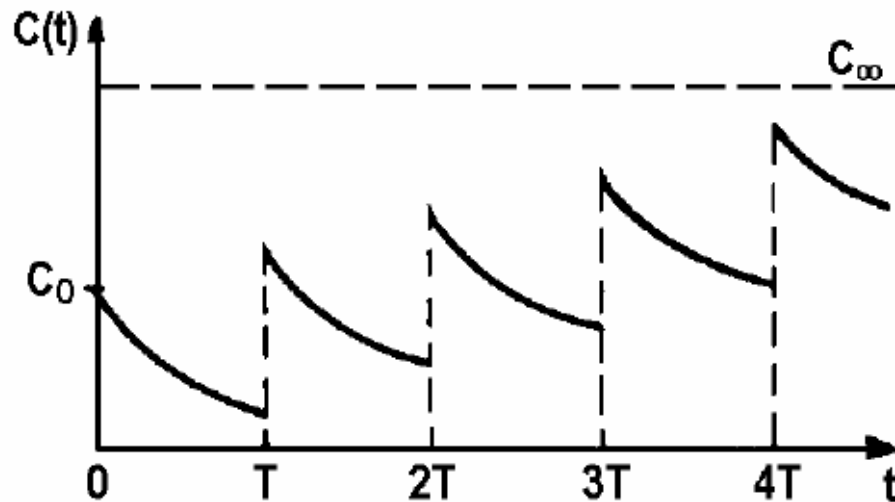
■ Types of dosing

- ☐ intravenous drug intake
- ☐ single oral intake of the drug
- ☐ repeated dosing of drugs



Pharmacokinetics models

- Repeated administration of drugs
- Immediately after administration of n-dose



$$C_{n-1} = C_0 \left(\frac{1 - e^{-nkT}}{1 - e^{-kT}} \right)$$

- The size of the resulting concentration doesn't depend on the first dose when there is a large number of doses

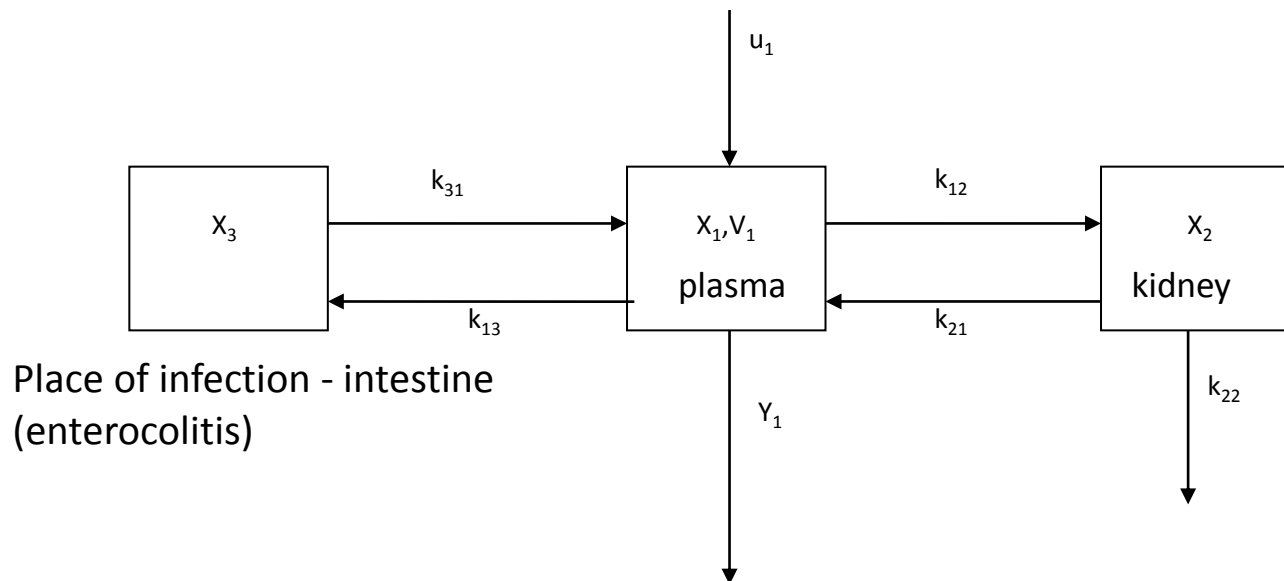
Practice 1 - assignment

- Drug vancomycin was intravenously administered to the patient.
- The first dose was administered at 400 mg.
- Subsequent doses were administered at intervals of 7 hours, always 400 mg.
- Determine the concentration of the substance 35 hours after the first dose using calculation and simulation.
- $V = 5 \text{ l}$
- $k_e = 0.4 \text{ hod}^{-1}$

Practice 2 - assignment

■ ***Pharmacokinetics model of Vancomycin***

- Vancomycin is a glykopeptidic antibiotics is used, for example, against staphylococci and enterococci in serious or resistant infections



Practice 2 - assignment

- Compose differential equations of the model
- Define matrix A, B, C, D
- Compose model in Simulink
- parameters of model
- $K_{12} = 0.6 \text{ 1/h}$, $K_{13} = 0.3 \text{ 1/h}$, $K_{21} = 0.2 \text{ 1/h}$, $K_{22} = 0.8 \text{ 1/h}$,
 $K_{31} = 0.7 \text{ 1/h}$
- Choose different kinds of drug dosing
 1. Single infusion of 200 mg vancomycin.
 2. Periodic dosage of 200 mg of vancomycin at intervals of 2 hours.
 3. Periodic dosage of 200 mg of vancomycin at intervals of 2 hours with an initial bolus of 400 mg.

Practice 1 – desired output

- Model file *.mdl with correctly described blocks
- Short paper in *.pdf containing
 - Block diagram of the model
 - Definition equation model
 - Table of all the parameters of the original model with columns: symbol, importance, value, unit
 - Table of all state variables of the model with columns: symbol, meaning the initial value, unit
 - Graphical output of the simulation results and calculate the concentration of the drug after 35 hours

Practice 2 – desired output

- Model file *.mdl with correctly described blocks
- Short paper in *.pdf containing
 - Block diagram of the model
 - Definition equation model
 - Matrices A, B, C, D
 - Table of all the parameters of the original model with columns: symbol, importance, value, unit
 - Table of all state variables of the model with columns: symbol, meaning the initial value, unit
 - Graphical output of the simulation with different types of dosing.